Theorizing Information and Information Systems

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Abstract

<Aim> To advance the understanding and use of 'information' and 'information system', two key concepts for Information Systems (IS).

<Relevance> To date these two concepts remain fuzzy, contradictory or arbitrarily defined. However, being fundamental to the IS field, they require continuing attention and insightful discourse, which have so far been missing. This thesis follows a call expressed by several IS academics over the past decades to engage with these concepts.

<Methodology> Several hundred publications engaging with information at a conceptual and theoretical level from a wide range of disciplines, as well as dozens of definitions of IS from within IS are reviewed. These publications were critically analyzed regarding their underlying epistemological and ontological assumptions, as well as their strengths and limitations. This critical engagement with the literature provided a basis for further theoretical development.

<Major Findings> (Chapter 2) A taxonomy of five different views of information: the material, engineering, objectivist, subjectivist and inter-subjective view. (Chapter 3) A facet based approach to information identifying 15 aspects associated with the semiological dimensions of information, namely its physical inscription, the rules of sign systems, meaning, and usage. (Chapter 4) Five views of IS are critically investigated: technological, social, socio-technical, modelling, and process oriented; in addition a sixth view is developed understanding IS as ongoing sociomaterial entanglement.

<Contributions> (1) The taxonomy of approaches to information identifies and critically reflects on different views on information, thus enabling conceptual clarity to the question of what is information and how information is seen differently. Moreover, shifting between views enables the generation of new ways of looking at existing research problems. (2) The facet view approaches information from a Wittgensein'ian perspective using description rather than definition. This enables researchers as well as practitioners to appreciate and appropriate various social and technical facets of information simultaneously and integratively in a meaningful way. (3) The review of 'information system' contributes to critical theoretical debate in IS, with the proposed sociomaterial understanding providing a solid ontological footing for approaching and investigating the entanglement of seven aspects associated with IS: practices, social actors, technology, data, information, development, and organizations.

Acknowledgments

Often acknowledgments are as readable as the credits at the end of a movie. What they make up in ensuring tribute to those to whom one is indebted they often lose in being readable. In contrast, I would like to recapture my thesis 'journey' in form of a short narrative introducing the names of other 'characters' that came onto the stage while my story unfolds. The result is of course chronological, but as in any story, the time a characters enters the plot does not indicate the magnitude of their role.

Naturally, any story needs a background, a stage on which the story can unfold. As Kant, Heidegger or Wittgenstein have noted, nothing can exist in itself without a backdrop that allows it to come into existence. This also applies to my story and the stage on which my thesis is found is in the love and nourishment of the people who care for me. Therefore, and foremost I am in debt to my family, partner and friends: my parents Gerda and Hans-Berthold who were there for me right from the beginning, my partner Jennifer who showed me that it can be done, my sister Nina, my brothers Fabian and Florian as well as their partners Matze, Judith and Sarah. I also extend my thanks to Margaret and Ting who started the 'food club' with me, and of course my friends and extended family who undoubtedly prefer their anonymity to be preserved.

My PhD journey began before it began while working with the Bibliometrics and Informetrics Research Group (BIRG) at the University of New South Wales (UNSW). There I was encouraged to pursue a doctoral degree by my colleagues Connie Wilson, Patricia Willard, and Mary Anne Kennan. Their support and the financial security provided to me when I was selected for an Australian Postgraduate Award (APA) and a faculty top-up scholarship by the Australian School of Business allowed me to begin my PhD journey at UNSW.

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thinker, to trust my own judgments, and that precious intellectual gems may be found outside of my own comfort zone.

I am also in debt to my co-supervisors Fletcher Cole and Patrick Finnegan who both provided invaluable insights on my writings by encouraging me to express my ideas clearly and vividly to those not familiar with every aspect of my research. Thanks to their help my thesis became more readable to everyone. Fletcher, I thank you in particular for his insights about the integrative nature of the different semiotic dimensions which helped me greatly in advancing on Stamper's work; and to Patrick in particular for pointing out the nuggets of the third essay that should be carved out and made more central to my argument.

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Publications Associated with this Thesis

Journal Publications

Boell, Sebastian K.; Cecez-Kecmanovic, Dubravka (2010). Literature reviews and the hermeneutic circle. *Australian Academic and Research Libraries*. 41(2). 129-144.

Conference Presentations

Boell, Sebastian K.; Cecez-Kecmanovic, Dubravka (2012). Conceptualizing Information Systems: From 'Input-Processing-Output' Devices to sociomaterial apparatuses. *European Conference on Information Systems 2012 (ECIS 2012)*. Paper 20. [online] http://aisel.aisnet.org/ecis2012/20

Boell, Sebastian K.; Cecez-Kecmanovic, Dubravka (2011). Theorizing Information – From Signs to Sociomaterial Practices. *Australasian Conference on Information Systems 2011 (ACIS 2011 Proceedings)*. Paper 53. [online] http://aisel.aisnet.org/acis2011/53/
Awarded 'Best Theoretical Paper' at ACIS 2011

Boell, Sebastian K.; Cecez-Kecmanovic, Dubravka (2011). Are Systematic Reviews better, less biased and of higher quality?. *European Conference on Information Systems 2011 (ECIS 2011)*. Paper 223. [online] http://aisel.aisnet.org/ecis2011/223

Boell, Sebastian K.; Cecez-Kecmanovic, Dubravka (2010). Attributes of information. *AMCIS 2010*. Paper 129. [online] http://aisel.aisnet.org/amcis2010/129.

Boell, Sebastian K.; Cecez-Kecmanovic, Dubravka (2010) Systematic review and the hermeneutic circle of literature reviews. *Research Applications in Information and Library Studies (RAILS) Conference, 22. January 2010*. Canberra : CSU.

Doctoral Consortium

Boell, Sebastian K. (2011). Information and Information Systems, a Sociomaterial view. *Doctoral Consortium at the International Conference on Information Systems (ICIS 2012), Shanghai China.*

Workshop Presentations

Boell, Sebastian K.; Cecez-Kecmanovic, Dubravka (2011). Theorizing Information – From Signs to Sociomaterial Practices. *SIG Philosophy Workshop at the International Conference on Information Systems (ICIS 2012), Shanghai China.*

Chapter 1 : Introduction

Information Systems (IS) as a field has a past, present and future. This past, present and future are linked through several core concepts that are of particular interest to IS (Baskerville, 2010; Lee, 2004, 2010; Straub, forthcoming). Two such concepts are the concepts of 'information' and the related concept of 'information system'. To advance the understanding and use of these concepts for IS is the aim of this thesis.

This introduction first provides a general rationale for engaging thoroughly with important IS concepts as a means for advancing IS research. As part of this it introduces 'information' and 'information systems' as two such concepts. Based on this, the relevance of information as concept is further established. This is followed by a section discussing the research objectives of this thesis, stating what is new, and why it matters. The second last section then briefly summarizes the research approach. Finally, the introduction summarizes the contributions made by the three essays presented in chapters two to four and thus also provides an outlook onto the content of the remainder of this thesis.

1.1 The Evolution of IS Research

IS is no longer a young field of academic endeavor as it can look back at several decades of IS research (Hirschheim et al., 2012; Hirschheim and Klein, 2011, 2012). As IS is starting to look back it is similarly looking forward at where it is heading (Cordoba et al., 2012; Grover, 2012, Lee, 2010). For instance, in a 2012 issue of the *Journal of Information Technology* Geoff Walsham (2012) reflects on a future agenda for IS research. Similar to Churchman (1968) Walsham emphasizes the potential of IS to engage in building a better world for humankind. In turn, the question of what a better world should look like is deeply related with the question of ethics (Adam, 2012; Avision, 2012; Mingers and Walsham, 2010). This exemplifies not only that ethics is an important aspect for future IS research, but more importantly that it underlines the constant need for IS to innovate and transform its research (Bryant and Land, 2012; Hassan, 2011).

However, this process of innovation is not one that is merely undertaken at the level of an individual researcher, but more importantly, it depends on decisions that are made on a collective level (Baskerville, 2012; Schultze, 2012). Like any other field IS is engaged

in an continuous normative process (Davison, 2012) that encourages particular research through a self-reflective cycle which is maintained by the intellectual core of artifacts published in its premier journals (Nevo et al., 2009). Subsequently, based on 1.056 articles published in *MIS Quarterly* and *Information Systems Research (ISR)* between 1977[1] to 2006 Nevo et al. (2009) describe IS identity as:

> the scientific study of the design, development, and management of information technologies, as well as their use by and impact on individuals, groups, and organizations. Of particular interest are information technologies (and their specific components) that enable communication, collaboration, and decision making (p. 237).

Published research can therefore be seen as glue that keeps together and maintains the coherence and integrity of the IS field.

One central aspect of this is how theories are developed, refined and tested as part of IS research. While theories in IS come in multiple forms (Gregor, 2006), theoretical contributions in IS are often incremental improvements of established models, or adapted versions of theories developed outside IS in so-called reference disciplines (Grover et al., 2008). One rationale driving this incremental improvement of well established theories can be found in the normative behavior of the IS field where authors seek to publish in established journals. Particularly if the tenure clock is ticking there is simply no incentive to engage with anything but “low risk” research that is most likely to survive the review process as there is a "tendency for AEs and reviewers to reject what is unfamiliar or questionable, so as not to rock the boat of the *status quo*" (Davison, 2012, p. 100, emphasis in original). Weber (2012) therefore noted that theories that are easy to test empirically may be more appealing to IS researchers than those that allow deeper insights but that are founded on less solid empirical footing. However, in contrast to providing substantial empirical evidence, solid theoretical contribution can also be made by "clearing away conventional notions to make room for artful and exciting insights" (DiMaggio 1995, p. 391). As a result there have been calls for IS to not only be more vigilant when adapting theories from outside IS (Grover et al., 2008), but more importantly to increase efforts in developing its own theories that can reverse the spread of theory from IS to other fields, thus allowing IS to enhance its standing as a reference

1 MISQ was incepted in 1977, ISR in 1990.

discipline itself (Baskerville and Myers, 2003; Cecez-Kecmanovic, 2002; Grover, 2012; Straub, 2006).

This therefore raises the question of how the intellectual development of the IS field can be further facilitated. In this context a number of suggestions to enhance IS research are made. For instance, Baskerville (2012) highlights the relevance of new and appealing philosophy. This may include novel ontological or epistemological approaches. In addition, IS researchers can adopt alternative narratives in their research (Westrup, 2012), or embrace alternative argumentation strategies and writing styles (deVaujany et al., 2011). Moreover, Walsham (2012) argues for methodological and disciplinary pluralism, with Constantinides et al. (2012) pointing our means for diversity in IS research. They assess the aim of IS research regarding four pragmatic ends of: ethics, logic, aesthetics, and the highest good in relation to three choices regarding: topic selection, methodology, and presentation of outcomes. The authors show that for each of these twelve areas (4 x 3) a dominant view can be contrasted with an alternative view. Constantinides et al. (2012) thus point out alternatives in the IS research landscape.

In addition, an ongoing engagement with central IS concepts can provide an important way to further IS research and to foster the development of IS theories (Baskerville, 2010; Davision, 2010; Lee, 2010; Straub, forthcoming). Two central concepts that are of particular relevance in this context are the concept of 'information' (Avgerou, 2010; Baskerville, 2010; Lee, 2010; McKinney and Yoos, 2010) and the concept of 'information system' (Checkland and Holwell, 1998; Lee, 2004; 2010; Paul 2007). The former, being of special interest to understanding what an 'information systems' is, is clearly linked to an understanding of what 'information' is. However, while information is a central concept for IS, efforts to advance this concept in IS are scant (Avgerou, 2010; Baskerville, 2010; McKinney and Yoos, 2010; Lee, 2004, 2010). This is particularly problematic, as it can be argued that understanding of 'information' is one aspect that distinguishes IS from other fields and thus offers IS a means to make a unique IS specific contribution that can render it a reference discipline to others:

> The unique and enduring purpose of IS that distinguishes it from its reference disciplines is this: To understand and improve the ways people create value with *information*. This purpose is [sic] foundational assumption for everything we research and everything we teach (Briggs and Nunamaker, 2012, p. 7-8, my emphasis).

There is therefore a clear need for IS to further engage with the concept of information to advance the understanding of information, as well as the engagement with, and use of this concept in its research.

