INTERROGATING SOCIOMATERIALITY: AN INTEGRATIVE SEMIOTIC FRAMEWORK FOR INFORMATION SYSTEMS

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Abstract

The paper seeks to interrogate and ground the concept of sociomateriality for information systems studies through the use of Peircean semiotics and critical realism as philosophies. The key concepts of information, meaning and embodiment are also utilized to help build an integrative framework, consisting of three worlds – the personal, social and material – in relationships of sociation, sociomateriality and embodiment. Semiosis relates to the personal world through the generation and interpretation of signs and messages. It relates to the material world in that all signs must have some form of physical embodiment in order to be signs, and must also be transmitted through some form of physical media. Semiosis relates to the social world in that the connotive aspects of sign systems are social rather than individual – they exist before and beyond the individual’s use of signs. The paper examines critically the implications of this formulation for studying IS. It discusses commonalities with and departures from other sociomaterial studies, illustrates points with empirical examples, and details how the integrative framework can be utilized.

Keywords: critical realism, embodiment, information systems, semiosis, sociomateriality
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INTRODUCTION

The two most distinctive characteristics that distinguish human beings from other animals are their advanced ability to use language to co-ordinate their actions (Maturana, 1978; Mead, 1934) and the ability to develop and use tools to shape their environment (Habermas, 1978). Tool-making, and language and signification are also the basis of knowledge as Habermas points out in his theory of knowledge-constitutive interests (Habermas, 1978) – the empirical-analytic sciences which underlie technology, and the hermeneutic sciences which underlie human communication. Language and communication are based fundamentally on meaning and signification which is essentially cognitive, while tools and technology are primarily realized in a physical form. It is therefore interesting to consider the possible relationship between these two, very different, systems – the social and the material.

Here we narrow technology down to the domain that is relevant to information systems, indicated by the common mnemonic ICT, i.e., information and communication technology. This immediately reveals that it is about technology applied to communication, in other words it immediately cuts across the communication/ signification divide. This is nothing new, but undoubtedly with mobile technologies and social networking it is more so than ever before.

In the literature we can distinguish three primary positions regarding this relationship. First, are those who emphasize the dominance of one system over the other. For example, technological determinists such as Woodward (1958) and Perrow (1970) argue that the nature of the technology imposes major constraints on individuals and organizations. More recent work is highly varied in scope and level but generally treats technology as an independent variable within the research (Orlikowski and Scott, 2008, p. 439-446). Perhaps in reaction to this view, there developed a focus on the social aspects of technology – the ways in which people organized around or shaped technology(Howcroft, et al., 2004) – which includes the social
shaping of technology (SST) and the social construction of technology (SCOT) (Pinch and Bijker, 1984) perspectives. These could be seen as social determinists.

Second, there are those who conceptualize two ontologically distinct systems that interact and mutually influence each other (Orlikowski and Scott, 2008, p. 446-454), for example, the original socio-technical studies of Trist and colleagues (Trist and Murray, 1993), Zuboff’s (1988), and Zammuto et al’s (Zammuto, et al., 2007) work drawing on Gibson’s theory of ecological perception and affordances. Third, and most recent, we find theorists who argue that the two systems are so inextricably inter-twined that they cannot in fact be separated, for example actor-network theory (ANT) (Callon, 1991; Latour, 1987), object-centered sociality(Knorr-Cetina, 1997) and relational materiality (Law, 2004). Within IS, this position has recently been called “sociomateriality” to emphasize the inseparability of the social and the material (Leonardi and Barley, 2008; Orlikowski, 2000; Orlikowski, 2007; Orlikowski and Scott, 2008) and is the subject of this paper.

To return to the beginning, we are concerned with the interaction of communication and technology. Communication is underpinned by systems of meaning and signification, and the discipline that most thoroughly deals with signification is semiotics – the science of signs and sign transmission. If semiotics conceptualizes the mechanisms of meaning and communication, and we are aiming to explore the relations between communication and technology, then we wish in this paper to consider the relation between semiotics and sociomateriality. At first sight this may not look promising since, by and large, semiotics has restricted itself to only one side of the equation – the social. However, we will argue that semiotics can relate more directly to technology through the concept of embodiment.

In the first section of the paper we review briefly Peircean semiotics, taking into account more recent developments relevant to our purpose, especially with regard to business and ICTs. In the next section we develop out of Peircean semiotics our theoretical position with regard to sociomateriality. This will be from an underlying critical realist position and will relate particularly to theories concerning the nature of information and the role of embodied cognition. From this build, we then develop an integrative framework that locates semiosis as the founding set of operations at the centre of three worlds – the personal, social and material. In the final
sections, we discuss critically the implications for sociomateriality as a founding concept for IS, illustrating our formulation and use of the integrative framework with empirical examples.

**DEVELOPING THE FRAMEWORK (1) SEMIOTICS**

Semiotics or semiology is the study of signs and systems of signification where a sign is an event, an object, a symbol or a behavior that represents something other than itself. Signs depend upon a shared set of meanings within a particular community and are the basis of all communication, whether linguistic or not. Semiotics studies the processes that lead signs to have particular meanings, and the ways in which such meanings are communicated and have effects. In many ways, semiotics can be seen as the most fundamental of the social sciences since it underlies all communication and social action.

In recent history, semiotics has two significantly different lines of development, one traceable to Ferdinand de Saussure (1960 (originally 1916)), a Swiss linguist, and the other to Charles Sanders Peirce, an American philosopher and scientist. From the point of view of this paper, there is a major limitation of Saussurian semiotics – it only involves a dyadic relation between signifier and signified and does not include reference to the world outside the sign system, i.e., the world of objects and events to which signs can refer. In this paper we shall be concerned primarily with Peirce’s approach, though noting that Saussure’s work also informed parts of Giddens (1984) structuration theory which is one of the approaches used in developing the sociomateriality concept in IS studies (Orlikowski, 2000).¹

**Peircean Semiotics**

For Peirce (1931-1958)², a sign involves a triadic relation between a representamen (signifier), an interpretant (signified) and an object—see Figure 1.

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¹The history of semiotics has been covered extensively and is not repeated here. Good general accounts include (Chandler, 2002; Krampen, et al., 1987; Martin and Ringham, 2006; Noth, 1990).

²We should note that Peirce wrote extensively about semiosis over many years, often developing or changing his terminology, so there is not a single model or theory. For example, in his late work there is the suggestion that semiosis may not be unlimited.
A sign … {representamen} is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. That sign which it creates I call the interpretant of the first sign. The sign stands for something, its object. It stands for that object, not in all respects but in reference to a sort of idea, which I have sometimes called the ground of the representamen. (Peirce, 1931-1958, 2.228, original emphasis)³

Peirce was primarily interested in the process of semiosis, that is, the way in which signs were continually interpreted and re-interpreted within the process of communication. Considering Figure 1 in more detail, the representamen is the physical manifestation of the sign – its form as opposed to its content (properly speaking “sign” should only refer to the whole combination of the three aspects but sometimes it is used to refer just to the representamen). The representamen brings with it two effects – the object that it represents, and the idea that it generates in an interpreter. The interpretant is not the interpreter per se but does imply that there is some form of interpreter. The interpretant is seen by Peirce as another sign thus leading to the idea of continual semiosis. These two effects can be seen as the same as Frege’s (1952) distinction between sense and reference. The “meaning” of a sign thus consists in both its sense and reference. The object is that which the sign stands in place of, and can be physical, mental, imaginary or another sign.

