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The Relationship of IT to IS: An Inquiry into the Technoscientific Nature of the IS Field

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ABSTRACT

This paper explores the philosophical questions surrounding the lack of clarity on information technology (IT) by the information systems (IS) field. It argues based on the historical origins of both terms for the IS field to position IT as the raison d'être for the IS field. Based on the technological foundations of the field, the IS field has a bright future, not as a pure or applied science, but as a technoscience, a method of inquiry that avoids the extremes of both rationalism and empiricism. As a technoscience, IS can be positioned like other "modern" natural and human sciences such as physics and psychology, but uniquely premised on technologies that carry structures of meaning for its interpreters.

Keywords

Philosophy of IS and IT, disciplinary foundations, IT artifact, information theory, technoscience.

INTRODUCTION

For a field that claims "information technology" (IT) as one of its core subject matter, it is curious that there is no clear definition for IT in the information systems (IS) field. The ambiguities surrounding the term "IT" impairs research efforts in the IS field. Although several IS scholars have voiced concerns about this issue (Orlikowski & Iacono, 2001), very little progress have been made (Weber, 2003). This lack of focus by the field on IT is inconsistent with IT's ubiquity and emerging role in society. Weber (2003) believes that a classification and explication of IT reinforces the IS field's efforts towards maturity. Not only does this lack of focus on IT hamper serious IS research, the increasing number of meaningless IT-related jargon and techno-babble invented in practice only serve to dilute the IS field. For instance, the legal profession is beginning to raise alarms on the proliferation of IT-related jargon—terms devoid of theory—that will only complicate the increasing number of legal proceedings involving IT (González, 2004).

This lack of focus on IT can be traced back to the practice of the field's "referent disciplines" (e.g., psychology, economics, sociology and organization science) that essentially treat IT as a "black box" (Orlikowski & Iacono, 2001). These disciplines treat IT as a lesser concern in comparison to the psychological, economical, sociological, or organizational issues related to it. This approach may concur well with their subject matter, but is not useful for the IS field. Weber (2003) stresses that information systems and information technology are *not* the same. He believes that progress in the IS field lies in IS-related phenomena and not IT-related phenomena. But he also believes that better IT theory offers much to the IS field. **This paper argues that the key to better understanding IS-related phenomena lies in a clear definition for IT.** What is IT? Clearly, computers are a kind of IT, but, are all computers IT? Are the computers auto-piloting an aircraft, maintaining the climate of a building, and helping to stabilize an automobile, IT artifacts (Alter, 2003)? If these systems are not IT, should they be excluded from IS research?

THE CONFUSION SURROUNDING INFORMATION SYSTEMS AND INFORMATION TECHNOLOGY

This confusion surrounding IT and IS operates at several levels. First, the field of IS is often confused with the product of IS (Keen, 1987). At this level, the confusion complicates efforts in understanding the "IS field" separate from one of its many object of study, the "IS product." Second, at the subject matter level, IS is often equated with IT. For example, out of the hundreds of universities that offer an IS or IT program, most of them are labeled with "IS" while a number of them use "IT." At the same time, many name their programs using both "IS" and "technology" presumably to insure inclusion of both subject matters. If IS is different from IT as Weber believes, is it possible that the institutions labeling their programs using just "IT" teaching something significantly different from the programs labeled with "IS"? This is very unlikely. At least for communicating the goals and content of academic programs (i.e. its subject matter), IS appears to be synonymous with IT.

Third, at the level of research, publications dated before 1995 preferred to use "IS" in their titles. After 1995, research articles preferred the use of "IT." An analysis of the most cited publications and journal articles in IS were compiled from two sources to examine which term was used most often. The first source is a list of 91 "classic" IS publications from 1986-1995 (Walstrom & Leonard, 2000). These publications are "classics" because they have been continuously cited on average at least four times a year (Price, 1963) since their publication. The second source is a list of "newer classics" or highly-cited IS articles collected from the five top-ranked journals in IS: MIS Quarterly, Management Science, Information Systems Research, Journal of Management Information Systems, and the Communications of the ACM (Rainer & Miller, 2005). Articles from these journals that were cited on average at least four times a year since their publication in the Social Science Citation Index between the years 1993-2005 were analyzed for the terms "technology" or "information technology" and "system" or "information systems" in their titles. References to specific systems such as "decision support systems" were ignored.