1.2 The Relevance of Information

While the concept of information is of clear importance to IS there is also a clear lack of interest in this concept. Over the last few decades different IS researchers have emphasized the importance for IS to engage more thoroughly with the concept of information:

Four decades ago Stamper (1973) already stressed that in addition to understanding information technology (IT) there is also a need for IS to engage with the concept of information to advance IS research:

> The explosive growth of information technology has not been accompanied by a commensurate improvement in the understanding of information. It is undoubtedly easier to manufacture and distribute electronic hardware than to refine our concepts of information and disseminate them to the hard-pressed men and women who are trying to put the new technology to work in government, industry and commerce (p. 1).

More than a decade later Galliers (1987) noted in regards to Stamper that not much progress in understanding information has been made raising again the need for IS to engage more thoroughly with the concept of information in addition to its engagement with IT:

> Unfortunately it is also the case today that our understanding of information *technology* has continued to outstrip both our understanding of *information* and our ability to develop truly effective information systems (p. vii, emphasis in original).

Also in 1987 Boland (1987) emphasizes the importance for IS to engage with the concept of information. He states that it is:

> a problem that has plagued research on information systems since the very beginning. The problem is the elusive nature of information itself, and the way we as researchers have failed to address the essence of information in our work (p. 363).

And finally, another two decades later McKinees and Yoos (2010) observe that:

> few manuscripts on information exist in widely read IS journals; information tracks or session [sic] are not found at academic conferences; information textbooks do not exist; and few information-centered courses are offered (p. 329).

Overall, these examples underline the fact that so far IS has not managed to thoroughly engage with the concept of information. However, information deserves more attention as "information itself is a rich phenomenon that deserves its own separate focus" (Lee, 2004, p. 13), and also because of the obvious ongoing importance of the concept of information for future IS research (Avgerou, 2010; Baskerville, 2010; Lee, 2010) and its relevance to neighboring reference disciplines: "Looking to the future, “information” is obviously a fundamental, transdisciplinary concept," (Mingers, 2010, p. 15; see also above Briggs and Nunamaker, 2012).

In addition to the general lack of attention, there are a number of specific reasons for IS to engage more thoroughly with the concepts of 'information' and 'information system':

First, unreflective use of the concept can be detrimental to IS research as it implies a particular understanding that is not made explicit by researchers. Moreover, researchers may not even be aware of their specific understanding and its implications and restrictions. As a consequence, unreflective use of the terms 'information' or 'information system' can condition research in a particular way without researchers themselves being aware of it (McKinney and Yoos, 2010), thus being a potential source of unreflected biases in IS research.

Secondly, there is a general need for conceptual clarity in regards to any scientific concept. Conceptual clarity is required in order to draw meaningful distinctions that are shared within an academic community as part of their research. However, within the IS community conceptual *un*clarity regarding 'information' and 'information systems' reigns in the sense that:

> The terms ‘information’, ‘systems’ and ‘information systems’ have fallen into such careless use that they seemingly no longer denote anything different from one another. In the same way, ‘information’ has come to be used interchangeably with ‘data’ and ‘knowledge’[...]. Such usage trivializes and obscures the rich ideas that these terms originally signified. (Lee, 2004, p. 10)

Third, lack of conceptual clarity can therefore be seen as potentially hindering advancement in IS as it can limit intellectual exchange. Thus, lack of interest in information and therefore a potential simplification of the concept can hinder theory development in IS, as the ability to draw fine distinctions is undermined:

> information is a pivotal IS term. The lack of attention by the IS field to the various views of information has restricted theory development as researchers neglect to specify assumptions that underlie the concept and treat information as a general purpose solution to an increasing range of problems (McKinney and Yoos, 2010, p. 340-341).

Fourth, different conceptualizations of information are possible and IS research needs to be aware of their differences in order to embrace a wider range of conceptualizations of information in its research (Lee, 2010). For instance, McKinney and Yoos (2010) distinguish four different views of information. However, they also establish that the bulk of IS research adopts an understanding of information that more or less equates information with data (c.f. Lee, 2010). Subsequently there is a need for IS to branch out and investigate alternative conceptualizations of information that go beyond a token or data-like understanding of information (Lee, 2010).

Finally, the dominant views towards information used in IS are often simplistic, preventing richer and more in-depth theorizing. In a survey of IS textbooks Rowley (2007) found a hierarchical understanding dominating that relates data, information, knowledge, and wisdom (Ackoff, 1989) in the sense that they are linked through an increased level of understanding (Bellinger et al. 2004). This view, however, is widely criticized, for instance, as being imprecise (Davenport, 1997; Stenmark, 2001), as not serving any scientific purpose (Stamper, 1985), as not allowing any deeper theorizing (Bates, 2010), and as not being able to explain why the same data can lead to different information (Fricke, 2009; Kettinger and Li, 2010).

Thus there is a general need for IS academics to reflect upon the concepts of 'information' and 'information system' as to further their understanding of information and the role information plays for them in their research.

1.3 Research Objective and Aim

The sections above underline that engagement with concepts that are central to IS are a valid means for advancing IS research and that 'information' and 'information system' can be regarded as being such concepts. Hence this thesis engages with the concepts of 'information' and 'information system'. In particular it follows three main objectives:

1. To provide an overview and reflect on the various concepts of 'information' and to increase awareness of IS researchers about the breadth and depth of concep-

tual variations in defining information and their potential implications for the IS discipline.

2. To investigate the concept of information in a way that can embrace social, as well as cognitive, technological and material aspects of information. Importantly, these aspects of information are not to be understood as existing side-by-side but instead in an integrative way.
3. To critically reflect on how 'information systems' can be conceptualized and to investigate what these conceptualizations entail.

These three objectives are engaged with by three different essays presented in chapters two, three and four.

Addressing these objectives, the thesis contributes to IS research by furthering the field's understanding of the concepts of information and information systems. Specifically:

1. It introduces a taxonomy that provides orientation over the complete range of existing conceptualizations of information. This taxonomy goes beyond existing overviews as its coverage of information in regards to IS is much wider than those provided in earlier research by Mingers (1996) and McKinney and Yoos (2010).
2. In addition, this thesis introduces a conceptualization of information based on different facets provided throughout the literature on information. This 'facets of information' theory thus overcomes the incommensurability associated with definition based approaches and thus can reconcile material, technological, cognitive, social and cultural aspects of information simultaneously.
3. Finally, it provides an overview of different understandings of information systems. Based on this overview it introduces a sociomaterial and performative understanding according to which IS are an entanglement of the aspects of practice, social actors, technology, data, information, development, and organizations.

The importance of this research stems from the potential benefits that are associated with this engagement. A number of points underline why this research is of interest to

IS: first, engagement with the concept of information is relevant, as a clearer understanding of information can help resolve confusion in regards to related concepts such as data. For instance, Boland (1987) argues that in IS, the concepts of data and information are confused, as IS often treats "the mere structured data that happens to be so readily available in information systems as if it were information" (p. 364). Thus engagement with information can contribute to greater conceptual clarity in IS (Checkland and Holwell, 1998; Lee, 2010). Secondly, better understanding of information can provide a foundation for future research in IS. Churchman (1968) already indicated that it is important for IS to "delve more deeply into the role of *information* in the managing of systems" (p. 103, my emphasis) as deeper understanding of the benefits of information can provide "a sound argument for more research" (p. 103). Thirdly, clearer understanding of information has potential benefits for the formulation of IS research. For example, McKinney and Yoos (2010) argue that "information plays the key role in explaining how users make sense, interpret, and create information in their environments" and that investigating these questions provides "*significant research opportunities for IS*" (p. 339, my emphasis). Fourth, broader understanding of information is necessary in order to unlock the benefits of information for organizations and society, as "to use information effectively for business and social purposes opens up a range of problems calling for the broadest vision of information" (Stamper, 1985, p. 198). Fifth, a thorough engagement with central concepts such as information and information system can enable IS to spread ideas from IS to other fields and thus clarify the role of IS in relation to its reference disciplines (c.f. Briggs and Nunamaker, 2012; Grover et al., 2008). Finally, theoretical work such as the one presented in this thesis is important for the development of an intellectual core for IS, thus for overcoming some of the struggles described by Grover et al. (2008), who argue that IS can be seen:

> as a low paradigm field where disagreements about the key research questions and methods dominate. This leads to divergent reviews, low acceptance rates, low citation counts, dispersion of talent, and high exit rates. […] This is the case, despite the fact that all top journals in our field promote strong theory. Perhaps an infusion of innovative thinking and generating fresh ways to look at the world information systems could help here. Above, we called such thinking "formulating forward looking theoretical insights." But where does such thinking come from? To answer that question, we might look at how we typically think about theory development in our field in order to under-

> stand where, in most cases, such thinking does not come from. The preferred route to strong theory in the IS field has been to adopt theories from "reference" disciplines […] In many cases the term is interpreted to mean "referencing" the content of those theories —and then inferring from them some incremental knowledge claims in a new IS context. The fact that these theories are available to be referenced is often thus assumed to make them automatically legitimate in our theoretical work. Because of this (mis)conception, IS scholars often rather mechanistically adapt reference theories to an IS context. This happens by sprinkling into the research model additional constructs about the "IT artifact" and then refining the associated instruments with IT-related sugar. Authors then go on to test/validate these adapted theories with data obtained by this preordained instrumentation. If (and when) successful, they then go on to incrementally refine and expand these theories and instrumentation. This process resides in the comfort zone of many IS researchers, as it offers a structured and low risk, and yet legitimate and manageable way for theorizing. Unfortunately, this tends also to be the best way to survive the ruthless scrutiny of reviewers who seek to avoid type I errors in accepted manuscripts, and go happily with the current theoretical beliefs that in most instances wipe out innovative theory. […] But where is the "spark" of innovation and "passion" in this sequence? It is difficult to conceive how such process could offer rich opportunities for "blue sea" theorizing. (p. 44-45)

1.4 Research Approach

The research approach chosen for addressing the research objectives stated above is to conduct an extensive survey of the existing literature addressing the concepts of information and information systems. This is crucial as in order to advance intellectual engagement with these concepts it is necessary to become aware of what is already known about them in the literature. Such an overview can then provide a solid foundation for additional investigation.

Literature surveys are *not* a mere summary of what others have said before; they are an important means for advancing research in their own right. Subsequently, a literature review is "more than the sum of its parts" as it creates "meta-knowledge about a subject area" (Schwarz et al., 2007, p. 43). For instance, literature surveys provide an important means for advancing theory (LePine and Wilcox-King, 2010) such as by problematizing earlier knowledge (Alvesson and Sandberg, 2011).

In addition, the relevance of literature reviews as a means for advancing scholarship is highlighted by the importance of so called review articles for research in general (Bensman, 2007; Garfield, 1987) and IS in particular (Watson, 2001; Watson and Weber, 2002). Garfield, the founder of the *Institute for Scientific Information (ISI)* who can be credited for highlighting the importance of citations and citation analysis to academia (Garfield, 1955) argues that literature reviews are an important contribution to academia in general:

> Just as peer review and refereeing are basic to the culture of science, so is the process of literature review. [...] It is not an accident that so many of our greatest scientists have used, created, and contributed to the review literature. [...] reviews can have great value and influence (Garfield, 1987, p. 3).

Moreover, literature surveys can be seen as an important empirical research method in their own right. Researchers conduct surveys, experiments, or interviews in order to collect empirical material for their analysis. Similarly, the collection of earlier publications and their analysis can be seen as an important empirical research method.[2] Regarding 'information' there are literally thousands of publications discussing information on a theoretical and conceptual level across different disciplines (Bates, 2010; Wersig, 1997; Yuexiao, 1988; Zaliwski, 2011). This underlines the need to "gather" this data for further analysis. As part of the effort to collect such 'data' on information, a hermeneutic approach for conducting literature reviews was developed as the research method. This hermeneutic approach was further validated through peer review as part of national and international conferences as well as journals (Boell and Cecez-Kecmanovic, 2010b; 2010c, 2011c). A thorough description of the hermeneutic approach for conducting literature reviews can be found in appendix A.

1.5 Contributions

This section briefly summarizes the contributions of the three different essays presented in chapters two, three and four.

