1. The struggle towards an understanding of theory in information systems

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Abstract

Information systems (IS) is a relatively new discipline with many researchers having their foundation studies in other disciplines. The IS discipline is moving towards some sense of its own identity and some agreement on what constitutes suitable foci of research. Coming from other fields of study, however, our researchers bring perspectives on particular modes of enquiry and methodological paradigms as well as perspectives on what is meant by 'theory'. The argument of this paper is that IS needs to critically examine the types of theorising relevant to its own discipline and recognise the unique nature of the theory that is needed. Perspectives found useful come from the philosophy of science (excluding positivism), interpretivism and Herbert Simon's depiction of the sciences of the artificial. It is shown how these perspectives can be melded, leading to a typology of interrelated theories that is unique to information systems.

Introduction

This paper is, logically, a precursor to an earlier paper that sets out the different interrelated types of theory that can be employed in information systems research, namely: (i) descriptive theory, (ii) theory for understanding, (iii) theory for predicting, (iv) theory for explanation and prediction, and (v) theory for design and action (Gregor, 2002). What that paper failed to do was show clearly why the distinctive nature of the information systems discipline requires a perspective on theorising all of its own. The aim of this current paper is to show clearly how ideas can be combined from some views of theory in supporting disciplinary areas to give a typology of theories that is appropriate for information systems research.

The information systems discipline is relatively new. Many researchers studied originally in disparate areas ranging from physics and chemistry to mathematics, psychology and sociology. It is perhaps natural that researchers will bring with them from these areas different views on the nature of theory, knowledge and epistemology. It is unfortunate, however, if we do not stop to think whether and how ideas from different disciplines apply in the information systems field. The argument in this paper is that information systems, being a field that requires knowledge pertaining to the world of physical systems, the world of human behaviour, and the world of designed artefacts, requires theorising that relates to all these types of knowledge and allows them to be addressed in an integrated manner. While ideas on the nature of theory can be taken from other disciplinary areas, this borrowing should not be done uncritically, but with an eye on the unique nature of information systems.

Information systems can be defined as:

> the effective design, delivery, use and impact of information technology in organisations and society (Avison and Fitzgerald, 1995, p. xi).

Information systems is not another management field, like organisational behaviour (contrary to the view of Webster and Watson, 2002), neither is it about technology alone, like computer science. A characteristic that distinguishes information systems from these fields is that it concerns the use of artefacts in human-machine systems. Lee (2001, p iii) uses these words:

> research in the information systems field examines more than just the technological system, or just the social system, or even the two side by side; in addition, it investigates the phenomena that emerge when the two interact.

Thus, we have a discipline that is at the intersection of knowledge of the properties of physical objects (machines) and knowledge of human behaviour. Information systems can be seen to have commonalities with other design disciplines such as architecture or engineering, which also concern both people and artefacts, or with other applied disciplines such as medicine, where the products of scientific knowledge (drugs, treatments) are used with people. Necessary knowledge for information systems encompasses the knowledge types found in the natural sciences (e.g. the properties of a communications medium), the social sciences (e.g. change management), mathematics (e.g. representational languages) and technology (e.g. design of an artefact).

Dictionary definitions show that the word 'theory' can take on many meanings, including: 'the general or abstract principles of a body of fact, a science, or an art', 'a belief, policy, or procedure proposed or followed as the basis of action', 'a plausible or scientifically acceptable general principle or body of principles offered to explain phenomena', 'a hypothesis assumed for the sake of argument or investigation' (Merriam-Webster, 2004).

In the remainder of the paper a number of different views of theory are given, choosing perspectives that are relevant to different facets of information systems work. Thus, perspectives are taken from the philosophy of science, encompassing both the natural and social sciences, and from theory of technology. Interpretivism and positivism are dealt with separately as they are so often referred to in information systems research, though usually in discussions of research methods rather than in terms of formulating theory. Positivism is presented first, basically to clarify some areas that are often confused and to argue that it is not a defensible position.

The aim in presenting these different views is to show how they can all (except positivism) be drawn upon to propose a 'theory of theories' in information systems that addresses the field's unique nature.

The lingering death of positivism

Positivism is a term used frequently in discussions of research in information systems, but rarely is it treated in depth or in terms of its historical development. Many philosophers of science regard positivism as defunct: 'Logical positivism, then, is dead, or as dead as a philosophical movement ever becomes' (Passmore, 1967). Why then is the term still used so uncritically in information systems? Positivism is discussed here in some detail to show the shortcomings detected by philosophers of science and to pave the way for less narrow views on theory from the philosophy of science.