The results of this analysis show that from the "older" classics between the years 1986-1995, only eight out of 91 publications use "information technology" or "technology" in their titles. For the list of 48 "newer classics" published between the years 1993-2005 that has either "information system" or "information technology" in their titles, less than half (18) use "information systems." If "information systems" phenomena are different from "information technology" phenomena, it appears IS researchers either prefer to study the "technology" instead of the "system" after 1995 or IS researchers are finding the term "information technology" to be more in vogue. Out of the list of 18 articles that use the term "information systems" in their titles, half of them are published in 1993-1995, and the rest after 1995. For the remaining list of 30 articles using the term "information technology," only nine of them are published in 1993-1995, the majority of them are published after 1995. It is not surprising, that people outside (and inside) the field, are confused with the relationship between "information systems" and "information technology."

WHY IS IT IMPORTANT TO CLEARLY DEFINE "INFORMATION SYSTEM" AND "INFORMATION TECHNOLOGY"

If the IS field wishes to be recognized as a legitimate discipline, these foundational concepts need to be made clear. Classifications and definitions are the foundations of any science. A field of knowledge is respected as a legitimate discipline because its content, including its definitions, is known to be rigorous and legitimate (Shumway & Messer-Davidow, 1991). Regardless of the field of knowledge, whether it is within the natural, social or the administrative and management sciences, the status of that field's knowledge is measured by the rigor of its conceptual foundations. The internal sociological practice among members of a discipline in creating knowledge benefits from the coherency of the disciplinary practice. For a certain proposition to belong to a discipline, it fulfills certain conditions set by that discipline, it refers to a specific range of objects of study, use certain instruments and techniques, and fits into certain theoretical models (Foucault, 1972).

Disciplinary practice provides the guidelines within which discourse and knowledge can grow and still remain coherent and relevant to its name. Within this structure legitimate disciplines recognize true or false propositions, old or novel approaches, and mainstream or peripheral categories. Researchers within a discipline have clear directions as to what will contribute to the maturity of their discipline, pitfalls to avoid, and novel sub-areas to study. As the result of disciplinary work, members of the discipline can recognize what does and does not qualify as disciplinary knowledge (Hassan & Will, 2006). This self-validating disciplinary practice contributes to its cogency and legitimacy. Therefore, basic foundational concepts and terms such as "IS" and "IT" need to be clear within the field and to others outside the field.

That is why "information systems" (IS) should not be confused with "information science" (also IS, but more commonly referred to as Library Information Sciences or LIS). The field of information science is very different from information systems because the goals of the former is to collect, organize and improve the techniques of communicating information (the signifying system) instead of enhancing and improving the human condition as it relates to IT (Bottle, 1997). In other words, information systems and information science are conjunctive (share some of the same objects such as IT), but are disjunctive (do not share the same disciplinary concerns) (Ellis, Allen, & Wilson, 1999).

DISCIPLINARY FOUNDATIONS—WHERE DID THE TERMS "INFORMATION TECHNOLOGY" AND "MANAGEMENT INFORMATION SYSTEMS" COME FROM?

The term "information technology" (IT) was coined by Leavitt and Whisler (1958) to describe a new "intellectual" technology that they predicted would transform the practice of management. One of the earliest instances "management information systems" (MIS) was used was when a graduate-level course by that name was offered three years earlier in 1955 at the Massachusetts Institute of Technology (MIT). Both terms came into circulation in academia and in industry practice soon after that time period. Leavitt and Whisler's discourse on IT defined a new kind of technology called "information technology" that was different from the "industrial technology" of the industrial revolution or the "participative technology" of the participative management era. This new technology, they surmised, is composed of three parts: (1) a computer which implements, (2) the techniques and methods for decision making and, (3) a component yet to be perfected at the time, simulation of higher order thinking. According to this discourse, the computer is one of the components of IT. What transforms a computer into IT is the computer's ability to manipulate information beyond merely processing and manipulating data. This ability enables IT to automate certain programmable tasks, allowing top managers to gain better control over the organization.