2 I am in particular debt to Allen Lee for raising this point in a personal conversation at ICIS 2011 in Shanghai.

1.5.1 Chapter 2 : Theorizing Information

The first essay is presented in chapter two and engages with different conceptualizations of information. At the heart of the first essay is the development of a taxonomy of the diversity of different conceptualizations of information. In total, five different views of information are distinguished (figure 1.1). Each of these views is introduced in detail as part of the first essay. In particular, it discusses ontological and epistemological assumptions underlying each view, as well as strengths and shortcomings that can be associated with each view. Furthermore, the usefulness of the taxonomy for IS research is exemplified by showing that it can be used as a device for generating additional insights and research questions. In particular, the first essay makes three contributions:

(1) It introduces the range of possible conceptualizations of information drawing from a vast body of literature. These conceptualizations are introduced by means of a taxonomy that can provide orientation within this body of literature.

(2) The different views covered by the taxonomy are discussed regarding their theoretical foundation, general implications, strengths, and limitations.

(3) The usefulness of the taxonomy for IS is exemplified by showing how it can enable additional insights into IS research. Shifting from one view of the taxonomy to another allows IS researchers to identify additional meaningful paths for future research.

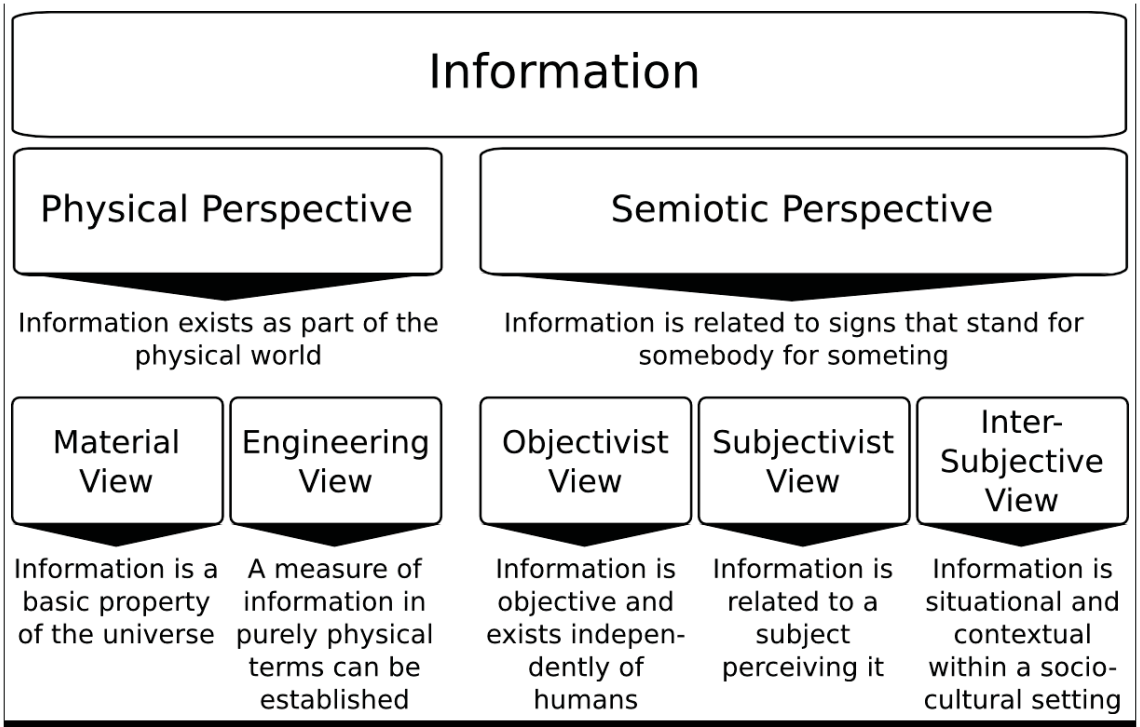

Figure 1.1 Overview of the Taxonomy of information

These contributions are important, as they help answering the research questions:

- What is information?
- How is information seen differently by different approaches? and
- On what theoretical bases do approaches to information differ?

As a result this essay contributes to the overall understanding of the concept of information for IS as it enables better conceptual clarity in regards to information. Moreover, the taxonomy not only provides a means for orientation in regards to information, it also introduces a means by which IS research can be advanced. It exemplifies this process by showing that the shifting understanding of information from one view to another generates new looks onto a problem. As a result, the taxonomy can also help identify gaps in current research and thus can be used as a means through which new research can be generated.

1.5.2 Chapter 3 : Towards a 'Facets of Information' Theory

The second essay presented in chapter three approaches the concept of information from a different angle. While the five different views, of information introduced in the first

essay allow us to look at information in different ways there is an irreconcilable clash between these views as they are based on mutually exclusive assumptions. For instance, it is impossible to understand information as objective and subjective at the same time. However, this clash can be overcome when abandoning definition-based approaches towards information. An alternative Wittgensein'ian (1953) approach towards 'information' looks at descriptions of different 'facets' associated with information instead. Moreover, building upon Ronald Stamper's work on information (Stamper, 1985, 1991, 1992) these facets can be further allocated within Stamper's extended semiotic framework. In total, 14 different 'facets of information' can be distinguished that are associated with the four semiotic dimensions of empirics, syntactics, semantics, and pragmatics (Table 1.1). The second essay makes in particular the following three contributions:

(1) It introduces a 'facets of information' theory that enables IS to look at human/social as well as material/technological aspects of information simultaneously.

(2) It identifies 14 different facets of information that describe a complex and fuzzy notion of information in different contexts and for different purposes thus allowing IS researchers as well as practitioners to further dissect the concept of information and appropriate the relevant ones.

(3) Finally, it exemplifies the usefulness of the 'facets of information' theory by re-analyzing the concept of 'informational capabilities' provided by Leonardi (2007).

These contributions are important as they help to answer the questions:

- How can information be approached through other means than definition?
- What do different aspects associated with information entail? and
- How can these aspects be understood in an integrative and meaningful way?

Table 1.1 Overview of Facets of Information

	Facet	Description
Pragmatics	action relevance	Information needs to be regarded as relevant and useful.
	novelty	Information needs to be new or unexpected.
	degree of trust	Information needs to be accepted and believed.
	time dependence	Information needs to be regarded as existent in regards to a specific point in time.
	bound to social practice	Information needs to be in accordance with social practices shared by a group.
Semantics	comprehensibility	Information needs to be intellectually understandable.
	contextual	Information needs to be regarded as dependent on a wider social, historical, and cultural context.
	level of detail	Information needs to be expressed at a specific levels of detail or completeness.
Syntactics	apprehensibility	Information is expressed in accordance with the rules and character set of sign systems.
	precision and accuracy	Information is expressed in accordance to the precision and accuracy provided by a sign system.
Empirics	physical inscription	Information is conveyed via sign-vehicles that are physically inscribed into a medium.
	detectability	Information needs to be differentiable against background noise.
	speed	Information is conveyed from a sender to a recipient within a specific time frame.
	access	Information needs to be physically accessible.

The second essay thus provides an understanding of information according to which information is bound simultaneously to a physical inscription, the rules of a sign system, meaning, and its usage. Such an understanding of information is of particular interest to IS as it provides a look onto information that can embrace a socio-technical understanding according to which information is always bound to material and social elements at the same time. Moreover, while information is always related to all 14 facets simultaneously, it is possible to discern information for research purposes through the use of facets. This allows IS to gain a better understanding of how people become informed and thus what role IS can play in supporting this process of informing. The use of a facets view of information is exemplified showing that it enables additional insights when interpreting an earlier case on informational capabilities (Leonardi, 2007).

1.5.3 Chapter 4 : Theorizing Information Systems

Chapter four contains the third essay shifting the attention from information to information systems. As discussed above, the two concepts of information and information sys-

tem are closely connected and one could describe their connection as similar to a chicken and egg. Understanding of information affects understanding of information systems and understanding of information systems affects understanding of information. Moving from the first to the second essay, different definitions of the concept of information were replaced by a sociomaterial understanding of information according to which information is always simultaneously related to material as well as social facets. The third essay advances on this understanding of information. Drawing from Karen Barad's (2007) work on agential realism, it introduces a concept of IS as sociomaterial and performative apparatuses.

The third essay reviews different definitions of IS based on which it identifies five different views on IS (Table 1.2). It introduces for each view its underlying rationale, the contributions made by it, and associated limitations. Moreover, looking at different aspects that are evoked by different definitions it identifies seven aspects that are associated with IS. Discussing each aspect, it shows that all aspects are entangled with each other, thus proposing that an information system is an entanglement of practices, social actors, technology, data, information, development, and organizations in which all of these aspects are in a continuous process of becoming through each other. Subsequently, the essay makes the following three contributions:

(1) It provides a review of five different conceptions of IS, critically examining the assumptions underlying theses conceptions and the contributions and limitations of each of these conceptions.

(2) It identifies seven aspects of IS referred to by different definitions of IS and looks closer at what each aspect entails and how they are related with each other.

(3) Finally, it shows that a sociomaterial understanding of mutual co-construction of these aspects integrates these aspects in a meaningful way.

These contributions are important as they help to answer the questions:

- What is the nature of IS and how are IS conceptualized in the literature?
- What are the contributions and limitations of the dominant IS conceptions?
- What are important aspects of IS that definitions of IS evoke? and
- How can these aspects be understood in an integrative and meaningful way?

Table 1.2 Overview of Views of information Systems

View of IS	Description
technology view	Emphasizes technological aspects in regards to IS, in particular it is engaged with the IT artifact and its theorizing.
social view	Emphasizes social aspects, primarily sees IS as social systems.
socio-technical view	Emphasizes the interactional character of social and technical aspects in regards to IS.
modelling view	Primarily focuses on design and may see IS as abstract entities.
process view	Emphasizes that IS are related to activity such as goal directed purposes or the processing of information and data.

Providing answers to these questions follows a call by IS academics to engage more thoroughly with the concept of IS (Baskerville, 2010; Lee, 2004, 2010; Paul, 2007). Moreover, Churchman (1968) in his statement about Marshall McLuhan's work points towards a sociomateriality of IS:

> Marshall McLuhan has pointed out that in the age of electric technology the telephone has actually become a part of the individual person. Indeed in many cases, it would be hard to differentiate between the ear and the telephone that serves the ear. His point is that we cannot "cut off" the telephone any more than we can cut a person's ear off in any satisfactory way. The telephone is part of the system that we call the individual person (Churchman, 1968, p. 35).

Thus a sociomaterial account of IS introduces an understanding that provides a solid ontological footing for early implicit understandings of IS and therefore for defining IS. It enables an understanding of IS in which information, material artifacts and social actors form an integrative whole.

Chapter 2 : Theorizing 'Information' for Information Systems Research: A Taxonomy of Views

2.1 Summary

This essay explores the phenomenon of 'information' and its alternative conceptualizations for Information Systems (IS) research. Based on an analysis of the range of possible conceptual approaches in the literature, a taxonomy of five views for understanding information is introduced. A key distinction is made between the perspectives that locate information in the physical world and those that locate it in the world of human signs. Within the physical perspective, a material and an engineering view can be differentiated. Conversely, within the sign perspective, information is either understood as objective, subjective, or as inter-subjective. It is argued that each view allows different and specific insights into the nature of information in IS research. A shift from one view to another has the potential to reveal new research problems. Such shifts allow the development of potentially new lenses for looking at problems, encouraging the formulation of different research questions, approaches and solutions.

Keywords: information; conceptualizing information; taxonomy of information; semiotics; information systems; information theory;

2.2 Introduction

The Information Systems (IS) field is sometimes viewed as struggling with developing in-depth and novel theories about IS phenomena. Instead, theoretical contributions are often incremental improvements of established models or adapted versions of theories developed outside IS in so-called reference disciplines (Grover et al., 2008). Importantly, theories come in multiple forms and Gregor (2006) argued that goals of theory could be either to analyze, to explain, to predict, or to describe. However, Weber (2012) noted that theories that are easy to test empirically may be more appealing to IS researchers than those that allow deeper insights but which are founded on less solid empirical footing. But, in contrast to providing substantial empirical evidence, a solid theoretical contribution can also be made by "clearing away conventional notions to make room for artful and exciting insights" (DiMaggio 1995, p. 391). As a result, there have been calls for IS to not only be more vigilant when adapting theories from outside IS (Grover et al., 2008) but, more importantly, to increase efforts in developing its own theories that can reverse the spread of theory from IS to other fields and, thus, for IS to become a reference discipline itself (Baskerville and Meyers, 2003; Cecez-Kecmanovic, 2002; Grover et al., 2008; Grover, 2012; Straub, 2006).