³References to Peirce are to the volume and paragraph in the Collected Papers (Peirce, 1931-1958). Other sources are Buchler (1940), Almeder (1980) and Greenlee (1973)
Peirce developed these basic categories in several ways (Noth, 1990). He produced complex typologies of different types of representamen. The main one was to distinguish between icons, indexes and symbols in terms of their relationship to the object. Icons are signs that resemble or imitate their objects in some way, for example a picture, a model, or a simulation. Indexes relate to their objects directly, either causally or temporally. For example, a thermometer is an index of the temperature; the sun setting is an index of nighttime coming. Symbols have no direct relationship to their object at all; the association is purely conventional as in language or mathematical notation. Symbols have a relationship purely through the habit of their association.

Peirce was very concerned with the way in which signs came to be interpreted in practice (Almeder, 1980). For the interpretant, he distinguished between the immediate interpretant and the dynamical interpretant. The immediate interpretant is the “quality of the impression that the sign is fit to produce and does not consist in any actual reaction” (8.315). It is thus the intrinsic

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4He also talked of a final interpretant but was somewhat unclear about what this meant. He also sometimes talked of the emotional/energetic/logical interpretants but there is debate about the relationship between the two schemes (Atkin, 2006)
meaning or interpretability of the sign *before* anyone has actually interpreted it. The dynamical interpretant is the “direct effect actually produced by a sign upon the interpreter of it” (CP 4.536). This is the idea or meaning that the sign generates in a particular person, related to the object represented by the sign. It is, therefore, in part dependent on the interpreter and may differ from one to another. It also generates some effect in the interpreter, whether a physical action, or a mental one such as another sign, which may in turn be expressed in a representamen. Thus we have the process of semiosis or signification.

Peirce also distinguished two forms of the object of the sign, also called the immediate object and the dynamical (or mediate) object:

“We have to distinguish the immediate object, which is the object as the sign itself represents it, and whose being is thus dependent upon the representation of it in the sign, from the dynamical object which is the reality which by some means contrives to determine the sign to its representation” (CP 4.536).

This very important distinction commits Peirce to at least some form of realism, although not a naive realism. The immediate object is that which is contained within the sign, and picks out certain aspects or grounds of the “real” object – the dynamical one. The latter is the underlying, but not immediately present, trigger of the sign.

To illustrate with an example, if someone asks “Where is the bathroom?” the immediate object is the concept of a bathroom as expressed in the sign. In this case it is just a bathroom in general, not a particular one. The dynamical object is the actual bathroom (assuming there is one), with all its particular characteristics, which exists outside the world of the sign. The immediate interpretant is the meaning of the question as a whole that any speaker would understand, and the dynamical interpretant is the effect the question has on an interpreter which may lead them to give directions or ask someone else.

Semiotics was only a part of Peirce’s extensive philosophical thought. We should also note for later that he was one of the founders of American pragmatism (Buchler, 1940; Peirce, 1878), (CP 5.411, 5.197, 5.597)] and thus his theory of meaning was built on his semiotics. Expressions gain their meaning through their conditions of use, i.e., the effects that they have on the world, which is precisely the dynamical and final interpretants of a sign or message. Less well known is that he was also a phenomenologist(Buchler, 1940), (CP 1.284-7, 1.536-7, to some extent pre-dating Husserl (1973 (orig. 1913)), and developed a theory of three modes of being: firstness –pure
quality or actuality in itself; secondness – relations between one thing or quality and another; and thirdness - cognition, concepts and laws about firstness and secondness. The sign embodies all three modes. One area that Peirce did not develop was the physical or technological aspects of semiotics and communication, which is obviously of importance for this paper, and so we consider here some later developments.

**Further Peirceian developments**

Charles Morris (1938) was an American behaviorist who developed semiotics as the science of all signs to include non-linguistic and non-human sign processes. He used a similar triad to Peirce, calling them the *sign vehicle* (representamen), the *designatum* (object) and *interpretant*. He therefore characterized semiotics in terms of three dimensions: syntactic which studies the relations between signs and other signs; semantics which studies the relations between signs and their objects; and pragmatics which studies the uses of signs by their interpreters.

Syntactics, or syntax, covers all the formal relations between signs, including the rules of language, or the sign system, and the syntagmatic and paradigmatic dimensions of sign relations as developed by Saussure. Semantics is a polysemous term that is closely related to meaning. Initially, Morris saw it as specifically the relations between the sign and its object, i.e., reference or denotation, but later included the sense, or immediate interpretant, of the sign as well. Pragmatics covers “the origin, the uses and the effects of signs” (Morris, 1938, p. 30) which would include the biological, psychological and social aspects of the intentional use of signs (Austin, 1962; Habermas, 1979b; Searle, 1969). Later work within information systems by Stamper (1997) extended Morris’s typology. Below the level of syntactics, Stamper added the *material* level of physical phenomena that allow the storage and transmission of signs, and the *empiric* level which concerns the effective and efficient transmission of messages as is dealt with by traditional information theory (Shannon and Weaver, 1949). Both of these are useful in considering sociomateriality. He also added an upper level – the *social* - that went beyond individual intentionality to the effects of signification in the social and organizational worlds (Stamper, 2001).

A second major figure was Roman Jakobson (1956) who contributed to both Saussurian and Peircean semiotics. He saw that Saussure’s distinction between the *syntagmatic* and *paradigmatic* axes was essentially based on the difference between metaphor and metonymy or,
more basically, similarity and contiguity. A metaphor is a figure of speech, or trope, in which one element (or signified) stands for another on the basis of some similarity or likeness (e.g., “the university of life”). Metaphor is incredibly common in language. Indeed, Lakoff and Johnson (1980) argue that the origin of almost all language is metaphorical in relation to our basic physical experience of the world. Metonymy is another trope in which one signified stands for another on the basis of a direct relation, e.g., part/whole, cause/effect or substance/form (e.g., “I spy the sails”, “The mercury’s through the roof”, “I’ll pay on plastic”). In this, it is very similar to Peirce’s indexical type of sign. So a sign gains meaning through a combination of likeness and contiguity.