Some sense of the historical development of positivist schools of thought is beneficial (see Godfrey-Smith, 2003; Magee, 1997). Comte (1864) is generally credited with the coining of the term 'positivism', using the word to contrast actual with imaginary, certainty with the undecided, the exact in contrast to the indefinite. Logical positivism as an extreme form of empiricism was developed in Europe after the First World War by what became known as the Vienna Circle, established by Moritz Schlick and Otto Neurath. It was formed in opposition to systems of philosophical thought that the logical positivists found pretentious, obscure, dogmatic and politically unattractive (such as Hegelian idealism). Logical positivism was a plea for Enlightenment values, in opposition to mysticism, romanticism and nationalism (Godfrey-Smith, 2003). A. J. Ayer, G. E. Moore and Bertrand Russell were responsible for the transposition of the ideas of logical positivism to England where they had a profound effect, with much of English philosophy retaining a strong empiricist emphasis ever since.

Many of the Vienna Circle were Jewish and had socialist leanings. They were persecuted to varying degrees by the Nazis, who made use of pro-German, anti-liberal philosophers, and who also tended to be obscure as well as anti-liberal. In contrast to the logical positivists, Martin Heidegger joined the Nazi party and remained a member throughout the Second World War. Some logical positivists – Carnap, Reichenbach, Hempel and Feigl – escaped to the United States where they were influential in philosophical development after the war. There was some softening and re-specification of the tenets of logical positivism and the later more moderate views are more usually called 'logical empiricism' (Godfrey-Smith, 2003).

At the base of logical positivism is the famous Verification Principle. This says that only assertions that are in principle verifiable by observation or experience can convey factual information and be meaningful. Assertions that have no imaginable method of verification must either be analytic (tautological) or meaningless (Magee, 1997). Thus, the two central ideas of logical positivism relate to language: the analytic-synthetic distinction and the verifiability theory of meaning. The first idea relates to the distinction between analytic statements, which are true in themselves (basically a tautology), and synthetic statements, which are true or false in relation to how the world is. The second idea is that experience is the only source of meaning and the only source of knowledge. Thus, if a sentence (in a theory, say) has no possible means of verification, it has no meaning. Scientific statements were to consist of verifiable, and hence meaningful, claims.

Karl Popper in his autobiography (Popper, 1986) takes the credit for 'killing' logical positivism as early as 1934 by pointing out some of its mistakes in *Logic der Forschung* (Popper, 1934), not published until 1959 in English as The *Logic of Scientific Discovery* (Popper, 1980). Popper was opposed to the concentration upon minutiae and especially upon the meaning of words by the logical positivists, and the avoidance of metaphysical problems. A difficulty with the Verification Principle is that it is neither analytic nor empirically verifiable itself and therefore, according to its own criterion, is meaningless. The Verification Principle has the effect of outlawing more or less the whole of metaphysical speculation in philosophy – everything apart from logic. Popper also showed that the Verification Principle eliminated almost the whole of science. An aim of science is the search for natural laws, which are unrestrictedly general statements about the world that are known to be invariantly true: for example, Boyle's Law, the law of gravity, or $E=mc^2$. Popper showed that these laws are not empirically verifiable, acknowledging that the English empiricist David Hume had made this observation two-and-a-half centuries before. The problem is that of induction: from no finite number of observations, however large, can any unrestrictedly general conclusion be drawn that would be defensible in logic. For example, we cannot prove 'all swans are black' no matter how many swans we observe.

The point of this discussion of positivism is that positivism is just one philosophical perspective on science, and a form that has largely been debunked. Focussing on positivism as being representative of views about theoretical formulation and epistemology in science obscures the rich value that can be found in many other writings in the philosophy of science, as discussed in the following section. The information systems literature provides many instances where 'positivism' is a label given to various, often conflicting, impressions of what scientific thought means. This habit is so widespread that no opprobrium should attach to the identification of particular instances. Positivism is characterised as being associated with naïve realism, a 'value-free' view of scientific enquiry, hypothetico-deductive methods, unilateral causal relationships or laws, statistical analysis and so on (see Orlowski and Baroudi, 1991). This depiction obviously does not match the original tenets of logical positivism, and neither is it compatible with the writings of prominent philosophers of science (see Nagel, 1979). Discussion of positivism is lingering on in information systems and our researchers are seemingly unaware that it is moribund. Orlowski and Baroudi (1991), for example, footnote the possibility that positivist dogma may be losing its currency among mainstream natural scientists, seemingly unaware of its recognised killing-off many years previously in what can only be regarded as very mainstream philosophy of science (Popper, 1936; Passmore, 1967).