Three years earlier, MIT's School of Industrial Management offered a course titled "Management Information Systems" as part of their graduate program (Gregory, 1956). An announcement in MIT's campus newspaper (The Tech, 1955) in December 1955 describes a seminar related this new MIS course:

> A special seminar, sponsored by the School of Industrial Management, will be held at the Institute from December 12 through 16. The subject for discussion will be the influence of electronic data processing on management, and the corollary influence of management upon this new executive tool. The program will be supervised by Dr. Robert H. Gregory, assistant professor of accounting. Its objectives, he says, will be "to appraise the characteristics and techniques of electronic data processing systems relevant to business management and to study recent developments in both local and long-distance data processing that are of special importance to management." The seminar should have appeal to men in several areas of management: controllers, accountants, systems specialists, and auditors. It will assume familiarity with management but little knowledge of computers, according to Professor Gregory. The program will cover the following subjects: analysis and revision of systems including statement of objectives, system description, economic appraisal, and revision of system to achieve new objectives; electronic data processing equipment and components; programming and coding (both manual and automatic) for solution of business problems; administration and cost of operation of an electronic data processing system; case studies in the use of data processing equipment reporting the experience of several firms in different industries; related developments that will make use of data processing equipment including operations research, linear programming, and inventory management; and important technical developments and their effect upon business information processing and business management.

The new MIS course itself, offered in the spring of 1955, was designed to be an accounting systems course dealing with industrial management. The content of the course was divided into (1) equipment design and construction, (2) system investigation and equipment application, and (3) system analysis, appraisal and revision. Today's IS programs have changed little since it was offered over 50 years ago. The term "MIS" therefore started not as a product, but as the name for a course before the term "IT" was coined.

However, it was not long before IS began to be called a product. In May 1958 during the 13th Annual Meeting of the Operations Research Society in Boston, Massachusetts, Stoller and Van Horn (1958) presented the "management information system" as the new enabling technology for businesses. This new technology was to be designed based on the operations and control of military weapon systems. They hypothesized that the requirements for military technology was similar to the needs of non-military business organizations, and the decision-making capability of this technology distinguished it from "data processing" technology.

WHAT IS INFORMATION TECHNOLOGY?

Disciplinary practice recommends a clear explanation of these two terms, IS and IT. "What is information technology and what is its relation with information system?" Taking the lead from Leavitt and Whisler and how "information" in "information technology" acts as a qualifier to "technology," IT is best positioned as a product, the result of human activity and labor and not as the field. This follows from the definitions of the term "technology." Ihde (1993) defines technology as something (1) invented, used, designed, or modified by man, (2) that has a concrete component or a material element, and (3) that must be implemented in practice (praxical). This definition summarizes the distinction the Greeks made between physis and poiêsis (Introna, 2002). Physis is what occurs in nature and is understood by the Greeks as that which creates itself. Poiêsis is the practical activity done in which human beings engage when they produce something. The result of this activity is often called an artifact and includes the products of art, craft, and social convention. Automobiles and computers are therefore technologies. But so is writing because it is also invented, it uses artifacts (pen and letters which are both material components) for the purpose of writing, and it is practically implemented, not an academic exercise.

The next step is to explain how the qualifier "information" in IT describes a specific kind of technology. The most commonly understood theory of "information" is the *mathematical* information theory of Shannon and Weaver (1949). This theory describes the transmission and communication of information, but not the kind of information that is of interest to IS. As Weaver (Shannon & Weaver, 1949, p. 8) states:

> The word information, in this theory, is used in a special sense that must not be confused with its ordinary usage. In particular information must not be confused with meaning.

If any theory of information is to inform the IS field, it needs to be one that assumes information contains meaning and therefore causes activity in a receiving system simply by virtue of its form. The most useful definition of information for the IS field is the one suggested by Dretske (Mingers, 1996). Dretske defines information as the "propositional content of a signal" (p. 202). This means the signal that is carrying the information necessarily implies a semiotic relationship between the signal and its interpreter. Every sign (signifier) carries meaning concerning something else (signified). This semiotic nature of information has the following implications (Mingers, 1996): (1) the information carried by the signal can be objectified and exists independently from its interpreter (e.g. the images and sounds from a television set is transmitted even if nobody is watching and can be stored and recorded), (2) information must be *true* to its origin to be information because a signal that deceives is inherently misinforming and is not therefore information, (3) the information carried by a signal is distinct from its meaning because information, being a propositional content of the signal, can be infinite whereas the meaning of the signal may be finite (e.g., the signal "the glass of water is on the table" carries a finite meaning, but the information that the water is hydrogen and oxygen and boils at 100 degrees Celsius is information "nested" in the signal), and (4) a signal may carry information but may not be meaningful (e.g., when the signs are in a foreign language) or a sign may be meaningful, but carry no information because the information was faulty.