Jakobson also developed a model that applied to any speech or communicative act (Jakobson, 1960) comprising of six components or elements, each of which leads to a different function of language. These are: the addresser (emotive or expressive), the addressee (conative or volitional), the context (referential or denotative), the message (poetic), the code shared by addresser and addressee (metalingual), and the physical or psychological contact (phatic). The first three of these formed an earlier model of language functions developed by Bühler (1982, orig. 1934) and picked up by Habermas (1994) as underpinning for his theory of communicative action. In relation to the Morris/Stamper typology, we can see that the emotive and conative functions concern pragmatics, the context concerns semantics, the poetic and metalingual concern syntax, and the phatic concerns the empiric and physical dimension which again brings in materiality.

\[5\] Freud used a similar distinction in his analysis of dreams which he saw as being based on displacement (metaphor) and condensation (metonymy) (Freud, 2004 (orig.1900)).
Semiotics has been used in a range of business areas particularly, as might be expected, in marketing, for example Mick (1986), Arnold et al. (2001), Harvey (2001), and Lawes (2002). In other domains, Barley (1983) used semiotics as a way of studying the systems of meaning within particular occupations; Fiol (1989) analyzed CEO’s letters to shareholders to understand a company’s propensity to enter in to joint ventures; Brannen (2004) studied the cultural differences that can undermine an organization’s transfer of policies and process abroad; and Cooper et al. (2001) used semiology to decode the reviews of regulated utility companies produced in the UK.

Moving to IS and IT, a considerable body of work has developed around Stamper’s (1991) extension of Morris’s framework mentioned above. This work generally goes under the name “organizational semiotics” (Gazendam, et al., 2003; Liu, et al., 2001; Liu, et al., 2002a; Liu, et al., 2002b) but it mainly concerns information systems and systems analysis. Work within this tradition is generally based on Peircean semiotics and ranges from studies of instrumentation and

Figure 2 Jakobson’s Six Functions of Semiotic Systems

Semiotics in Business and ICT

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the human-computer interface (HCI) (May and Andersen, 2001) through the development of
information systems having regard to both their technical and human aspects (Stamper, 2001) to
studies of IS within their organizational context (Clarke, 2002). There are other sources used, for
example, Robichaud (2002) employs Greimas’s narrative grammar to analyze a process of public
theory in user interface design.

Moving away from Stamper’s framework, there are several semiotic analyses of ICT as a
communicational tool. For example, Warschauer and Grimes (2007) analyzed Web 2.0 type
software such as blogs, wikis and social networking sites in terms of semiotic constructs such as
authorship, audience, and artifact. Tredinnick (2007) also used post-structuralist semiotics (e.g.,
Barthes, Foucault, Derrida) to study the effects of hypertextuality in the WWW. Menchik and
Tian (2008) used Peirce’s and Morris’s semiotic frameworks to analyze the ways in e-mail users
overcome the exclusion of non-linguistic cues and gestures in e-mail interactions. Mancini and
Buckingham Shum (2006) discuss a discourse representation system, based on semiotics,
specifically for domains of debate and contestation such as academic discourse. Researchers who
have approached information from a semiotic perspective include Benyon-Davies (2009), Huang

The final area we shall discuss is the human-computer interface (HCI) where signs and symbols
obviously play a central role. Here, Anderson (1990) coined the term “computer semiotics” by
which he meant adapting the semiotic theories that had primarily arisen in linguistics to the
specific domain of computing. In particular, he drew on both the structuralist tradition of
semiotics as represented by Barthes and Eco (Ramussen, 1986), and the
phenomenological/speech acts approach as represented by Winograd and Flores (Winograd and
Flores, 1987). However, for the purposes of this paper we wish to highlight a more recent trend
that goes beyond structuralism or phenomenology to encompass the idea of embodiment. De
Souza (2005) has developed a theory of semiotic engineering which sees HCI as enabling an
active communication process between the system user and (implicitly) the system designer, and
O’Neill (2008) has built on these ideas. This strand of thought will form part of the theory
developed in a later section.

DEVELOPING THE FRAMEWORK (2): CRITICAL REALISM
As we have seen, sociomateriality covers two potentially distinct domains – the social and ideational on the one hand, and the physical on the other – so it is important that these can be reconciled philosophically. For this reason, we begin by locating our work within the critical realist (CR) paradigm which accepts the ontological reality of a variety of different entities, be they physical, social, cognitive or abstract (Archer, et al., 1998; Bhaskar, 1978; Bhaskar, 1979; Bhaskar, 1993). Such entities do not need to be measurable, or even directly observable, so long as we can postulate that they have causal effects. CR has been advocated as a philosophy for IS (Dobson, 2001; reference withheld; Mutch, 1999), and used in empirical research (Bygstad, 2010; Longshore Smith, 2006; Volkoff, et al., 2007; Wikgren, 2005; Wynn and Williams, 2008) so we will only highlight the significant aspects.

The first is the distinction between the *transitive* and the *intransitive* domains of science and knowledge. Science (and social science) is a human activity and therefore much of it is a social production – theories, experiments, papers, journals, debates etc. – are all human-dependent and therefore transitive. However, the *objects* of knowledge, that which knowledge is *about*, are external and independent of our knowledge of them – they are intransitive. This is not only true for the physical world, where it seems uncontentious that physical laws would operate even if humans did not exist, but also for the social world, even though social laws and mechanisms can only operate in and through people in general. Even speech can become intransitive once it has been uttered and become detached from the circumstances of its production.

Second, there is a distinction between the *real*, the *actual* and the *empirical*. The real, that is, everything there is, consists of enduring structures and mechanisms that have particular tendencies and powers generating causal effects in the world. These structures, which may be unobservable and may not exercise their powers all the time, interact with each other and generate the actual events that do (and do not) occur. Some of these events are observed and experienced, and have the potential to become the empirical data of science. Both the actual and the empirical are part of the real and have causal effects of their own. CR also emphasizes the idea of *generative causality* in opposition to the Humean version of a constant conjunction of events. And it is comfortable with the view that reasons can be causes, that is, that the reasons an actor gives for their actions may be an adequate explanation although we must always be aware of unknown or perhaps unacknowledged conditions of action.
With regard to semiotics, critical realism has already recognized its importance although it is not that well developed. Bhaskar himself says that “the centerpiece of any adequate theory of meaning must be the semiotic triangle” (Bhaskar, 1993, p. 222-223), where his triangle consists of signifier, signified and referent. In this, it is clearly invoking Peirce rather than Saussure with its inclusion of the referent or object of the sign. In fact it can be seen as a simplified version of Peirce’s scheme (Nellhaus, 1998): the signified, or interpretant belongs in the transitive dimension while the referent or object is part of the intransitive dimension. In fact, Nellhaus argues that Bhaskar’s ontological domain of the empirical – those events that we actually observe and experience - should be re-conceptualized as the domain of semiosis. Important for our theoretical approach is CR’s insistence that semiosis cannot be reduced either to the play of signifiers, as with Saussure or Derrida, or to a purely hermeneutic sphere (Fairclough, et al., 2004). Semiosis must always have external referents, and extra-semiotic conditions and consequences: “semiosis presupposes embodied, intentional, practically-skilled social actors, social relations, material objects, and spatio-temporality” (Fairclough, et al., 2004, p. 28) not to mention the technology that both enables and conditions communication. We could call this “material semiotics” to use a term from Haraway (1988) and Law (1995).