The author believes that 'positivism' should no longer be even mentioned as a defensible position in discussions of theory or epistemology in information systems. If what is meant is a scientific perspective, then it is better to say so; to go directly to writings in the philosophy of science and to examine issues separately and carefully. The conclusion from this summary of positivism is that it is not a fruitful source of ideas on theorising in information systems.

A 'scientific' perspective

Unfortunately, if we turn to the philosophy of science for views on theory we still find disagreement on many important issues. Godfrey-Smith (2003) notes that there has been a state of fermentation in recent years concerning many problems: causality, the distinction between experimental laws and theories, induction, and the cognitive status of theories, to name just a few. Some of the views of prominent philosophers that appear especially relevant to at least some types of information systems theory are discussed here. Note, however, that the term 'post-positivist' is not appropriate for describing these views since some are pre-positivist (Hume, Locke, Kant) and some are anti-positivist (Popper).

Sir Karl Popper is a philosopher of science whose views appeal to many working scientists and who is regarded as a hero by many (Godfrey-Smith, 2003). Popper (1980, p. 59) gives this view of theory:

> Scientific theories are universal statements. Like all linguistic representations they are systems of signs or symbols. Theories are nets cast to catch what we call 'the world'; to rationalise, to explain and to master it. We endeavour to make the mesh ever finer and finer.

Popper sees theories as uncertain and as approximate representations of reality. His ontological position recognises theory as having an existence separate from the subjective understanding of individuals. Theory is an inhabitant of World 3, the objectively existing but abstract world of man-made entities – language, mathematics, knowledge, science, art, ethics, and institutions, for example. Other worlds are World 1, the objective world of material things, and World 2, the subjective world of mental states (Popper, 1986).

Popper saw the work of science as being to take a theory that is proposed, to deduce an observational prediction from it, and then to test the prediction. If the prediction fails, then we have refuted or falsified the theory. If the prediction is supported, then all we can say is that the theory has not been falsified – yet. This position is referred to as the 'hypothetico-deductive' model and is reasonably common among philosophers of science and practising scientists.

Popper was not much concerned about where theories come from in the first place, and was strongly opposed to the use of inductive methods in science; that is, in building or supporting a theory on the basis of a large number of observations of a certain kind. Popper has been criticised on these grounds and others have included, in the hypothetico-deductive model, a first stage in which observations are collected and a conjecture (a theory) is generated from these observations (Godfrey-Smith, 2003).

Space precludes a detailed treatment of many of the compelling issues that are discussed under the heading of the philosophy of science. In summary, views that appear useful in discussion of information system theory, which in synthesis can be referred to as a 'scientific perspective' of theory and theorising follow:

1. Theories, as systematic and responsibly supported explanations, are the aim of science. Such explanations may be offered for individual occurrences, for recurring processes or for invariable as well as statistical regularities. The explanations offered can rely on different ideas of causality and what constitutes an explanation (Nagel, 1979, p. 15).
2. Theorising, in part, involves the specification of universal statements in a form that enables them to be tested against observations of what occurs in the real world (Popper, 1980).
3. Some propose a distinction between experimental laws and theories, though the distinction is not clear-cut (Nagel, 1979). Experimental laws, such as the gas laws, which relate pressure, temperature and volume in invariant relationships, refer to 'observable' entities in at least a loose sense of the word. Theories, on the other hand, tend to offer a more comprehensive interrelated set of explanations and include terms like 'molecule' or 'gene' which are less readily directly observable, relying on assumptions for their definition. This point is interesting because the experimental laws, which may result from close observation and description of nature, and not necessarily impute causality, may give rise to a broader scientific theory. For example, an experimental law arising from observation, such as 'All platypuses suckle their young', can be eventually fitted into a theory about the nature of mammals.
4. It is expected that theories and laws in the social sciences, for a number of reasons, will be pervasively generalised in statistical terms (e.g. 'most rural Americans belong to some religious organisation'). Compared with the natural sciences, theories in the social sciences will have narrower scope, or lower-order generality (Nagel, 1979). This observation is not intended pejoratively as social scientists can still manage to advance explanations for a large variety of social phenomena.
5. Dubin (1978) gives a very detailed treatment of how theories can be specified in the social sciences, which is in accord with the scientific perspective described here. He describes how theory can be used for both understanding and prediction, and how ideally it should deal with both process and outcomes.
6. The development of theory or conjectures in the first place can occur in many ways: as a result of observations of what occurs in the real world (Nagel, 1979; Godfrey-Smith, 2003) or from insights, imagination, problems or feelings (Popper, 1980).