One way to develop further theory in IS is to look more closely at the central concepts used in IS (Lee, 2010; Straub, forthcoming). One of these is the concept of 'information'. While information is arguably central to the understanding of IS, efforts to advance this concept in IS are scant (Avgerou, 2010; Baskerville, 2010; McKinney and Yoos, 2010; Lee, 2004, 2010). However, there is considerable interest in this concept in neighboring and related fields such as library and information science (Bates, 2010; Capurro and Hjorland, 2003), psychology (Collins, 2007), and philosophy (Floridi, 2009b; Lenski, 2010) as well as in interdisciplinary studies (Diaz Nafría et al., 2010; Lin, 2010; Rice et al., 2001). In contrast, in the IS discipline, the concept of information is often not explicitly defined and is frequently used as a synonym for data or knowledge (Lee, 2004, 2010). In Lee's (2010) view, while the IS community is concerned with rigor in its research, it nevertheless fails to treat the concept of information rigorously as a scientific construct. "Ultimately, the IS discipline needs to be explicit in what it means by 'information,' much as it has been explicit in what it means by its (other) scientific con-

structs" (Lee, 2010, p. 345). Of course, there have been a few attempts in IS to engage more seriously with 'information' on a conceptual level. For instance, Stamper (1991, 1992) looked at it in the context of organizational semiotics. Boland (1987), similarly to Stamper, pointed out that a human dimension rather than a technical dimension for understanding information needs to be central in the context of IS. And Mingers (1995, 2010) argued for differentiating information from meaning, thus seeing information as an objective content of a sign. However, overall, the interest by IS scholars in the concept of information has been limited.

Currently there is no general introduction to or overview of the concept of information from an IS perspective that covers the wealth of available approaches. But there are hundreds of publications engaging with information on a conceptual and theoretical level across a wide range of disciplines, and anyone seeking to review how information is understood and defined is likely to be overwhelmed by the volume of literature (Bates, 2010; Wersig, 1997; Zaliwski, 2011). Moreover, as a result of the range of possible concepts of information, it is easy for novices to be drawn into a particular view of information, thus failing to recognize alternative viewpoints that could further enrich the understanding of information.

This review introduces a wide range of possible approaches to information. It thus provides an important addition to the work of McKinney and Yoos (2010) who engaged with the concept as it is currently employed by IS. However, to further the debate and add to its intellectual depth, it is necessary to explore the wider range of possible conceptualizations offered by the literature beyond the IS field. This will support IS to further develop their own understanding. The purpose of this essay is to broaden the views of information and stimulate the development of a more in-depth understanding of information that is unique to IS. This, it is hoped, will open new paths for future IS research and potentially allow IS to offer insights to neighboring disciplines regarding the understanding of 'information' and 'information systems' and their relationship to information technology (IT).

The aim of this essay is, therefore, to taken an overview and reflect on the various concepts of 'information' and to increases the awareness of IS researchers about the breadth and depth of conceptual variations in defining information and their potential implica-

tions to the IS discipline. This aim thus follows a call made by Lee (2004, 2010) and others (Avgerou, 2010; Baskerville, 2010; McKinney and Yoos, 2010) to further engage with this concept for IS. In order to achieve this research aim, the essay seeks to provide an answer to the questions: What is information? How is information seen differently by different approaches? On what theoretical bases do approaches to information differ? This essay thus contributes to a deeper understanding of the concept of information relevant to IS by providing an extensive overview of existing approaches towards information in the broader literature. Specifically, it makes the following contributions:

(1) It introduces the range of possible conceptualizations of information drawing from a vast body of literature. These conceptualizations are introduced by means of a taxonomy that can provide orientation within this body of literature.

(2) The different views covered by the taxonomy are discussed regarding their theoretical foundation, general implications, strengths and limitations.

(3) The usefulness of the taxonomy for IS is exemplified by showing how it can enable additional insights into IS research. Shifting from one view of the taxonomy to another allows IS researchers to identify additional meaningful paths for future research.

The introduction of a taxonomy of the views of information thus helps IS to engage with information as a key concept for its research. It shows that 'information' is not a single construct, but that different approaches to information exist that allow different insights for IS depending on what view of information is taken. A taxonomy is of particular use here as it provides a rigorous ordering system for looking at information. Taxonomies not only provide an exhaustive coverage of possible conceptualizations, but also provide distinct boundaries without fuzzy and overlapping groupings between those conceptualizations through the principle of mutual exclusiveness (Jacob, 2004; Marradi, 1990). These properties of taxonomies make them especially valuable for theory development (Weick, 1989).

The remainder of this essay is structured as follows. The next section argues for the importance of IS engaging with the concept of information. This is followed by a description of the taxonomy development process including a discussion of quality criteria for judging taxonomies. Then, an extensive overview of the literature of information is pro-

vided by classifying the views of information into five categories. This is followed by a comparison of the different views. The usefulness of the taxonomy for IS research is discussed by showing how the shift from one view to another allows the identification of meaningful paths for future research. The concluding sections discuss the theoretical contributions and implications of the taxonomy, as well as its practical relevance to the IS discipline.

2.3 The Relevance of Theorizing Information for IS

> [I]nformation itself is a rich phenomenon that deserves its own separate focus (Lee, 2004, p. 13).

As Boland observed in 1987, the failure of IS researchers to explore the concept of information as such is "a problem that has plagued research on information systems since the very beginning. The problem is the elusive nature of information itself, and the way we as researchers have failed to address the essence of information in our work." (p. 363). However, more than 20 years after Boland's observation, McKinney and Yoos (2010) still argued that "few manuscripts on information exist in widely read IS journals; information tracks or session [sic] are not found at academic conferences; information textbooks do not exist; and few information-centered courses are offered" (p. 329). It seems that little progress in understanding information within IS has been made over the past few decades.

However, the necessity of such work is underlined by Lee's (2010) plea to the IS community that the concept of information deserves more attention by IS researchers, a claim further backed by Baskerville (2010) and Avgerou (2010) in their responses to Lee. There are several reasons for this claim. The term 'information' is widely used in IS research by itself and in phrases such as 'information overload' or 'information requirements' (see McKinney and Yoos, 2010 for a list of phrases) and in the very notion of an information system. However, when there is little reflection about what is meant by information, the content of such phrases becomes vacuous and can be interpreted arbitrarily. Surprisingly, IS fails to address the concept of information with the same rigor as it does with other concepts (Lee, 2010; Stamper, 1985) despite the central role and importance of the concept within IS (Stamper, 1992; Avgerou, 2010).

As information is central to most IS research, any IS scholar should think about the notion of 'information' that they bring to their work, the way this is reflected in their research approach and chosen methods, and the way their research questions are formulated. Checkland and Holwell (1998) even argued that unreflected underlying assumptions about information are one of the reasons for the "very different schools of thought in IS work" (p. 40). Even if one questions whether the consequences are as dramatic as stated by Checkland and Holwell, underlying assumptions about information will condition research results (McKinney and Yoos, 2010). Implicit understanding of information is, therefore, a potential source of bias in IS research that is often not accounted for. For instance, implicit 'objectivist' understanding of information have been criticized as "fostering an image of the world in which the human meaning of knowledge and action are unproblematic, predefined, and prepackaged" (Boland, 1987, p. 365). By being aware that information encompasses aspects that go beyond an objectivist account, researchers can better frame the limits of their research, its range of application and implications. Moreover, unreflected usage 'trivializes and obscures' (Lee, 2004, p. 10) and thus the concept loses much of its potential richness and capacity for theorizing. As a consequence, the concepts of 'data', 'knowledge' and 'information' are often conflated and used interchangeably (Checkland and Holwell, 1998; Lee, 2004) and information becomes a "general purpose solution to an increasing range of problems" (McKinney and Yoos, 2010, p. 341).

This situation is not helped by the fact that only a limited number of the available range of concepts of information is currently used in IS (McKinney and Yoos, 2010). IS has to embrace a wider variety of approaches towards information (Lee, 2010). For instance, while a viewpoint that equates information with processed data enables insights regarding transactional processes, it is limiting the understanding of information in the context of organizational strategy and competitive advantage (Lee, 2010). In the latter case, an inter-subjective semantically-rich concept of information is required. Different approaches to information can therefore be more or less helpful in regards to different areas of interest to IS. Adopting multiple approaches to information can thus help to develop a deeper understanding of different issues of interest to IS.

Moreover, the dominant views towards information used in IS are often simplistic, preventing richer and more in-depth theorizing. In a survey of IS textbooks, Rowley (2007)

found that they were dominated by a hierarchical understanding that relates data, information, knowledge and wisdom (Ackoff, 1989) in the sense that these are linked through an increased level of understanding. This view, however, is widely criticized, for instance, as being imprecise (Davenport, 1997; Stenmark, 2001); not serving any scientific purpose (Stamper, 1985); not allowing any deeper theorizing (Bates, 2010); and not being able to explain why the same data can lead to different information (Fricke, 2009; Kettinger and Li, 2010). Moreover, most of this criticism also applies to approaches which reverse the hierarchy (e.g. Dahlbom and Mathissen, 1993; Tuomi, 1999) in which knowledge instead leads to information.

Developing conceptual clarity and precision in defining information has several potential benefits. Firstly, it may allow the development of ways to better relate information to other important concepts in IS (Stamper, 1992). It can thus help to distinguish information more clearly from other important concepts with which it is currently often mixed. Often IS research is not clear when distinguishing information from concepts such as 'data' or 'explicit knowledge', with 'information' and 'data' frequently used as synonymous terms with identical meaning (Boland, 1987; Lee, 2010; McKinney and Yoos, 2010). However, as Lee (2004) argued, conceptual clarity will allow richer conclusions to be drawn as unclear "usage trivializes and obscures the rich ideas that these terms [information, data, knowledge] originally signified" (p. 10).

Secondly, engaging more deeply with the concept of information will allow IS researchers to develop a basis for research that is not coupled to specific technologies. This can provide a foundation for IS research that is no longer focusing solely on the 'T' in IT but on the 'I' as well (McKinney and Yoos, 2010). Such disciplinary knowledge not only facilitates the creation of insights that can be transferred between different generations of technology but, more importantly, can help in creating discipline-specific knowledge and insights that are unique to IS and therefore also of interest to neighboring disciplines. Currently, IS research often focuses on the latest technological developments such as the recent spread of mobile technologies. Research and theorizing then often focus on the adoption, use and possibilities offered or enabled by these technologies. Theorizing of information can, however, provide the means to further decouple IS discourse and theorizing from particular technological advances towards a more general theorizing of IS.

Thinking more thoroughly about information can therefore contribute to IS redefining its position in regards to neighboring disciplines by offering a particular view of this "fundamental, transdisciplinary concept" (Mingers, 2010, p. 15). And, finally, a more reflective engagement with the concept of 'information' can stimulate the formulation of additional views on existing research problems. Different understandings of information enable the foregrounding of, for instance, technological, cognitive, social or contextual aspects. Thus, shifting through different approaches towards information in regards to a particular phenomenon can reveal areas that are insufficiently covered by existing research. As a consequence, exploring a research area using different approaches to information can help in identifying additional research questions and promising areas for future research.

2.4 Some Basic Concepts

Before different approaches to information are introduced, it is important to clarify some of the essential concepts referred to in this essay. Generally, two different roles can be differentiated. On the one hand, there is a provider of information who can be referred to as the 'informant', 'provider' or 'sender'. Due to the technical connotation of the last term, only the labels 'informant' and 'information provider' are used here. On the other hand, there is a 'recipient' of information who can also be referred to as the 'informee'. As it is a more common term, the label 'recipient' will be given preference over the term 'informee'. In addition, when not explicitly referred to otherwise, 'information' refers to that which is being exchanged between an informant and a recipient (figure 2.1). However, at several points in the discussion, it will be necessary to differentiate between that which is being provided by an informant and information. In these instances, the term 'message' is used to describe that which is being exchanged between an informant and a recipient.