DEVELOPING THE FRAMEWORK (3): INFORMATION AND MEANING

From the perspective of sociomateriality, we need to consider how signs and symbols get translated into action (embodied cognition) and how actions and information get transmitted (technology). As a first step we will consider the relation between meaning and information. Are they in fact the same, so that the meaning of a message is the same as the information it conveys? Or are they distinct, in which case how do they relate to each other?

A semiotic theory of information can be developed (reference withheld) combining ideas from Dretske (1981), Habermas (1984), and Maturana (1980). Following Bateson (1973), the foundation of information, data and more generally signs, must be differences in the physical world, for without difference there is only uniformity. More particularly, differences that “make a difference”, that is, generate an event or a sign. Events carry information because the occurrence of an event reduces the possibilities of what might happen to what actually does happen, as Shannon and Weaver (1949) argued. In particular, an event (which includes a sign or message) carries the information about what caused it, or led to it. That is, what must be the case
in the world for the event to have occurred? Such information exists independently of any observer, indeed, it might never actually be observed\(^6\). Nevertheless it carries with it the information concerning its own genesis.

Information can also be transmitted provided that there are causal links between the sender and the receiver (not necessarily people). This occurs to the extent to which states of the sender are correlated or connected to states of the receiver. Independent events transmit no information; completely linked events transmit all information. Most situations are between the two extremes – the receiver can be affected by things other than the sender (noise), and not all of the information from the source will affect the receiver (equivocation). We note also that, following Bhaskar (1993), absences can be causes and therefore can generate information. So the gas bill that is not paid by the due date generates information to that effect for the company, which then triggers a reminder letter.

Information is, then, clearly defined – semantic informational\(^7\) is the propositional content of a sign, that is, what is implied about states of affairs in the world given that the sign exists. This definition has several consequences:

- Information is an objective commodity – it is carried by events and signs whether or not it is observed or extracted, and information can be stored and transmitted by the environment, artefacts and people.
- Information is distinct from its embodiment in a sign or message since the information itself can have causal events – a knock on the door leads us to open it not because of the physical knock, but because it carries the information that someone is there.
- Information must be true. We may misunderstand or misinterpret a sign but the sign itself only carries true information.

This approach allows us to define clearly concepts such as data, information and meaning (reference withheld):

- Data is a collection of signs, usually brought together for some purpose, to store or transmit information. They are usually numeric, pictorial or linguistic.

\(^6\) In Bhaskar’s terms, differences and information exist in the domain of the actual, but if they are observed they becomes empirical.

\(^7\) In terms of Stamper’s typology, we are interested in the semantic, pragmatic and social levels.
• Semantic information is the propositional content of data, typically in the form of a message but also in the form of a naturally occurring sign.

• Meaning has two different usages. First there is the system of meanings that are publically available within a sign system such as language. These can be drawn on by competent language users in their communications (Habermas, 1979a). It is that which allows an utterance to carry information but it is not identical to that information. This is termed “connotation” above. The second usage is the “meaning” that the recipient gains from an utterance (“import”) and/or that which the sender intends (“intent”). Again, these are all different from the information itself (“signification”).

This draws a clear distinction between information and meaning. Information is *objective*, in the sense of being independent of the sender or receiver, and must be *true* to be information. Meaning is intersubjective, in being at least partly dependent on human interpreters, and is generated from information. Thus, information systems, which store, process and transmit information, are only a part of wider systems of meaningful human communication.

**DEVELOPING THE FRAMEWORK (4) MEANING AND EMBODIMENT**

We now move on to the process by which messages come to be interpreted, reacted to and acted on to generate technologically-based communicative interaction. In contrast to the traditional cognitivist, representationalist paradigm, we shall adopt the perspective of cognition as an active, embodied phenomenon (reference withheld). This draws on the phenomenology of Heidegger (1962) and Merleau-Ponty (1962; 1963), autopoiesis (Varela, 1991), and work within ICT such as Winograd and Flores (1987), Dourish (2001), O’Neill (2008), Schultze (2010) and Schultze and Orlikowski (2010).

The essence of this position is to deny the Cartesian split between mind and body so fundamental in disciplines such as artificial intelligence, computing, information and cognitivist psychology, in favor of one that recognizes the essentially embodied nature of human cognition whether at the level of perception, thought, behavior or language. This is also the position underscored by the work of Johnson (1987) and Lakoff and Johnson (1980), including their emphasis on reason shaped by the body, a cognitive unconscious to which we have no direct access, and metaphorical thought of which we are largely unaware.
As autopoietic living systems we have a nervous system that is organizationally-closed and self-referring, but which is interactively open to the environment. The type and limitations of these interactions are shaped primarily by our own nervous system rather than by the environment (structure-determined). External events, e.g., messages with information, trigger responses but the nature of the response is determined by the readineses of the nervous system at the time – indeed the system determines what can be triggers for it. The transformation of information into meaning (digitalizing the analogue) is carried out largely unconsciously by the body presenting our conscious mind with pre-structured meanings. This is the process of embodied cognition.

“There is not thought and language … Expressive operations take place between thinking language and speaking thought; … It is not because they are parallel that we speak; it is because we speak that they are parallel … I do not speak of my thoughts; I speak them and what is between them.” (Merleau-Ponty, 1964, p. 18, orig. emphasis)

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8 Much of this was recognized by Peirce who saw that semiosis worked on the basis of “habits”, both mental and physical, which enables us to process and act on signs.
This is not to say that the meaning triggered by signs and symbols is completely arbitrary or subject-dependent. The very fact that they can trigger anything in the nervous system reflects the way in which we are socialized to the wider social system within which connotative systems exist. We, as human beings, are “structurally coupled” with our immediate environment of people, signification systems and materials. We can say that signs act as affordances and constraints – they tend or afford to lead to particular interpretations and constrain against others – but this is always relative to the knowledge and intentions of the receiver.

On one view, the interpretation of signs can be seen in terms of three stages, illustrated with an example in Figure 3 (reference withheld).

Suppose the addresser sees the addressee look out of the window at the weather and asks what it is like. In Peirce’s terms, the immediate object is wanting to know the current weather, the
dynamical object is the fact that the addressee has looked at it. The first stage of interpretation (understanding or immediate interpretant) is simply appreciating the general meaning of the message, what any competent speaker of the language would be able to do. This will be done sub-consciously by the body and nervous system (what Heidegger would term “ready-at-hand”) unless there is some degree of ambiguity in which case the message may become more an object of conscious reflection (“present-at-hand”).