7. Scientific theory often, but not always, involves the use of mathematical tools and logic, both for specifying and testing theory (Godfrey-Smith, 2003).
8. Epistemologically, knowledge for the building and testing of theories, can be gained both empirically (the 'empiricist' tradition of Locke and Hume) and from thinking (the 'rationalist' view of Descartes and Leibniz). Kant (1781) developed this intermediate position: that thinking involves a subtle interaction between experiences and pre-existing mental structures that we use to make sense of experience, and others, including Schopenhauer and Popper, have followed in this tradition.
9. Naïve realism is not necessarily a part of a scientific perspective, and neither is a theory-neutral view of observations of the real world (see Godfrey-Smith, 2003 for a 'scientific realist' view).

This scientific view of theorising has been little recognised in information systems research, usually because writers in the field confuse scientific views with positivism. Researchers who use Dubin's principles for the formulation of theory are implicitly following a scientific-like prescription (e.g. Weber, 1997).

An exception in information systems is Lee (1989), who explicitly describes a scientific methodology for case studies and provides a description of the scientific method that is largely congruent with the perspective given above. A second exception is Cushing (1990), who describes the role of frameworks, paradigms and scientific research in management information systems in similar terms, and suggests that frameworks are a precursor to the development of theory with generalisations and laws. Otherwise, the richness of the discussions in the philosophy of science on the nature of theory has been little recognised in information systems as a source for our perspective on theory.

From this discussion of scientific views of theory, we can draw several useful ideas for information systems. Observation of phenomena can precede analysis and description (Type I and Type II theory) and description of regularities (predictive Type III theory). Scientific-type laws that allow both prediction and understanding can also be searched for, but as they will have aspects of human social behaviour included, they are likely to be cast in a probabilistic form (Type IV theory below). Insights for a new theory can come from almost anywhere.

Interpretivism and constructivism

Intrepretivism and constructivism are related approaches to research that are characteristic of particular philosophical world views. Schwandt (1994) describes these terms as sensitising concepts that steer researchers towards a particular outlook:

> Proponents of these persuasions share the goal of understanding the complex world of lived experience from the point of view of those who live it. This goal is variously spoken of as an abiding concern for the life world, for the emic point of view, for understanding meaning, for grasping the actor's definition of a situation, for Verstehen. The world of lived reality and situation-specific meanings that constitute the general object of investigation is thought to be constructed by social actors (p. 118).

Many of the ideas in these approaches stem from the German intellectual tradition of hermeneutics and the *Verstehen* tradition in sociology, from phenomenology, and from critiques of positivism in the social sciences. Interpretivists reject the notions of theory-neutral observations and the idea of universal laws as in science. Theory in this paradigm takes on a different perspective:

> Knowledge consists of those constructions about which there is a relative consensus (or at least some movement towards consensus) among those competent (and in the case of more arcane material, trusted) to interpret the substance of the construction. Multiple 'knowledges' can coexist when equally competent (or trusted) interpreters disagree (Guba and Lincoln, 1994, p. 113).

The emergence of interpretivism in information system research is described by Walsham (1995). Walsham saw interpretivism as gaining ground at that point against a predominantly positivist research tradition in information systems. Klein and Myers (1999) consider that theory plays a crucial role in interpretive research in information systems. Theory is used as a 'sensitising device' to view the world in a certain way. Particular observations can be related to abstract categories and to ideas and concepts that apply to multiple situations, implying some generalisability. The types of theory that information systems researchers are likely to reference are social theories such as structuration theory or actor-network theory.

The interpretivist paradigm leads to a view of theory which is theory for understanding (Type III), theory that possibly does not have strong predictive power and is of limited generality.

The technological perspective

Information systems involve the use of information technology and so we would like theory that can deal with technologies. Recognition that theory might relate to technology is rather uncommon and it might even be that there is definite prejudice against it. This view may go back a long way. O'Hear (1989, p. 216) says the ancient Greeks tended to despise the merely mechanistic or banausic. Popper saw the worship of science and technology as instruments for control over nature as shallow and worrying because of our ignorance of the effects our interventions might have. Nevertheless, the development of science and the development of technology have gone on hand-in-hand. For example, the start of the scientific revolution 'coincided' with the (mid-16th century) development of the telescope and the microscope (Gribbin, 2002, xix)

The classic work that treats technology or artefact design as a special prescriptive type of theory is Herbert Simon's *The Sciences of the Artificial* (1996), first published in 1969. Simon (1996, p. xii) notes that in an earlier edition of his work he described a central problem that had occupied him for many years:

> How could one construct an empirical theory?
>
> I thought I began to see in the problem of artificiality an explanation of the difficulty that has been experienced in filling engineering and other professions with empirical and theoretical substance distinct from the substance of their supporting sciences. Engineering, medicine, business, architecture and painting are concerned not with the necessary but with the contingent – not with how things are but with how they might be – in short, with design.