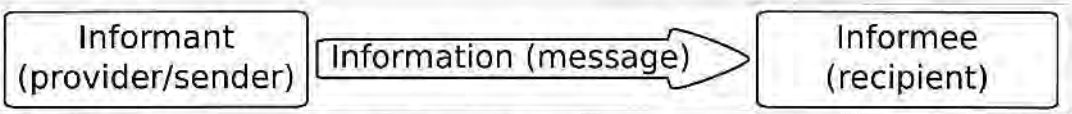

Figure 2.1 Informant, Information, and Informee

As a note of caution, while this model implies linearity, in everyday communication, the exchange of information is normally the result of a reciprocal process. In such instances,

the roles of recipient and informant can change seamlessly between communication partners. Moreover, while the model implies a one-to-one relationship, this does not necessarily have to be the case as information can be conveyed from one informant to many recipients, or one recipient can be informed by a complex network, composed of these information dyads. If this requires the existence of different 'information instances' or, indeed, if every occurrence of information needs an informant and a recipient, then these are some of the points seen differently by different approaches to information.

The aim here is to approach information as a concept in its own right. For this reason, discussion of information in regards to concepts such as knowledge or wisdom will only be brief. The reason for this is that approaching information from this angle not only means stepping into murky waters, but also sidestepping the problem of definition by evoking concepts for the explanation of information that are themselves elusive. It is unclear how the understanding of information in IS can be advanced if "[n]otions that are even less well understood than information are invoked for its explanation" (Stamper, 1985, p. 195). The concepts of knowledge (Adams, 2004; Gettier, 1963) or wisdom (Ryan, 2009) are themselves, however, subject to extensive debate:

> Knowledge is not a straightforward concept to deal with, as millennia of debate concerning its status and nature attest. Even in everyday use, the term 'knowledge' is employed in a variety of ways to mean different things (Lilley et al., 2004, p. 161).

Therefore, those concepts are limited in their ability to provide a solid grounding for a clearer understanding of the concept of 'information'.

2.5 Research Problem and Research Approach

This section introduces the research objective of this essay. It also describes how the research was undertaken with regard to the location of different conceptualizations of information and the development of the taxonomy. The section therefore introduces criteria for the development and assessment of taxonomies in general, followed by a discussion of these criteria as part of the development of the taxonomy of views of information.

2.5.1 Research Problem

McKinney and Yoos' (2010) survey on the usages of the concept of 'information' in IS was a first step towards increasing efforts to theorize information in IS. However, this survey mainly provides a glimpse at the current state of the usage of 'information' in IS. In order to allow IS to further their understanding beyond what is currently available, an overview of the range of possible approaches to information was also needed. Undertaking an extensive survey of the current literature on information is thus an important means for opening up the whole landscape of available approaches to information for IS research. Thus, the objective of this essay is to:

> Provide an overview and reflect on the various concepts of 'information' and to increases awareness by IS researchers about the breadth and depth of conceptual variations in defining information and their potential implications to the IS discipline.

An exhaustive taxonomy of current conceptualizations can thus identify additional approaches for IS researchers and provide an answer to the questions: what is information? how is information seen differently by different approaches? and on what theoretical bases do approaches to information differ?

2.5.2 Surveying the Literature

Literally thousands of publications discuss information on a theoretical and conceptual level across different disciplines (Bates, 2010; Wersig, 1997; Yuexiao, 1988; Zaliwski, 2011) making it virtually impossible to engage with all of them in a review. It is therefore necessary to limit the scope of such an investigation. Nevertheless, earlier literature reviews and the scope of the literature covered by them (Boell and Cecez-Kecmanovic, 2010b; see also appendix A) are a good starting point for any literature review. This approach was chosen for this study as it takes into account a wide range of perspectives. These originated in various disciplines, such as IS (Mingers, 1996); library and information science (Bates, 2010; Cornelius, 2002; Capurro and Hjorland, 2003); psychology (Collins, 2007); philosophy (Floridi, 2009b; Lenski, 2010); the natural sciences (Fischer, 1993); information theory (Martignon, 2001; Ritchie, 1986); computer science (Aspray, 1985); and a cross-disciplinary review in communications (Rice et al. 2001). In addition, an extensive glossary of information-related terms was published by BITrum (Diaz Nafría et al., 2010) and, in 2010, *Information* (Lin, 2010) was established as an

interdisciplinary journal focusing on this concept. Subsequently, reviews covered by this survey looked at information from a wide range of disciplines. Moreover, readers interested in a particular discipline-specific view of information may find some additional orientation in them. Based on this initial survey of the literature, further investigation was conducted using database searches, focusing on aspects of relevance in the context of IS, while appreciating the breadth, depth and complexity of the range of other approaches to information and their relationships to each other in various neighboring disciplines. Using this approach, more than 400 publications on information were identified, read in-depth and analyzed. A thorough analysis and categorization process led to the identification of key dimensions along which different perspectives and views of information could be distinguished.

2.5.3 Development and Assessment of Taxonomies

Based on this extensive survey of the literature on information, a taxonomy on different possible conceptualizations of information was developed. It is important to note that the development of any ordering system is, to some extent, subjective and dependent on a particular understanding that develops on a subject over time. Development of 'the' one, correct, objective ordering system on a subject is not possible. However, taxonomies are the result of a rigorous process, and criteria exist for guiding the development of taxonomies. For this reason, it is important to differentiate taxonomies from other types of ordering systems, namely, typologies and classifications (Marradi, 1990).

The construction of high-quality taxonomies is guided by four aspects that are of relevance to the development and assessment of taxonomies. These four are: a *rigorous* allocation of class members (rule-governed and repeatable); adherence to the principle of *inheritance*; *exhaustiveness* of its coverage; and *mutual exclusiveness* of its classes.

Firstly, taxonomies are based on a *rigorous* classification process. Such a process assigns individual members to classes based on a set of predetermined principles that allow a lawful (rule-governed) and systematic (repeatable) ordering process (Jacob, 2004). The result is a set of classes with clear boundaries. This is in contrast to typologies which are the result of a more flexible ordering process that may result in fuzzy and overlapping groupings (Jacob, 2004; Marradi, 1990).

Secondly, how the hierarchies of its classes are built matters in taxonomies. Central to the creation of taxonomies is the concept of *inheritance* (Jacob, 2004). This means that all members of a subclass share the attributes of their parents. The order in which classes are constructed is therefore important in taxonomies as classes are the result of going through the hierarchy of the classification system of a taxonomy. Taxonomies therefore need to have at least two hierarchical levels.

Moreover, there are criteria for judging taxonomies. The two most important criteria for assessing a taxonomy are 'mutual exclusiveness' and 'exhaustiveness' of its classes (Marradi, 1990). *Exhaustiveness* means that a taxonomy can accommodate all instances for which it is developed. For instance, if a particular approach to information cannot be allocated within the taxonomy, the taxonomy is not well designed. In addition, *mutual exclusiveness* refers to the fact that, at any particular level in the hierarchy, the members of different groups at that level can only be assigned to one group at the time. If a particular approach to information is assigned to one particular view, it should be assigned only to that particular view.

2.5.4 Development of the Taxonomy of Information

In order to ensure the quality of the taxonomy of information introduced here, all four aspects for the development and assessment of taxonomies were strictly adhered to.

Firstly, the taxonomy developed here is *rigorous* as the allocation of individual publications to classes is based on clear rules that allow the rule-governed and systematic ordering of different approaches to information. To ensure the rigor of the process, a set of seven different rules for allocating the literature into the different classes of the taxonomy was established (table 2.1). Applying these rules to the literature allowed a rule-governed and repeatable allocation of an individual approach to information to a particular view. These rules were developed on the basis of a thorough assessment of the whole range of publications on information. Thus, the labels used here for each view of the taxonomy are chosen to reflect and summarize the literature covered by a particular view.

Secondly, the taxonomy is developed in adherence to the principle of *inheritance*. The principle of inheritance requires that each view of information shares the same aspect at the parent level. Moreover, each of the views of information not only adheres to the rule

established for the perspective with which they are associated (table 2.1), but also all approaches within a particular view share the general criteria of that view. For instance, all approaches allocated to the subjectivist view regard information as being related to signs *and* as relative to a recipient. The principle of inheritance is ensured by the hierarchical application of the seven rules for allocating individual approaches (table 2.1). In order to allocate any approach to information to a particular view, firstly, the two rules governing allocation to either the physical perspective or the semiotic perspective are considered. It is only after allocating a particular approach of information to either of the two perspectives that the rules regarding its subordinate views are applied.

Table 2.1 Rules for Allocation of Approaches to Information in the Taxonomy

View	Rule for allocation of approaches to this perspective/view
Physical Perspective	Encompasses all approaches that relate information to the physical world in general.
Material View	Information is seen as related to a material manifestation and as being a phenomenon of the physical world. This encompasses approaches that use physical concepts in a more abstract way such as relating information to organization and structure.
Engineering View	Information is understood to be measurable in purely physical terms.
Semiotic Perspective	Encompasses all approaches that relate information to human understanding and signs.
Objectivist View	Information is understood as existing objectively independently of a recipient.
Subjectivist View	Information is relative to a specific recipient.
Inter-subjective View	Information is dependent on a wider sociocultural dimension. Information is relative, but not in a purely individual sense.

Thirdly, the taxonomy is *exhaustive*, in so far as it accommodates the full range of the literature on information. The principle of exhaustiveness is achieved here by associating abstract definitions of information that make reference to physical principles, such as structure or organization, to the material view. This means of allocation is justified by the deliberate attempt of such definitions to be broad enough to relate to a wide range of information phenomena including material ones.

While this approach ensured exhaustiveness, it had consequences for the fourth principle of *mutual exclusiveness*. Abstract definitions of information such as those relating information to organization, structure and processes provide approaches to information that do not specify a particular domain. They are deliberately formulated in a way that can relate information to both the physical world and the world of human signs. As a

consequence, they may relate to different classes of the taxonomy. This is an inherent characteristic of abstract approaches as they are deliberately vague regarding the aspects of information to which they relate. For instance, information as structure may not only refer to a physical structure but also to a cognitive structure. However, this makes statements about information vague as criticized by Borgmann in regards to structural definitions of information. He observed that they do not allow any understanding that is more specific than what is looked at in material approaches:

> When we look at the world as structural information, we see order and structure everywhere and all the way down. There is nothing that escapes description or explanation. But from the standpoint of structural information, neither is there anything that stands out from the rest with a commanding presence. There is no difference between a fence post and a person. Both are structured through and through (Borgmann, 1999, p. 17).

Alternatively, a third abstract perspective of information could have been introduced into the taxonomy. However, this would have glossed over the fact that many abstract approaches evoke physical concepts for their definition.

In addition, some authors, especially when they seek to provide an overview of information, discuss several approaches to information that fall into different branches of the taxonomy. For instance, Qvortrup (1993) discussed material approaches, engineering approaches and subjectivist approaches. In this case, one publication may be referred to from the context of different views.

Finally, one additional important benchmark for taxonomies is their assessment by those for whom they are designed. To enable such an assessment, the taxonomy was introduced for discussion at IS workshops and at conferences (Boell and Cecez-Kecmanovic, 2011a, 2011b) as well as being circulated to colleagues and peers for feedback. Additional assessment of the taxonomy and its use for IS needs will be established over time and through the accumulation of empirical evidence by the IS community.

To summarize, the taxonomy of information developed here is the result of a rigorous, replicable and law-governed process based on established criteria for assessing taxonomies. In particular, it fully adheres to the principles of inheritance and exhaustiveness, and partially to the principle of mutual exclusiveness. Moreover, the resulting taxonomy is applicable independent of a particular domain and was exposed to the IS community for feedback.

2.6 A Taxonomy of Views of Information

The taxonomy of information introduced here has two hierarchical levels (figure 2.2). At the first level, information is distinguished between perspectives that relate information, on the one hand, to the physical world (physical perspective) and, on the other hand, to the world of signs (semiotic perspective). Signs are understood here in Peirce's sense as: "[a] sign [...] is something which stands to somebody for something in some respect or capacity" (Peirce, 1955, p. 99). At the second level, five different views of information are distinguished.