The second stage (connotation or dynamical interpretant) brings in the individual knowledge and motivations of the addressee. It is the effect of the message or sign on that person; it is the process by which the semantic information carried by the message is transformed into meaning. This stage is not purely individual but socially structured in terms of the addressee’s forms of life (Wittgenstein, 1958). Finally, the third stage (intention or final interpretant) leads to some form of action or result which could be a reply, or an activity, or just a decision not to respond. In any event, the addressee’s state of readiness’s will be changed in some small way.

Where some physical action such as a reply is involved, there will be a similar set of stages involved in the production of a response. The whole of this process is one of embodied cognition in that much of it happens beneath the level of consciousness, carried out through the structure of the body and nervous system.

It is at this point that we can bring in technology, or perhaps in this context it is better to call it media – “the material of the world that affords the mediation of some form of content” (O’Neill, 2008, p. 138). Or, as Dourish (2001), who is concerned with tangible and social computing, has said: “Tangible and social computing both capitalize upon our familiarity with the everyday world, a world of social and physical interactions. As physical beings, we are unavoidably enmeshed in a world of physical facts. ... So, the social and the physical are inescapable aspects of our everyday experiences.” (p. 100).

A SUMMARY INTEGRATIVE FRAMEWORK - SEMIOSIS AND THREE WORLDS

We have now reached the point at which we can introduce the integrative semiotic framework (see Figure 4) that draws on all the material developed above. In Figure 4  semiotics is shown at the center of a triangle formed by Habermas’s three worlds: the personal, the social and the physical worlds. But this framework goes beyond Habermas to consider both the relationships between the three worlds, and semiotics’ mediating role within these relationships.
Let us consider first the interior of the triangle. Semiosis relates to the personal world, the world of the subject, in the ways outlined above through the generation and interpretation of signs and messages. As human beings we exist in a world of meaning and communication and that is always a process of semiosis. Events and symbols have meaning for us (import) because of what they represent or stand for and our communicative intentions (conscious and unconscious) can only become operative when represented in some form of sign system. We would want to stress again that meaning is to be distinguished from information. Information is that content of a meaningful message that is, in fact, true whether or not it corresponds with the meaning that the recipient actually derives from the message.

Semiosis also relates to the material world in that all signs have to have some form of physical embodiment in order to be signs, and they must also be transmitted through some form of physical media. By media we do not mean necessarily technology, although that is increasing our human mode of communication, but sight, sound, touch etc are all media for semiotic communication.

Finally, semiotics relates to the social world in that the connotative aspects of sign systems are social rather than individual – they exist before and beyond the individual’s use of signs. Some

Figure 4 The Relations Between Semiosis and the Three Worlds
semiotic interactions may be non-social, for instance taking hoof marks as a sign that a horse has passed by (an indexical sign), but the vast majority are symbolic and so rely on pre-existing agreements about the meanings of particular signs.

Looking next at the outside, each side represents an ongoing form of relationship between the corners. Between the personal and social worlds there is a relationship of what we might call sociation. This is essentially the relationship between structure and action that has been so heavily discussed and debated (reference withheld). From a critical realist position, the work by Bhaskar (1979) and Archer (1988; 1995; Mutch, 2010) on morphogenesis addresses this area. The social and the individual are conceptualized as two real, independent but mutually interlocking systems. Society is an “ensemble” of structures, practices and conventions realized in the form of “position-practices” – role positions and social practices. It thus pre-exists the individuals who occupy these positions and conditions that activities they undertake. But, at the same time, society is reproduced or transformed by that individual activity. Whilst emphasizing the ontological reality of social structures, Bhaskar accepts that they only exist through the activities they govern. An alternative conceptualization would be through Giddens’ (1984) structuration theory which is already well known within IS (Jones, 2008).

Between the personal and the material worlds we have a relation of embodiment. This occurs in two ways – the first is embodied cognition which is to do with the physical human body and the manner in which this inextricably links thought and action, as has been outlined above. The second concerns technology, taken very broadly, and the ways in which it both enables and constrains human action (Dourish, 2001; O'Neill, 2008).

Finally, between the social and the physical we have a relationship of sociomateriality as envisaged in the introduction to the paper (Leonardi and Barley, 2008; Orlikowski, 2000; Orlikowski, 2007; Orlikowski and Scott, 2008). As we recognized there, there are several different ways of conceptualizing this relationship: as on in which one side of the other dominates; as one in which there is a mutual interaction between different systems; or as one in which the two systems are inseparable. We shall discuss these three in more detail in the next section. In fact, what we can see from this diagram is that the outside relationships - sociation, embodiment and sociomateriality - are in fact all mediated through the process of semiosis. Since, phenomenologically, humans always already exist within a space constituted through
meaning, and semiosis is the process of production and interpretation of meaning, it is not possible to conceptualize these forms of interaction without involving semiotics.

INTERROGATING SOCIOMATERIALITY IN INFORMATION SYSTEMS

In this section we examine the implications of our framework for how sociomateriality has been conceptualized and used in the Information Systems (IS) field, focusing on leading work and critiques on the subject. As sociomateriality is the specific subject of this special issue, we will forebear from developing a comprehensive overview of the concept and its origins as they will no doubt have been covered elsewhere, but will instead highlight specific characteristics as we develop our critique. Within IS, it is primarily associated with Orlikowski (2007; 2008) who in turn has drawn on writers such as Barad(2003), Suchman (2007) and Latour (2005). Orlikowski herself has changed and developed her position – the later papers adopt a significantly more ‘entangled’ view than Orlikowski (2000). If we primarily address Orlikowski’s work, it is because she has been leading quite the most interesting and prolific work in the field to date.

Two existing critiques of sociomateriality as a concept in IS are particularly pertinent to the present paper and deserve comment. Firstly, Jones (2010) uses the eight criteria of Gerring (2001) to assess the ‘conceptual goodness’ of sociomateriality. He finds the major criterion of coherence as ‘an area of particular weakness with sociomateriality, due to a number of terminological, definitional and theoretical inconsistencies. The case made for sociomateriality also exhibits some looseness of argumentation that makes it difficult to assess the scope of the concept, and hence the coherence of the ideas it involves’. Flowing from these weaknesses, Jones sees further difficulties in operationalization and validity of the concept. We concur and seek to locate and define the concept more precisely in relation to other concepts with which it regularly interacts, but also to revise its realist assumptions, and make transparent conceptual issues on meaning, information and semiosis that are only latent or unclear within the sociomateriality research literature.