Simon contrasts design science with natural science, which is concerned with knowledge about natural objects and phenomena. Design science must take account of natural science since an artefact is a meeting-place or interface between the inner environment of the artefact and the outer environment in which it performs, both of which operate in accordance with natural laws. Simon discussed design science in the contexts of economics, the psychology of cognition, and planning and engineering design, but not information systems. It has taken some time for Simon's ideas to filter through to information systems and they are still not unequivocally accepted in this discipline.

Weber (1987), for example, recognised difficulties with design work in information systems. He saw the 'lure of design and construction' as a factor inhibiting the progress of information systems as a discipline and called for theory that gave information systems a paradigmatic base.

In 1992, Simon's ideas were adopted and applied to consideration of information systems design theory by Walls et al. (1992). Recently the ideas of these authors have enjoyed some currency, as shown in the specification of a design theory for knowledge management systems by Markus, Majchrzak and Gasser (2002). The explication of information systems design theory by Walls et al. (1992) is probably the most complete and thorough to date. Since 1992, there have been varying and rather scattered approaches to the problem and articulation of design theory in information systems and allied fields. March and Smith (1995) and Hevner et al. (2004) followed Simon's ideas closely, but with an important difference. They saw design science products as comprised of four types: constructs, models, methods, and implementations, but excluded theories. Jarvinen (2001) expresses similar views.

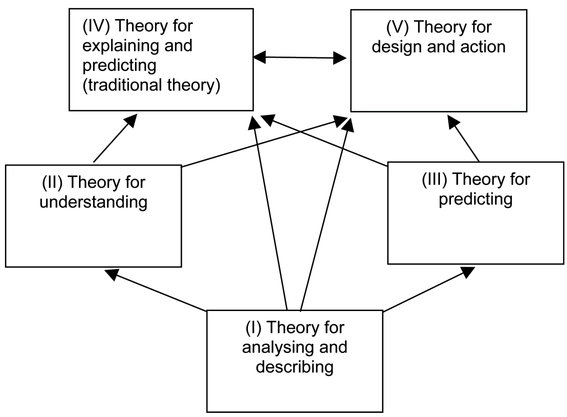
More recently, Iivari (2003) argued that determining the distinctive identity of information systems relies on the recognition that our knowledge and theory is concerned with the developing and building of information system artefacts.

Thus, these considerations provide a justification for a fifth type of theory of interest to information systems researchers: theory for design and action (Type V).

A typology of theory for information systems

The perspectives presented above provide justification for distinguishing five different interrelated types of theory that are relevant to information systems research (see Figure 1.1). Each type is described more fully in Gregor, (2002).

Figure 1.1. Interrelationships among theory types.



Type I. Theory for analysing and describing

Descriptive theory says 'what is' and is the basis for all other types of theory. Description and specification of constructs in theories of this type are needed (Dubin, 1978), as are descriptive frameworks that specify and classify the phenomena of interest in a theoretical domain (Cushing, 1990).

Type II. Theory for understanding

This type of theory says how and why something occurred. Theory from interpretive approaches can be used as sensitising devices that allow greater insights into familiar situations (Klein and Myers, 1999). Conjectures can be drawn on the basis of a number of limited observations that are used as a basis for hypothesis formation and theory building.

Type III. Theory for predicting

Predictive theories say what will be, given the presence of certain conditions. These theories give predictive power without necessarily having explanatory power (Dubin, 1978). Again, knowledge of this type, such as statistical regularities, can yield hypotheses for theory building.

Type IV. Theory for explaining and predicting

This type of theory says what is, how, why, and what will be. It is the type of theory commonly specified in the 'scientific' perspective (Dubin, 1978).

Type V. Theory for design and action

Design theory is the prescriptive type of theory that gives principles for the construction of a tool or artefact to meet a set of meta-requirements (Hevner et al., 2004; Iivari, 2003; Simon, 1996). Design theory is informed by, and can inform, theory for explaining and predicting.

Concluding remarks

The purpose of this paper is to show that the distinctive nature of information systems research, being concerned conjointly with the study of artefacts and human behaviour, requires a meta-understanding of theory that draws on work from the philosophy of science (both natural and social) in addition to work on the sciences of the artificial. Some of the misunderstandings surrounding the concept of positivism also need to be exposed and removed, so that full value can be gained from readings in the philosophy of science, which underpins notions of theorising. The outcome is that five interrelated forms of theory can be distinguished, all of which are needed for information systems research. Acknowledging the contribution that each type of theory can make will allow work in information systems to proceed in a more integrated manner.