Therefore, when a person has downloaded a web page and is interacting with the various texts, links, images, audio and video, all that information is objective and can be saved as a file. Each sign on the web page points to other things, some of it meaningful, others, not so. Not all the signs on the web page generate information, depending on its truth value and propositional content. Nevertheless, the structure of meaning that is created between the person and the web page describes a rich semiotic relationship. Not all technological artifacts qualify as IT just because a semiotic relationship exists. Both a calculator and a television generate information and structures of meaning, but are not considered IT. To qualify as IT, an additional condition needs to be specified on the artifact. The artifact needs to be "computer-based." A computer is defined by the ACM as a general-purpose programmable electronic device that use stored instructions to manipulate symbols (Fritz, 1963). Artifacts that do not include the computer as a component is not considered IT. So a calculator is not IT because it is not general-purpose and is not typically programmable. Gaming technology on the other hand is computer-based, capable of a variety of programs and clearly creates a structure of meaning for the interpreter. **IT can therefore be defined as a computer-based artifact that generates a structure of meaning for its interpreter.**

If IT can be so defined, can IT become a field of study of its own? Is there enough discourse to justify setting up a unique discipline called IT? The answer to this question depends on whether there are sufficient rules that can distinguish "the field of IT" from other related fields such as computer science and IS (Hassan & Will, 2006). The first reason why IT should not be the name of the field is because it is by definition *a technology*, and technologies are not necessarily limited to any particular field, nor will they remain constant within that field. For example, the whole idea of media convergence imply that IT or information and communication technologies (ICT) can take any form as long as they fall within the same definition of a computer-based artifact. Based on the confusion surrounding these terms, it is probably safe to treat IT not as a field but as a core concern of other fields of study such as IS, computer science or information science. The idea behind clearly defining IT is to allow these fields to continue their discourses on IT based on its clear theoretical foundations rather than on speculation taking place in industry.

INFORMATION SYSTEMS AS TECHNOSCIENCE

The inclusion of meaning into the discourse surrounding IT agrees with the IS field's history of research but places the field in a predicament. If any science is to inform on IT, it cannot be totally a natural science or totally a social science. The subject matter surrounding IT involves physical artifacts that obey natural science laws. But at the same time, the focus of that study is on human and social aspects, which obey social laws. How should IT be studied?

A new philosophy of studying the subject matter of science and technology was proposed in the early 20th century, primarily as a result of the prevalence of technology in scientific research. In 1934, Bachelard (1984, p. 13) described this kind of inquiry as "phenomeno-technology," a combination of rationalism and realism. This view of scientific inquiry inverts the relationship between science and technology. It rejects the traditional view that science is the basis of technology. It draws from Heidegger's phenomenology and Dewey's "knowing as a technological artifact" view that, technology is not only paramount over science, it is a prerequisite for the progress of science. To explain this concept, Latour (1987, p. 174) coined the term "technoscience" to describe the kind of science that depends on its technological instruments. Foucault (1970) also supports this view and assigns not only power to technology but also attributes the evolution and progress of knowledge to technology. According to this view, technology is the origin and cause of science (Ihde, 1979). This is a view of science that is most useful to IS, one that avoids classifying IS as either a natural science or social science, but at the same time, creates a foundation for a scientific inquiry into IT.

Francis Bacon was probably the first to envision what was to become technoscience, by transforming the contemplative ideal of Classical science into the instrumental and interventionist science of the Modern period—an experimental science, a science which necessarily entailed technologies. He was the first to note that experimental science is necessarily a technological or instrument-mediated science. Many other established disciplines developed as a result of the intermingling of science and technology. Biology, which developed in the early 19th century was not based on the classificatory methods of its predecessor, natural history. The invention of the microscope made possible the new field of biology (Foucault, 1970) because it enabled scholars to go beyond natural history and observe what could not be seen with the naked eye. Consequently biological scholars could relate cells and organs to their functions, not by observing their forms and shapes, but by studying their microscopic functions and activities independent of their physical form.

It was this creation and transformation of science as a result of technology and experimentation that Gaston Bachelard (1984) described in 1934 as the "modern spirit of science." He proposed a new epistemology that did not depend solely on rationalism or empiricism, but is located between them. This philosophy of science avoids the reductionism that characterizes rationalist Cartesian thought but also was able to take advantage of the subjective intuition of scholars. According to this epistemology, scientific discoveries are not solely the product of rational thought, but are preceded by extended study, often involving empirical tasks rooted in instrumentation. Science, according to this epistemology, must cross both the theoretical and the experimental: "Experimentation must give way to argument, and argument must have recourse to experimentation" (Bachelard, 1984, p. 3-4).