Secondly, Faulkner and Runde (2010) address how a focus on sociomateriality leads to the neglect of the non-material nature of many of the technological objects that populate the contemporary world. Kallinikos (2011a) is correct in according modern information and communications technology and technological design (form and function) ‘a growing

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9 Jones (2010) is also questioning of its field utility, and more positive on its resonance, contextual range and parsimony, while seeing sociomateriality as a concept having strong potential analytic/empirical utility.
emancipation from the materials with which they are entangled.’ Hyle (matter) increasingly gives way to eidos (function/form), and software, for example, is to some degree technology without matter, reflecting a move towards a culture of the virtual or non-material (Kallinikos (2011b). These developments underline the seriousness of the concern of Faulkner and Runde (2010) when they state with reference to Orlikowski’s work that: Sociomateriality, at least as it has been developed so far, does not appear to have an explicit place for non-material technological objects.’ Part of this, of course has been because Orlikowski has been primarily addressing Law and Urry’s (2004) point that contemporary social science is ill-equipped to address emerging issues of ephemerality, multiplicity, dispersion and mobility, and that ‘some of these shortcomings arise from our conceptual difficulties in grappling with the intextricably material nature of sociality’. (Orlikowski, 2007). But this has led to a radical under-conceptualisation in the IS sociomateriality literature not just of the non-material, but of a range of issues and relationships that have always been inbedded in socio-technical interplay, and that contemporary technological advances have pushed even further to prominence.

In this, then, we concur with Faulkner and Runde (2010) but extend the analysis addressed but underplayed in their paper by suggesting that the integrative summary framework in Figure 4 provides a more coherent and explicit description of how non-material technological objects vitally depend on semioisis for their ontological status. Indeed, we would suggest that one of the limitations of Faulkner and Runde’s otherwise excellent ground-clearing paper is that the relevance of semiotics to their arguments and position are heavily implicated but nowhere explicitly applied in a coherent manner. However, their work is more explicitly consistent with the Figure 4 framework in their realist position, their characterisation of non-material technological objects as ‘deeply social things’ (p. 17), and in their qualified rejection (see page 28, note 15) of what they call the interpenetration thesis put forward by Orlikowski (2007).

In terms of our summary integrative framework, we would first critique Orlikowski’s later work, where the relationship between the social and the material (primarily technology) is quite radical. We neither have one dominating the other; nor two independent but interacting domains; but rather the two are so inextricably interrelated that they cannot be separated, and their properties are defined only in relation to each other.

“In other words, entities (whether humans or technologies) have no inherent properties, but acquire form, attributes, and capabilities through their interpenetration. This is a relational
ontology that presumes the social and the material are inherently inseparable.”(Orlikowski and Scott, 2008, p. 455).

Interestingly, this quote would actually seem to be inherently self-contradictory since if we take it to be true then it would not be possible to parenthesise “humans or technologies” since the two would be indistinguishable. In terms of the framework articulated in this paper, we would argue that sociomateriality as described in Orlikowski and Scott (2008) actually involves a triple reduction. Let us look at these in more detail.

Firstly, it reduces what should properly be two distinct but interacting structures to a duality that loses sight of both of its components. One reason for this reduction is the lack of what Elder-Vass (2008a) calls a depth ontology, and this would seem to be an inherited influence from Giddens’ structuration theory, and also from Actor Network Theory (ANT) (Elder-Vass, 2008ab). The distinctions between the empirical, the actual, and the real provides a dimension of depth to critical realism’s ontology. Bhaskar’s ontology, as we use it, has a second dimension of depth in its recognition that reality is stratified into an ontological hierarchy of entities, in which higher level entities have emergent properties – properties not possessed by the lower level entities that are their parts. These mechanisms in the domain of the real are responsible for emergent properties, synonymous with causal powers, that interact to produce actual events. For critical realists both social structures and human individuals are entities with emergent properties that arise from their ontological structure. Thus a critical realist account of the social, material and personal can recognise that human individuals, social structures and indeed entities of other kinds have causal powers that are distinct from each other, and that both (or all) interact to produce events - for example social events – even though human individuals are parts of the social structure concerned. By contrast, Orlikowski and Scott (2008) subscribe to a relational ontology that presumes the social and the material are inherently inseparable, an ontological fusion signalled by the lack of a hyphen in ‘sociomaterial’. They also see ANT, sympathetically, as the most prominent part of the sociomateriality literature. But as Elder-Vass (2008b) points out, ANT’s ontology has a multi-dimensional absence of depth ontology and tends to be limited

10Writing from a critical realist perspective on integrating institutional, relational, embodied and emergent attributes of structure, Elder-Vass (2008a) rejects structuration theory’s conflationist ontology while seeing some value in Gidden’s theory of the embodied facet of social structure.
to the empirical. Its ontological flatness, and its assumption of symmetry between human and non-human actors, mean that it cannot subscribe to critical realism’s assumption that particular causal powers (and hence the particular terminology appropriate to their description) vary depending on the underlying structure and mechanisms of each type of actor, be it material, social or personal.

Secondly, sociomateriality reduces the role of active subjects without whom neither society nor technology would actually exist or be reproduced; semiosis itself only operates through individual subjects who must always be the ultimate efficient cause of any interaction. As critical realism argues, social structures (and technological structures to the extent that they are part of a social system as characterized in socio-technical systems and actor network theories) do not exist independently of the activities and practices that they regulate, and only exist in their effects or occurrences. Moreover, social structures do not exist independently of peoples’ understanding of what they are doing. Thus the social and the material cannot have a direct interaction, or indeed entanglement, without the mediation of people and semiosis. In the way sociomateriality is portrayed and operationalised in, for example, Orlikowski, (2009) and Scott and Orlikowski (2009) people and semiosis are operational but, we would argue, insufficiently theorised.

Thirdly, sociomateriality reduces the role of semiosis as the process and mechanism through which meaningful human activity occurs. Social relationships and structures are all embedded and represented in a semiotic fashion and physical media both represent and transmit signs and symbols but also only become objects of representation and interaction to the extent that they are or can be represented symbolically. In other words, technology/media are both a medium of semiosis, but also both a condition for and result of semiosis.

Interestingly, the position represented in Figure 4 is in fact quite compatible with Orlikowski (2000) which puts forward the idea of a technology-in-practice view, though we have of course provided the addition of semiotics. We also preserve the idea inherent in a critical realist position but not in that of Orlikowski (2000) that, notwithstanding the second point above, social structure is ontologically separate from the activities of individual people. It both pre-dates any particular individual, and can in time be reproduced or transformed by their activities. Thereafter our major differences would seem to be with the more recent papers on sociomateriality, but especially with Orlikowski (2007, 2008), Orlikowski and Scott (2008) and Scott and Orlikowski (2009).
APPLYING THE INTEGRATIVE SEMIOTIC FRAMEWORK

The weight of our argument so far is that sociomateriality needs to be more precisely located within a broader integrative framework that makes more explicit a family of concepts and their relationships needed to study advanced information and communications technologies in contemporary organizations. We arrived at such a framework in Figure 4, but how can this be applied in practice? We use recent studies of diverse ICT contexts to address this question.