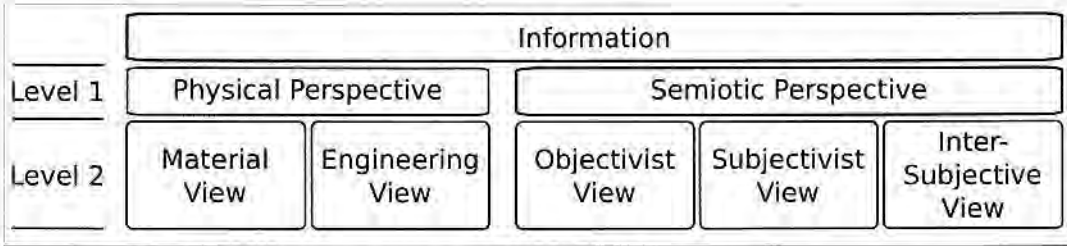

Figure 2.2 Overview of the Hierarchical Structure of the Taxonomy

In order to provide a clear distinction about what level of the hierarchy is being discussed, the remainder of this essay adopts specific terminology: the term *perspective* refers to the first level of the hierarchy while the term *view* refers to the second level (figure 2.2). In addition, within a particular view, different *groups* of similar approaches may be distinguished. And finally, *approach* refers to one particular conceptualization of information. For instance, Checkand and Holwell (1998) provided a particular approach to information. Their approach belongs within the semiotic perspective (level 1), to the subjectivist view (level 2) and within that, more concretely, to a group of approaches that see information as meaningful data.

Within the physical perspective, two different views are distinguished. The *material view* relates information to the material world, often seeing information at the same conceptual level as concepts such as energy or matter. By way of contrast, the *engineering view* seeks to establish information as a physically measurable quantity. The most notable example of this view is Shannon's 'bit' (1948).

The semiotic perspective is further divided into three different views of information. According to the *objectivist view*, information is independent of "knowledge, beliefs, or understandings in itself" (Mingers, 1995, p. 295). Information thus exists independently

of a particular human interpretation. The objectivist view is in contrast to the *subjectivist view* which argues that information depends on an interpretation process by an individual. And finally, the *inter-subjective view* argues for the importance of a wider sociocultural context for understanding information.

Each of these five views is introduced in detail below. Table 2.2 provides an overview of the different views. For each view, examples from the literature are provided. The aim of this taxonomy is to provide an overview of what is available and how approaches differ from each other. There is no underlying intention to define one 'correct' or 'best' approach, as each approach has certain strengths as well as omitting aspects that are captured instead by other approaches. However, it is argued that a critical analysis of any view of information is necessary in a concrete research or practical context. By raising awareness of different views and their characteristics, the taxonomy will allow researchers to better choose an approach towards information that is most suitable for a particular research problem while being more aware of the limitations that are attached to this choice.

Table 2.2 Summary of Different Views of Information

View		Exemplary Definition	Assumptions about information	Key Proponents
Physical Perspective	**Material View**	"Information is the pattern of organization of matter and energy." (Bates 2005)	- exists independently of humans; - often related to thermodynamic entropy.	Bates, 2005, 2006; Stonier, 1989, 1990
	Engineering View	Concerned with communication of messages between a sender and a receiver; information is a message selected from a set of possible messages (Shannon and Weaver 1949) "a measure of information [is established] in terms of purely physical quantities" (Hartley 1928, p. 536)	- exists independently of humans; - semantic aspects are irrelevant; - is measurable; - is context free; - is linear and diadic.	Hartley, 1928; Shannon, 1948; Shannon and Weaver, 1949
Semiotic Perspective	**Objectivist View**	"Signs carry objective information, but humans cannot access this" (Mingers 1995, p. 303) "Information is an objective, although abstract, feature of the world in the same way as are physical objects and their properties" (Mingers 1995, p. 295) Information is processed data; data are raw 'facts' that describe entities and their properties; they simply exist as recordings or traces of reality (Bellinger et al. 2004)	- exists independently of humans; - is embedded in signs; - is divorced from meaning; - is carried by signs and can be interpreted differently by individuals.	Dretske, 1981; Floridi, 2004b, 2009b; Mingers, 1995
	Subjectivist View	"Information is an inward-forming. It is the change in a person from an encounter with data. It is a change in the knowledge, beliefs, values or behavior of the person." (Boland 1987, p. 363) "Information is the meaning produced from data based on a knowledge framework that is associated with the selection of the state of conditional readiness for goal-directed activities." (Kettinger and Li 2010, p. 415)	- is dependent on individual; - often related to cognition, knowledge and values of individuals; - "caused" by stimuli; - does not acknowledge context.	Boland, 1987; Belkin, 1980; Kettinger, and Li 2010
	Intersubjective View	"information is inherently bound closely with numerous phenomena – language, action, logic and technology" (Beynon-Davies 2009, p. 5) "information ... is a process of creating, adjusting and maintaining relationships among the participants in a drama or real task." (Stamper 1991, p. 522)	- is dependent on individual as part of a community; - is different for different groups; - is contextual; - is situational; - is part of a dynamic process.	Beynon-Davies, 2009; Goguen, 1997; Romm, 1997; Stamper, 1991

2.6.1 Physical Perspectives on Information

Physical approaches to information define information in relation to the physical world. While it could be argued that information according to the physical view is of limited use to IS, it is relevant to at least briefly introduce this perspective here. Numerous publications have adopted a physical approach to information and sometimes such approaches are purported as foundational in understanding information in a more social context (e.g. Brown and Duguid, 2000). Therefore, anyone interested in information should at least be familiar with the most central arguments of this perspective. Moreover, some works associated with this perspective such as Wiener's cybernetics (1961) or Shannon's information theory (1948) are widely employed outside the natural sciences.

2.6.1.1 The Material View

> [I]nformation is more fundamental than space [sic] time and energy
> (Mukhopadhyay, 2008, p. 27).

The material view of information sees information as an important and fundamental concept related to the physical world. According to this understanding, information is something that exists independently of humans as part of the physical world. Some authors have even argued that information is indeed more fundamental to understanding the make-up of the world than concepts such as matter or energy (Landauer, 1996; Vedral, 2010; Wheeler, 1990) or that information should be given at least similar importance as these concepts (Seife, 2006; Stonier, 1989; Wicken, 1987). Frequently, these approaches relate information to the concept of thermodynamic entropy (Landauer, 1991; Leff and Rex, 2003). The argument here is that while entropy is a measure of chaos, information is a measure of order and is thus inversely proportional to order (Stonier, 1989; Brillouin, 1951). Consequently, information is a fundamental determinant of the physical world as much as matter and energy, with only total entropy containing no information at all (Bates, 2006).

However, not all authors go as far as to adopt an understanding that sees information as a central physical concept (table 2.3). Instead, it is argued that information is a property of the physical world existing independently of living beings (Bates, 2006). According to this account, the universe is filled with 'raw information', such as "[w]aves of radia-

tion traveling through space may contain information about the Big Bang before anyone detects it" (Adams, 2004, p. 229). Information is thus an objective, physical entity which needs to be approached as a mass-energy phenomenon (Young, 1987).

Table 2.3 Overview of the Material View

Subgroup	Description
Information as fundamental physical construct	Information is seen as a fundamental property of the material world.
Information as structure	Information is the way in which the world is structured.
Information as structuring process	Information is the process by which the world is structured.

Material approaches to information also frequently point towards structure and organization. Structural approaches often argue that information is related to a particular structure formed by entities in the physical world. Simply put, the same physical objects can be arranged in different ways and information is that which is required to describe the different ways in which the same physical objects are arranged in a particular setting (Zaliwski, 2011). Bates (2005) thus argued that one possible definition for information is to describe it as "the pattern of organization of matter and energy". This view is also contained in the more abstract definition provided in Wiener's work (1961) on cybernetics which stated that, "[t]he amount of information in a system is a measure of its degree of organization" (p. 11) and by Zaliwski (2011) who argued that information is the relationship between the states of two physical processes.

In contrast to approaches linking information to structure, other material approaches have linked information to a structuring or ordering process rather than to structure as such. Such approaches are often formulated abstractly, so that they do not necessarily have to relate to the physical world alone but could include all kinds of structuring. Slight differences among authors approaching information from this angle can be observed. On the one hand, some link information to the process and its potential for change, such as Karpatschof's (2000) definition of information as a 'release mechanism', or Belkin and Robertson (1976) for whom information was the possibility to change: "[i]nformation is that which is capable of transforming structure" (p. 198). On the other hand, approaches emphasize the outcome of a process rather than the process itself. Thompson (1968) argued that information is the result of an organization process; Colgate and Ziock (2011) that it is something that has been selected; or Wersig (1997) that

information is the reduction of complexity. For IS, McKinney and Yoos (2010) provided a similarly vague definition for their 'adaptation view' of information: "[i]nformation is created when a system perceives differences in its environment which alter that system" (p. 331). In even more general terms, Losee (1997) argued that all types and usages of information can be described as the outcome of a process: "[i]nformation is produced by all processes and it is the values of characteristics in the processes' output that are information" Losee (1997, p. 256).

Finally, it should be noted that material approaches to information include work on so-called quantum information (Fuchs, 2003). Interestingly, such approaches highlight the importance of context (Mahler, 1996) which is also understood as crucial in the inter-subjective view which looks at information from a different angle. That is the context of quantum information what is considered to be information depends on a concrete situation (Mahler, 1996).

2.6.1.2 The Engineering View

> Roughly 3.6 zettabytes (or 3,600 exabytes) of information were consumed in American homes in 2008 (Bohn and Short, 2009, p. 8).

The engineering view encompasses approaches to information that seek to develop objective, observer-independent measures of information (table 2.4). In contrast to the material view, information is not seen as existent in a material sense by itself. Instead, information exists in relation to basic, measurable physical units. This makes information a measurable entity (Losee, 1990). For instance, Houston and Harmon (2002) argued that information is the summation of 'basic dimensions of the universe: mass, distance, and electrical charge' over time.

Table 2.4 Overview of the Engineering View

Subgroup	Description
Information as measurable	Information can be described or measured in purely physical terms.
Information as transmitted signals	Information are signals transmitted between a sender and a recipient.

However, the most well-known approach that takes an engineering view is Shannon's (1948) mathematical theory of communication (MTC) which is also often labeled 'information theory'. Shannon built on work by Hartley (1928) and Nyquist (1924) in order to

establish a general theory of the transmission of signals through time or space (Aspray, 1985). Two reasons warrant a short discussion of Shannon's work. Firstly, the label 'information theory' is so striking that it is important to state what is covered by this theory and where its coverage ends. This can help to avoid confusion regarding Shannon's work as its label "continues to cause endless misunderstandings" (Floridi, 2009b, p. 20-21). Secondly, the importance of Shannon's work can hardly be overstated (Bates, 2010). For instance, citation counts for Shannon (1948) dwarf even the most highly cited IS papers by at least one order of magnitude.

Faced with the problem of signal transmission between two locations, Shannon argued that the smallest amount of information that can be transferred between them is the ability to differentiate between two states. From this, it follows that the smallest measurement of information is the difference between two states, a 'binary digit' (shortened to a 'bit'). Alongside this measure, Shannon introduced a model of communication which differentiates several aspects that affect the transmission of messages from a sender to a receiver (figure 2.3). On the sender's side, a message will need to be encoded first; it is then sent as signals through a channel where it is subject to noise that can distort the signal. Finally, on the receiver's side, the signal has to be decoded again. Shannon's contribution was to develop a calculus that allows an estimate of the number of signals that can be sent through a channel given a specific degree of noise resistance. It states how certain the recipient of a message can be that the message received is the same message that was initially sent. Shannon therefore linked information with uncertainty. The mathematical details of Shannon's work are not of relevance here and those interested can find a comprehensible introduction to Shannon's calculus in Floridi (2009b). It is important, however, to mention that Shannon's model of communication was quickly picked up as a more general model of human communication (Shannon and Weaver, 1949).