Technoscience offers a new perspective to the traditional view that theory is the basis of science or that technology is applied science. Webster's dictionary defines technology as "the application of scientific knowledge to practical purposes in a particular field," giving the impression that there is a clear distinction between "pure science" and "applied science." This notion of pure versus applied science is being challenged. The synthetic-dye industry in the 19th century that became the precursor to modern chemistry originated from the intermingling of science and technological crafts of the 18th century (U. Klein, 2000). Quantitative bibliometric analysis of scientific sources used in patents show that there is no direct linkage between the scientific sources cited and the patent published. In other words, science does not necessarily push technology (Meyer, 2000), but is instead inextricably linked with it (Narin & Noma, 1985). Even earlier discoveries are not necessarily the result of theory or pure science. The windmills that made possible changes in agriculture came from India and Iran, not from any theoretical contemplation. The arches that took higher support functions in buildings and became the standard for architecture came from Middle East architecture. Leonardo da Vinci's incredible (and essentially unscientific) designs of machines for warfare, flying and submarine purposes were not based on any pure science research. In many instances, technology preceded science. Galileo's invention of the telescope made possible many scientific observations. He used a technologically embodied science in his instruments and experimental devices for experiments. The Law of Thermodynamics was worked out not from bare scientific speculation, but from puzzles arising out of machinery—technology. Today it is impossible to think of science without its technologies. This spirit of technoscience can be the basis for the growth of the future IS field. IS can be viewed as a field that makes scientific discoveries based on its technology, in much the same way that the instruments of physics helped make molecular biology possible (J. T. Klein, 1990).

CONCLUDING REMARKS

As a Technoscience Information Systems is Not an Applied Field

The first major implication of the technoscience view of IS contradicts the conventional view of IS as an applied field. The problem with viewing IS as an applied field suggests that IS is dependent on theory and "science" of other fields. By implication, its progress is primarily guided not by the genius or efforts of its own scholars, but the work of scholars of its "referent disciplines." The "applied" nature of IS also suggests that IS has little to offer other fields. For a field premised on technology such as IS, the division of inquiry into basic and applied research is neither useful nor productive to the field's continuing efforts towards maturity. At its worst, it will impede the progress of the IS field. As Thomas Huxley (Huxley, 1881, Vol. 3, p. 155) wrote in 1880:

> I often wish this phrase, "applied science," had never been invented. For it suggests that there is a sort of scientific knowledge of direct practice use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed "pure science."

The future of IS should not be found in its role as a pure or applied science, but rather, as a technoscience. Thus it is able to take advantage of what one of its many core objects of study—technology—has to offer.

IS can be Freed from the Baggage of its Referent Disciplines

Viewing IS as a technoscience frees it from the baggage of its "referent disciplines." Since its formalization in the late 1960s, the research program of IS has been dominated by management and organization science (Orlikowski & Barley, 2001). Consequently, technology has not been the focus of IS research (Orlikowski & Iacono, 2001; Weber, 2003). The result of this dependence on organizational research has been a tendency for IS researchers to look for theory in organizational science rather than develop their own. Viewing IS as a technoscience implies that IS researchers should worry less about finding and testing theories from its reference disciplines and should focus more on developing theories with IT as a core concern.

Positioning Information Systems as the Field and Information Technology as a Core Concern

To be consistent with these "founders" of the field who used the term MIS to describe the field, the IS field should use the term "information systems" to refer *only* to the field and not to the product. This is consistent with the European use of the term "informatics" to describe the field, not the product. IT should not refer to the field, but should refer to the product, the technology that is being studied by the IS field. Viewing these two terms in this manner not only is consistent with current research practices in IS, but places appropriate focus on them. **The information systems field therefore is free to study any object, concept or theory that falls within its subject matter, not only IT**.

Carving a Clear Domain for the IS field

Finally, the proposed explication of IT and IS in this paper carves a clear domain for the field of IS, distinct from the field of computer science, management, psychology or engineering. It is consistent with the definition of the field as one concerned with **the semiotic interrelationships between computer-based signifying systems and the organization and management of human decision making, operations, design, support, and control** (Hassan & Will, 2006). In other words, the rules that govern the IS field surround the relations that carry meaning between humans and computer technology. The domain of the IS field encompasses any activity involving both the social and technological aspects that carry a structure of meaning.

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