Of course, as established earlier, semiotics has been widely applied already in the study of ICTs and business though this has not always been through utilizing Peircean semiotics. Particularly interesting, in the light of the framework, is the work of Dourish (2001) and O’Neill (2008) who look at human computer interaction by drawing on phenomenology, Heidegger, Merleau-Ponty’s work on embodiment, and semiotics, to develop the notion of embodied interaction. They are particularly interested in how interactive media can be studied and designed, taking into account the physical and social worlds in which they operate, and how media and technologies relate to the human beings interacting with them. The framework plays directly into such work. As one example, O’Neill (2008), who at one point talks of the ‘semiotic screen’, refers to the Brazil-based SERG group that draws heavily on Peirce’s conception of a sign to develop their understanding of signification with interactive media in screen-based interfaces. Here they find particularly useful Peirce’s concept of how signification takes place through thirdness, where a representation is related to its object via an interpretant (Prates, de Souza and Barbosa, 2000). If this example seems to focus on the cognitive semiotic dimension of the Figure 4 framework, then these HCI researchers are also focusing on the embodied interaction of the personal and material, in a physical, human designed space. Dourish (2001) in particular also stresses the role of the social in HCI assessment and design processes, giving as an example the study of an air traffic control centre by Hughes et al., (1995).

However, the relevance of the framework can hardly be restricted to HCI studies. Recall our position that signification processes must be located in relation to the personal world of minds, intentions and knowledge; the social world of power and normative practices; and the material world of space-time, technology and bodies (Habermas, 1984). Orlikowski (2009) provides a powerful example of these issues and the relevance of the Figure 4 framework in her description of MPK20, and the Sun Microsystems Project Wonderland rooms, offices, screens and documents that form part of an online, three dimensional, immersive environment for workplace
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collaboration. While she does not develop the analysis of this synthetic world, she asks interesting questions of how they can be researched. She chooses the perspective of entanglement and draws upon Actor Network Theory and Barad’s (2003) notion of apparatus to focus the research possibilities. However, given the centrality of humans and of meaning and communication in how MPK20 and the Project Wonderland Rooms operate, the sociomateriality perspective as described fundamentally lacks a coherent semiotic dimension in understanding the material, social and personal worlds being described and analyzed. How does meaning arise? What sign systems are operating and how are they employed? What are the power dimensions of the control or lack of influence over meaning, communication, and information? How do social structures and processes relate to personal understandings and influence action? What is the role of non-material technological objects in the generation of meaning, behavior and performance? These are only illustrative research questions that follow from using our integrative summary framework, but do not flow easily from applying a more limited ‘sociomateriality’ perspective.

We can pursue this issue in the work of Schultze (2010) on embodiment and presence in virtual worlds. These are multi-modal platforms featuring rich graphics, 3D rendering, high-fidelity audio and video, motion and interactivity. Examples include Second Life, Teleplace, EverQuest, consisting of technology designed to create and experience virtual spaces, objects and people with which a user can interact. We would suggest that a semiotic approach is much more attuned to studying such phenomena than the sociomateriality perspectives we are interrogating. For example, Schultze reveals a complex world where avatars re-embody the communicator who has been disembodied through computer mediation. Embodiment here means that the communicator can engage in practices of the body (e.g smile, sit, move) and have a sense of presence whether in an actual or virtual environment. Semiosis pervades both the design process and features of the virtual world, but also how it is operationalised through social, personal and material interaction. As Schultze describes it, how the users constructs an avatar with regard to personality, appearance and behaviour is imbedded in a system of meaning informed by the social norms and conventions shaped by both the actual and the virtual world. Indeed Nowak and Rauh (2005) highlight some of the social norms of avatar appearance, with a humanoid gendered avatar being the first choice of self-representation, having the more likeable and persuasive qualities necessary to be effective in social settings. Here we can see the personal and social worlds interacting through sociation and semiosis, mediated by technology (see Figure 4). One
of the avatar’s key affordances is embodiment, in the sense of giving participants a virtual body that enables them to engage in practices of the body and recapture the body’s non-discursive, semiotic capabilities. Here we see the personal and the material interacting through embodiment and semiosis. This interaction is also performed to give experiences of presence. Schultze (2010) helpfully list six kinds of illusory presence – telepresence, social presence, co-presence, self-presence, hyper presence, and eternal presence – made possible through personal-material interactions. And, as we saw with Project Wonderland, virtual worlds can also be social worlds where sociomaterial and semiotic interactions link the social, the material, and emergent meanings and performance.

Another example we will look at is Scott and Orlokowski’s (2009) analysis of the social media TripAdvisor, which, they argue, as enacted social media, is a sociomaterial phenomenon. TripAdvisor, they record, is one of the largest online travel communities with over 20 million reviews and opinions stored on over one million hotels, restaurants and venues, contributed by some 30 million visitors per month. Scott and Orlikowski (2009) plot the transformation of how assessment knowledge of the industry is produced by studying two hotels. They find that TripAdvisor ranks them using the same algorithm, thus configuring them as rivals, though the hotels have different attributes, characteristics and, indeed, markets. There are also noticeable differences between the profiles of travelers posting their reviews of these two establishments. Postings can also be multi-media including images, e.g photographs of rooms, level of cleanliness, window views.

TripAdvisor’s ratings reflect individual users’ personalized and situated experiences in a hotel, and their decision to provide a review. Unlike the more traditional Automobile Association (AA) ratings that focus on operational issues and standardized assessments of facilities, TripAdvisor’s ratings are ‘temporally sensitive continually reconfigured, personal, and based upon relatively unregulated content’ (Scott and Orlikowski, 2009). Not surprisingly hoteliers found the views and ratings often variable and subjective, but also felt unable to do much to change the type of knowledge being produced through this form of social media. Thus TripAdvisor, as a social media technology, gives the subjective reviews and ratings a determinacy and reach not otherwise achievable while also challenging the hoteliers’ and institutionalized hotel recognition schemes like AA’s primacy and control.
This exploratory study brings out several points that lie within the sociomaterial dimension of the framework. But does it not thereby exclude many interesting questions from the other two dimensions – the personal/technological and the personal/social? For example, how do individuals themselves relate to the technology – in what circumstances do they use it? Why do they use it? Is it only very good or bad experiences that get recorded? What is their level of belief on the accuracy and reliability of the data provided? Is it the ease of access that determines use, i.e. convenience, rather than confidence in the information? Is the description of “actual” experiences more convincing than statistical data? What is the role of semiosis in seeking answers to these questions? Then there is the personal/social dimension i.e. sociation and semiosis - and how the personal influences the social ‘facts’ being created, and how these are then influencing personal decisions. Semiotically, how does social media like TripAdvisor change meaning, the flow of information, and create ratings and assessment as social ‘facts’? These sorts of questions raise issues about the creation, interpretation and response to signs, and the role of signs in creating a continually remade and contested social and personal reality.