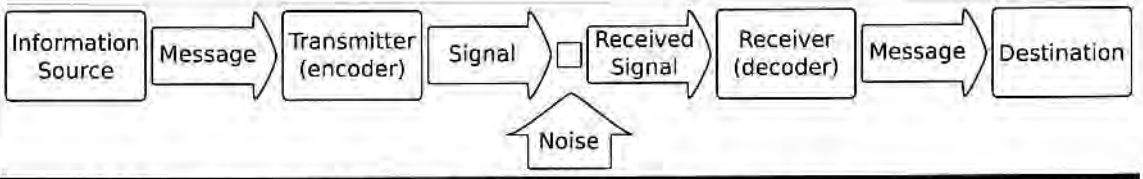

Figure 2.3 Reproduction of Shannon's (1948) Model of Communication

Other approaches to measuring information have been suggested in addition to Shannon's 'bit'. For instance, Konorski and Sypankowski (2008) proposed a measure that, in contrast to Shannon's formula, can accommodate aspects such as delay and space. Another example of a measuring approach that falls under the engineering view is Harmon's (1984) 'inform'. Harmon argued that 'informs' allow us to compare different solutions or work processes by comparing the amount of energy saved or lost when different solutions are taken. He defined one 'inform' as equalling one joule of work, and one has to wonder why the word 'joule' was not used in the first place. Moreover, not all attempts to measure information take a physical approach: they are therefore not discussed here.

Other contributions to the engineering view of information have been made by Alan Turing and by John von Neumann (Aspray, 1985). Turing not only believed that electronic machines can be used for general purpose information processing, but also in the creation of intelligent machines (Turing, 1950). He suggested a test for assessing if computers were capable of intelligence, now commonly known as the 'Turing test'. According to this test, if a person who interacts with a terminal is not able to tell if the responses given to her are coming from another human or are generated by a machine, the machine can be labeled 'intelligent'. Von Neumann's contribution lay in his 'general theory of automata' (von Neumann, 1951) and its implications for the understanding of information processing. For a more thorough discussion of the contributions made by Turing and von Neumann, see Aspray (1985).

2.6.2 Semiotic Perspectives on Information

In contrast to physical approaches, semiotic approaches relate information to signs rather than aspects of the physical world. According to Peircian semiotics (1873), a sign consists of a triad (figure 2.4). Firstly, there is an object or 'significatum' to which a second sign-vehicle or utterance refers, which is interpreted by a third entity (Stamper, 1992). This distinction is important here, as signs can be confused with being only the sign-vehicles; however, sign-vehicles cannot exist without those things which they stand for and those which interpret them. A similar interpretation of semiotics is also put forward by de Saussure (1959) who saw the focus of semiotics as being on the link between an interpretant and the signified. In addition, semiotics has been extended beyond

the use of signs by humans such as in biosemiotics (Alvarez, 2009; Barbieri, 2008) or zoosemiotics (Sebeok, 1972). Information in relation to signs can therefore also exist, for instance, for animals, such as a dog following a scent trail. However, for the purpose of this review in the context of IS, semiotics is limited to signs exchanged in human communication.

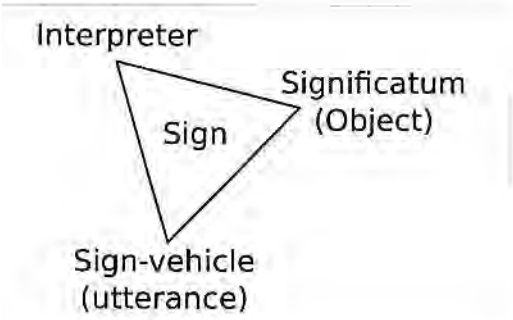

Figure 2.4 The Triad of a Sign Consisting of Sign-vehicle, Significatum and Interpreter

The focus here is not on semiotics and differences between semioticians, but on the fact that there are approaches to information that understand information in relation to signs exchanged in human communication. Such approaches to information are especially fruitful to IS as they potentially allow us a better understanding of the exchange of signs communicated by different systems. IS serve a purpose and this purpose, one can argue, is the exchange of signs between different actors in regards to some action. To use Peirce's definition from above, systems contain and enable the exchange of "something which stands to somebody for something in some respect or capacity" (Peirce, 1955, p. 99). Moreover, McKinney and Yoos (2010) argued that the perspective that sees information as "a model of something to someone" (p. 334) is, in fact, "the most widely used view of information in business, computer science, psychology, and IS" (p. 335).

2.6.2.1 The Objectivist View

> A weekday edition of *The New York Times* contains more information than the average person was likely to come across in a lifetime in 17th-century England (Wurman, 1989, p. 6).

The first semiotic view is labeled the 'objectivist view' as it encompasses approaches to information that understand information as the observer-independent content of a sign. Objectivist approaches see information as existing independently of humans (Mingers, 1995, 2010) and as being bound to physical carriers existing independently of a particular observer (Buckland, 1991; Glowalla, 2004). Information in this view most closely resembles physical approaches to information as it assumes the objectivity of information. Mingers (1995) summarized this perspective therefore as:

> Information is an objective, although abstract, feature of the world in the same way as are physical objects and their properties. Information does not depend on knowledge, beliefs, or understandings in itself (p. 295).

The different ways of arguing for this approach can be differentiated into four groups (table 2.5): firstly, to separate information from knowledge; secondly, to separate information from meaning; thirdly, to see information as recipient-independent messages; and lastly, to argue for the existence of factual approaches and propositional statements about reality that can be made independently of an observer.

Table 2.5 Overview of the Objectivist View

Subgroup	Description
Information as external to humans	Information is seen either as stimuli or knowledge that exists independently, outside of humans.
Information as different to meaning	Information is distinguished from its interpretation. Thus meaning is created from information.
Information as message	Information is an exchanged message. This is in contrast to signals in the engineering view.
Information as factual	Information is facts or propositional knowledge statements that exist independently of an observer.

The first group of objectivist approaches to information argues that information is a physical inscription of knowledge, and that such an inscription exists independently of individuals. While knowledge is bound to a subject, information can exist independently of an individual. This view is described by Thorngate (1995) as:

> Information is not knowledge. We consider the former is what exists 'out there' beyond our senses; it lives in nature, in print, on hard disks, in the air. Knowledge is that which exists 'in here' behind our eyeballs, sitting just above uncertainty (p. 197).

While this view of information is most prevalent in psychology, it is shared by numerous authors outside of psychology (e.g. Drucker, 1993; Peters, 1988; Keller and Tergan,

2005; Kogut and Zander, 1992; Lenski, 2010; Schultze, 2000). Understanding information as the external representation of knowledge was succinctly expressed by Farradane (1979) who defined information "as any physical form of representation, or surrogate, of knowledge, or of a particular thought, used for communication" (p. 13). In the context of IS, systems can then be understood as storing representations of knowledge in a sense that sees information as the product created by knowledge workers (Schultze, 2000) similar to physical products created by manufacturing workers.

The second set of objectivist approaches differentiates information from its interpretation (e.g. Brown and Duguid, 2000). It sees information existing objectively, while it is the meaning ascribed to information that is subjective. These approaches therefore separate information from meaning. While information exists objectively, meaning is generated from information:

> Information is different from meaning. [...] Meaning, however, is generated from information by interpreters through a process of digitalization that abstracts only some of the information available. [...] humans can never experience or interact with it [information] in an unmediated way, it is literally untouchable (Mingers, 1995, p. 295).

What is different for different individuals is not the information they obtain, but the meaning they generate from it. Information that exists objectively in the world is 'obtained' from the environment acting as an input to a process from which meaning is generated (Freeman, 2000). In contrast to the approaches based on knowledge, this view can account for the fact that the 'same' information can have different meaning for different individuals.

However, not all approaches arguing for an objective understanding of information separate information from meaning. Most notable is the work by Floridi who has done considerable work on the philosophy of information (Floridi, 2002, 2004a, 2009a) and information ethics (Floridi, 2005b). Floridi strived to provide a general definition of information (GDI) that is applicable across different domains and disciplines. According to his approach, information has to be understood as "syntactically well-formed and meaningful data" (Floridi, 2009b, p. 19). He argued that meaning can exist without a particular individual, using the Egyptian hieroglyphics as an example. Floridi argued that hieroglyphics had meaning even before the Rosetta Stone was discovered that allowed them to be deciphered. Floridi further argued that this definition has the advantage of

being neutral in four aspects: typological neutrality – the GDI makes no statement about the kind of data involved; taxonomic neutrality – the GDI makes no statement of what relata suffice as data; ontologic neutrality – the GDI only states that information is grounded in data without imposing further restrictions on the existence of information; and genetic neutrality – information can exist without a recipient. In addition to GDI, Floridi (2004b, 2005a, 2009b) also introduced the specialized definition of information (SDI). He argued that factual information deserves a special status, as facts can only then be considered information if they are true. Information that is not true should be labeled misinformation or disinformation (Floridi, 2004a, 2009b). This required a truth condition in addition to his GDI, according to which the SDI has to be understood as 'GDI + truth'. A truth condition for information was also demanded by Dretske (1981) and by Mingers (2010).

Similar to approaches that separate information from meaning are those that relate information to messages. Such approaches associate information with messages exchanged between different actors. As they also divorce information from meaning, they can be seen as a specialized case of the second set of approaches that bears some similarity to Shannon-type engineering approaches. But, in contrast, they relate information to something that is understood by a recipient rather than simply the exchange of physical signals (cf. Meadow and Yuan, 1997; Wersig, 1997). Information is related to a purpose and is not simply the transmission of messages (Osterloh and Wartburg, 1997). From this, it follows that not every message is information, thus warranting the difference between information and message. Scarrott (1989) formulated this abstractly as: "[i]nformation is that which is exchanged between the components of an organized system to effect their interdependence" (p. 262).

Finally, the last group of objectivist approaches sees information as a fraction of knowledge. Information is either relevant facts, or information is understood as the smallest possible unit of knowledge. Proponents who relate information to facts point out that it is possible to make statements about the world that reflect what is the case (Dretske, 1981). Such facts are not a matter of interpretation and, therefore, factual information is objective:

> Information can be regarded as a piece of knowledge of an objective kind: details about an event or a situation in the past, the present or the future, or an indisputable scientific fact such as pi = 3.14 (Wikström and Norman, 1994, p. 11).

Such approaches are found in situational theory (Barwise and Perry, 1983; Israel and Perry, 1990) and channel theory (Barwise and Seligman, 1997) that both employ a logical approach to develop a generalized account of Dretske's (1981) 'informational content'.

In addition, in understanding information as factual knowledge, authors have associated information with propositions. For instance, Mingers (2010) summarized semantic information as "the *propositional content of a sign*" (p. 5, emphasis in original). Propositions are the smallest possible expressions of knowledge that can be made, thus they cannot be broken down into smaller statements. For example, if anything is taken out of the propositional statement 'lions are mammals' the whole statement becomes meaningless. Approaches to information which fall under this group associate information with these smallest possible units of understanding. For instance, Devlin's (1991) extension of situation theory introduced an 'infon' as the smallest possible 'quantum of information', or Debons (1992) who sought to measure the 'informs' contained in a statement by breaking it down into the number of different facts which it contained. Propositional approaches are partly driven by the observation that Shannon's (1948) information theory is not capturing the semantic dimension of information (Ostale, 2009). For instance, Bar-Hillel and Carnap (1953; Bar-Hillel, 1955) argued that propositions can be used to assess the information contained in different messages by comparing the number of different states of the universe which they exclude. The more possibilities are excluded, the higher the level of information.

2.6.2.2 The Subjectivist View

> Information isn't just information in itself; it only becomes information when it is information *to somebody* (Qvortrup, 1993, p. 3, emphasis in original).

> In reality there has not been an information explosion, but rather an explosion of non-information, or stuff that simply doesn't inform (Wurman, 2001).

In subjectivist approaches, something needs to be appropriated by a subject, a human being, in order to become information. From a recipient's perspective, it is impossible to

differentiate information from other messages or even from noise without an appropriation process taking place. From this, it follows that information can only exist after an appropriation has taken place. In contrast to objectivist views, subjectivist views regard information as something which is always already appropriated.

Three different groups of subjectivist approaches can be distinguished (table 2.6). Firstly, some subjectivist approaches relate information to meaning; secondly, some approaches take a cognitive viewpoint of information; and lastly, some approaches relate information to knowledge and action.

Table 2.6 Overview of the Subjectivist View

Subgroup	Description
Information as related to meaning	Information is data that are meaningful to a recipient.
Information as related to cognition	Information is the result of a cognitive process, variously described as inward-forming, understanding, or as a change in knowledge.
Information as knowledge in action	Information is action or goal-related knowledge.