The study of a fully computerized dairy production plant by Kallinikos (2011b) is particularly alive to the role of signification in seeking to understand how ICTs interact and help change the material and cognitive foundations of work. He points out that, as ICTs proliferate, they bring with them symbol schemes and codes that do not rely on the signifying conventions of similarity and proximity (Peirce’s indexical signification). This can create real difficulties in sense-making, and explains to a degree the attempts in our previous examples to technologically create similarity and proximity for social and personal use e.g. in the Project Wonderland and avatar examples. Kallinikos points to computer technology bringing to organizations on a massive scale comprehensive systems of information tokens and codes that sustain software packages, and also generating an immense output of data and information tokens. He follows Zuboff’s (1988) claim that ICTs alter the tangible, social and personal nature of work and transforms it, literally to reading, that is, ‘an encounter with symbol schemes and data items that are supposed to represent surrogate versions of physical and social items and relationships.’ (Kallinikos, 2011).

His study focuses on the milk refinement process at the heart of dairy production. Seven treatment lines produce over 50 products. Production is steered from a separate room that forms
the production control centre of the plant. Planning, controlling and monitoring are highly computerized, with process operators following the status and progression of production on panels of bulbs and monitors in the control centre. Several printouts also report incidents in the production process. The software package provides the means for controlling the quantity of received milk, channeling it into milk silos where it is preserved at the appropriate temperature before being refined. Quantity is reported both in numerical and analogue form. One form shows graphically the level of the milk in the silo tanks. The complex process of production is steered with the aid of three computers with human intervention at points to make commands and check progress. The mechanics of the various processes is steered through electronic sensors and more than 1000 electronic valves, which connect the seven treatment lines with the computers in the control rooms.

Compared to other semi-automated production plants, high computerization changed the nature of work and personal-social-technological interactions. For example, in order to grasp how the software package worked and what it signified, it was necessary to reconstruct mentally the physical processes and flows regulate by the package. The cognitive burden and reliance on not easy-to-understand symbols and text were greatly increased through use of the software, computers and related displays, while physical presence in the production process, and information there from, were greatly decreased, not least due to the operators’ location in the remote control room. We see here fundamental changes in the way the personal, social and material interact through sociation, embodiment, sociomateriality and semiosis. Signification becomes increasingly abstract and representational. Thus sixteen panels with 700 color coded bulbs report the progression and status of the process. A process printout records failures and their location though in a highly coded form. A highly coded system printout, often requiring specialized staff for its interpretation, records disturbances to the adequacy of the conceptual and organizational logic of the software package itself, and brings another series of codes, categories and definitions. In fact the documentation of the software package and the installations to which it relates involves 50 manuals of symbols definitions, codes and relationships and functions. Not surprisingly, operators with experience in semi-automated plants decried the increased cognitive complexity and the constricted embodied and sociated interactions. Lack of physical experience with the installations, and lack of knowledge of the
tangible reality of the plant were seen as severe limitations on operator capability, while at the same time the increased reliance on abstract coding systems increased their stress and anxiety.

Kallinikos records that some moves towards improving referential attribution were made in the sign systems utilized. For example, the bulb system was geometrically organized to recapture the totality of the production process, through the decomposition and elaborate segmentation of its various steps. A sort of structural resemblance was thus established between the bulbs (symbol tokens) and the absent reality of the refinement process (reference). The geometric arrangement of the signaling system also contained an indication of temporal patterns. In a relatively simple and precise way, the process printouts came to complement the bulbs system by indicating through numerical description the installation item concerned and through binary coding (right-wrong, stop-go) its current state. However, operators seemed to suggest that the vicarious representations of the software ‘failed to restore the confidence that referential reality is capable of providing to people accustomed to context-embedded work based not just on the reasoning and distancing capacity of the eye, but on sensory-motor manipulation of tangible things (Kallinikos, 2011).

His study is particularly rich in showing the central role semiosis needs to play in the study of ICTs in work organizations. ICTs interacting with people and organization in this case, saw process operators seemingly needing to turn their back on the physical production process and devote themselves instead to the task of examining the very structure of signs, codes and symbol schemes, whereby physical relationships were mediated and regulated. The codifications of the software package did not represent a mirror image of the material and technological constitution of the work processes, but produced a multi-layered fragmented systems of signs and codes that saw little relationship between token and referent, but influenced and was influenced by interaction through sociation, sociomateriality and embodiment as represented in our framework.

In this section we have used case research in HCI, virtual worlds, social media and computerized production plants to illustrate the applicability of the integrative semiotics framework arrived at in this paper. This, of course, does not exhaust the possibilities for the framework, especially in an IS field replete with technologies of information and communication highly dependent on codes and signification processes. Our own view of the three worlds framework in Figure 4 is
that there are different degrees of relationship between them in different contexts. Thus social networking/communication would seem to be heavily technologically dependent, with each new generation bringing forth new possibilities, while religion, for example, is heavily based on social practices and symbolism, and little on technology. The three systems interact generating emergent and enactive phenomena within any particular context, and following our critical realist underpinning, these emergent phenomena can themselves affect the underlying systems in a process of downward causation.

**CONCLUSION**

This paper identifies and addresses limitations in the theoretical and operational coherence of the concept of sociomateriality as applied in many IS studies to date. By establishing philosophical foundations in a Piercean semiotics rendered consistent with critical realism, we were able to build in theories of information, meaning and embodiment to construct a consistent integrative framework of operationalizable concepts for studying information systems and the personal, social and material worlds they inhabit. In fact, we welcome the recent development of the discourse on sociomateriality in IS as a refreshing invitation to think anew how we research contemporary advances in ICTs, particularly in terms of its aim to re-establish the importance of technology and to renew socio-technical studies, especially in the light of advances in ICT and their effects such as social networking.

This paper has responded by locating more precisely where sociomateriality, as a usable concept, fits with a family of concepts and with the relationships between them. The aim has been to provide a more philosophically grounded, more comprehensive theoretical framework for use in carrying out research. The framework is consistent with several aspects of previous conceptualizations of sociomateriality, not least the notion that sociomateriality is always being enacted, performed and in the making. But on our revised view, two other relationships - of sociation and embodiment - also need to be addressed on a more precise basis, and semiosis needs to play a central, explicit rather than implied part in the study of contemporary ICTs. We identified and attempted to address a number of limitations observed in the sociomateriality studies under review. These included a flat or contradictory ontology being employed; insufficient philosophical underpinning, with little philosophical or practical account of information and meaning; semiosis implied rather than raised to the level of a descriptive or
explanatory framework; and insufficient attention, as a result, able to be given to non-material technological objects such as discussed by Faulkner and Runde (2010). In brief, we found that sociomateriality was not sufficiently located in the broader context and network of concepts and relationships needed to study contemporary ICTs. Sociomateriality as a concept has been asked to do too much work. Our integrative framework has sought to delimit its role, and so make the concept more useful, and valuable as a complement to other dimensions of human social activity.

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