According to the first group information is explicitly related to meaning, with meaning being a subjective concept. While Miller (1987) or McKinney and Yoos (2010) equate information with meaning: "information is meaning" (p. 330), others see information as data plus meaning (e.g. Checkland and Holwell, 1998; Davis and Olson, 1985; Galliers, 1993; Galliers and Newell, 2003; McLeod and Schell, 2007). This is in contrast to both the engineering view that deliberately excludes meaning from information, and to objectivist accounts that divorce information from meaning seeing information as that from which meaning is generated (e.g. Mingers, 2010). Floridi (2009b) is an exception, as discussed above.[3] In contrast, subjectivist approaches that relate information to meaning state that information is something which has meaning for a recipient (Denning, 2001; Kuhlen, 2004; Hansen and Neumann, 1978): "information is the meaning someone assigns to data. Information thus exists in the eyes of the beholder; the same data can be nonsense to one person and gold to another" (Denning, 2001, p. 20).

The second set of subjectivist approaches takes a cognitive viewpoint of information. These approaches emphasize the importance of individual cognition regarding informa-

3 Floridi argued that meaning can exist independently of humans, see p. 41.

tion, in the sense that "information is mediated by a potential recipient's state of knowledge" (Cornelius, 2002, p. 406). While on some points the differences can be small and there is an overlap between the different formulations, three different stances for formulating a cognitive approach can be observed. Some authors emphasize an internal shaping of a recipient, others point out an understanding process, and yet others relate information to a change in a recipient's knowledge structure.

According to formulations that relate information to internal shaping, information should be understood as 'in-formation' or as 'inward-forming' (Boland, 1987; Cole, 1994; Pratt, 1977, 1978, 1982). This view relates information to its origin in the Latin '*informatio*' (Capurro, 2009), where '*in*' refers to in/within and '*formare*' to shaping or giving form (Pratt, 1977). Information is thus something that alters a specific recipient internally, thus making information a unique, individual and subjective process: "[i]nformation is an inward-forming. It is the change in a person from an encounter with data. It is a change in the knowledge, beliefs, values or behaviour of the person" (Boland, 1987, p. 363). The argument is thus that something can only be in-forming and thus information when it evokes a mental shaping process for a recipient.

> A document [or any other item providing information], so it seems, can be informing only if the reader is mentally formed, a process imagined as the content of the document becoming present to readers' minds when they are in the mental state of understanding the document (Frohmann, 2004, p. 393).

This approach to information is similar to those that relate information to a process of understanding. However, approaches relating information to understanding are slightly more narrow as 'in-forming' can include any kind of encounter with the world, such as gaining impressions or forming beliefs. Understanding, in contrast, relates information more closely to the formation of knowledge thus excluding encounters with the world that do not make sense to a particular recipient. Information is thus the process of converting impressions from the environment into individual knowledge (Von Foerster, 2003). This view was summarized by Meadow and Yuan (1997) as: "[i]nformation is the process of converting received messages, data, signs, or signals into knowledge" (p. 706). It is important to stress the difference of this approach from the objectivist view that sees information as a feature of the environment that is then converted into in-

dividual knowledge. In contrast, the viewpoint here sees information as a subjective process of understanding.

Cognitive approaches to information can also be formulated by stressing that information is a change in a recipient's knowledge. Information is "a stimulus which expands or amends the World View of the informed" (Madden, 2004, p. 9). Information thus not only needs to be received, as an objectivist approach would indicate, but also needs to actually change a recipient's knowledge structure. If something does not actually change an individual's knowledge, it does not qualify as information. This point was probably most succinctly expressed by Brookes (1980) who stated that a knowledge structure 'K(S)' is altered 'K(S+△S)' by the encounter with information '△I', or simply: 'K(S) +△I=K(S+△S)'. This was summarized by Meadow and Yuan (1997) as: information is "[a] message understood by the recipient and which changes that person's knowledge base" (p. 705). In contrast to other cognitive views, this excludes messages that may be understood by a recipient, but which do not actually change a recipient's knowledge. "[S]omething that the receiver already knows (i.e., a stimulus that does not alter cognitive structure) is not information" (Paisley, 1980, p. 118). Information therefore leads to an increase in knowledge (Schucan, 1999) and is thus dependent on a recipient's predispositions that determine a recipient's ability to be informed. Something that MacKay (1969, 1983) labeled 'conditional readiness' or 'state of conditional readiness' (SCR) was captured by Rice et al. (2001) in their description of expressing information needs:

> being able to even express one's information need is influenced/constrained by one's individual or collective knowledge structures; which in turn are influenced/constrained by one's knowledge of the world; knowledge of a language, knowledge of what relevant informants know (shared cognition), and knowledge of the social situation and conventions (Rice et al., 2001, p. 26).

The third group of subjectivist approaches to information relates information to action. As with the previously discussed approach, information is related to knowledge. However, the aim is not a change in knowledge structure, but the ability to take action (Mason and Mitroff, 1973; Galliers, 1987). Information is thus variously described as something that: provides guidance (Davenport, 1997); is useful (Lewis, 1991; Machlup, 1983); needs to fix problems (Taylor, 1986); makes a difference (Bateson, 1972); or that is relevant to a problem (Capurro and Hjorland, 2003; Fischer, 1993; Taylor, 1991). Due

to its emphasis on the relevance of information for action, this view of information is also labeled as the 'pragmatic view', a view for which Kuhlen (1990, 1991) coined the phrase 'information is knowledge in action'. Expressing information as action-relevant knowledge is particularly popular in the German information science literature (e.g. Bauknecht and Zehnder, 1997; Bendel and Hauske, 2004; Hartmann, 2000; Kuhlen, 1999; Zimmermann, 2004).

Often approaches that relate information to action relevance describe information as being answers to specific questions (Alfino and Pierce, 2001; Zehnder, 2005) or as solutions to problems. For instance, Kuhlen (1991) described information as "the subset of knowledge which is needed by but not available to a specific person in a concrete situation in order to solve a problem" (p. 98). This view is almost identical to that of Fischer (1993): "What is, after all, information? It is the subset of knowledge that is needed (but for the time being unavailable) for solving a problem" (Fischer, 1993, p. 230).

However, not all authors arguing for the action relevance of information relate information explicitly to problem solving. Because Wersig (1997) related the action view of information to Habermas' (1984) theory on communicative action, action relevance has to be understood as a much wider term than simply problem solving. An exclusive understanding of information as the solution to a problem requires not only the existence of a problem, but also the awareness of the existence of that problem. Often this is not the case, and information could very well be, for example, something that raises awareness of an emerging problem in the first place. Thus, Furner (2004) has suggested understanding information as relevance; Bonfadelli (2005) as the reduction of uncertainty; or Fugmann (2007) as that from which one can learn.

Apart from Boland (1987) as discussed above, other subjectivist approaches specifically related to IS are the work by Kettinger and Li (2010) and Langefors' (1980) infological model. In Langefors' (1980) interactive model, information is the result of the interaction of data with a mental structure at a specific point in time. Kettinger and Li (2010) built on Langefors' model stating that it lacked a clear statement on the role of knowledge and that it was unclear why time should be an important factor. In contrast, the authors formulated a knowledge-based theory of information (KBI), defining information as the result of the interaction of data with knowledge:

> *Information* is the meaning produced from data based on a knowledge framework that is associated with the selection of the state of conditional readiness for goal-directed activities (Kettinger and Li, 2010, p. 415, emphasis in original).

While clearly putting forward a subjectivist approach to information, this view stretches across different subgroups of subjectivist approaches encompassing all three groups discussed above. Kettinger and Li (2010) related information to meaningful data, based on a cognitive process with the aim of action relevance.

2.6.2.3 The Inter-subjective View

> In this way, the key element is neglected: human existence, which represents the essential ingredient of what information is, of how the life world gets encountered, defined, reshuffled (Ciborra, 2002, p. 18).

The inter-subjective view of information points out that information is dependent on a wider sociocultural setting. Information is, therefore, contextual and situated, as well as connected to culture and social practice (table 2.7). In this sense, it opposes both objectivist approaches as well as subjectivist approaches for neglecting the point that what is considered as information in a particular context is dependent on social norms and socially-shaped appropriation processes.

Table 2.7 Overview of the Inter-subjective View

Subgroup	Description
Information as dependent on social context	Information depends on a particular social context in which it is regarded as information.
Information as culture dependent	What is considered to be information will change over time (historical dimension) or between languages.

What is considered as significant, what is technologically possible, or the things for which one has labels, categories and words will change from social setting to social setting: "[a]n item of information is an interpretation of a configuration of signs for which members of some social group are accountable" (Goguen, 1997, p. 31). Inter-subjective approaches can, therefore, be seen as an extension of subjectivist approaches that shift the attention from an individual to the wider social context. In this sense, "information is a subjective concept, but not primarily in an individual sense. Criteria for what counts as information are formed by sociocultural and scientific processes" (Capurro and Hjorland 2003, p. 395). Subsequently, information needs to be investigated at the group level

rather than the individual level as it is the result of an understanding process that goes beyond an individual:

> [i]nformation cannot be understood at the level of the individual, that is, at the cognitive level of individual psychology, because it arises through ongoing interactions among members of a group (Gougen, 1997, p. 34).

Inter-subjective approaches to information all have in common that they emphasize the social dimension of information. Information "is a *social construct*, [it] is created and tailored on purpose by somebody for somebody else or collectively, accepted, believed, or propagated through social interactions" (Castelfranchi, 2002, p. 381). However, the criteria for what is considered meaningful, important and relevant, and therefore what can be considered as information is not based on purely subjective criteria, but on a shared understanding of the world by a particular group in a particular setting. In other words: "[i]nformation is impossible without a society and its shared culture" (Stamper, 1992, p. 32). To understand information thus requires us to investigate the social and cultural context in which it occurs:

> [I]nformation is properly seen not as an objective independent entity as part of a 'real world', but that it is a human artefact, constructed and reconstructed within social situations. As in law, every bit of information is only information when understood within its own cultural packaging which allows us to interpret it (Cornelius, 1996, p. 19).

Information has an inherent social dimension (Alfino and Pierce, 2001; Hakken, 1999; Liebenau and Backhouse, 1990; Romm, 1997; Stamper, 1991, 1992) as information signifies certain aspects relevant in a particular social setting (Beynon-Davies, 2010, 2011). Subsequently, information is related to inter-subjective meaning-making and agreement upon what are meaningful differences in a given situation. As Bateson (1972) stated, information is not simply a detectable difference, but "a difference which makes a difference" (p. 459). Information is, therefore, not only conveying a message, but it can also be regarded as symbolic:

> The symbolic significance of any activity depends on the social norms within which it is undertaken. Information is significant symbolically because of a particular set of beliefs in a particular set of cultures. [...] As social norms change, the relevance of information as a symbol, or signal, changes with them (Feldman and March, 1981, p. 184).

The social dimension of information is therefore evident in the fact that what can be information for different actors will depend on their social status and their role within a social setting such as an organization or a department. Thus, the social dimension of information is one of the factors why "good technology doesn't necessarily translate into good information" (Davenport, 1997, p. 6). For instance, access to information is not simply a matter of being able to physically obtain a particular document or file. Access also depends on one's legal, political and economic entitlement to access information which in turn is related to one's social status and role. Moreover, access has a cognitive dimension which is related to training and education (Rice et al., 2001). It therefore follows that what can be considered as information will depend on the needs of a particular group of actors (Capurro and Hjorland, 2003).

Moreover, social context changes over time, for instance, when novel technologies emerge, organizational structures change or new options become economically viable. "Hence what counts as 'information' will never be static, or subject to only one definition; it too will be in a state of flux" (Checkland and Holwell, 1998, p. 238). The dynamics of change regarding information become obvious in works on information that take a historical perspective (e.g. Borgmann, 1999; Rayward, 2010; Wright, 2007). The way information can be created, collected and disseminated is influenced by the social and technological forces at work at particular times in history. An obvious example is the invention of the printing press which used movable letters. This invention not only allowed the dissemination of information on a new scale but also gave rise to social change and the creation of new forms of information such as newspapers (Wright, 2007). Another example is how social forces led to the widespread use of clay tokens in Mesopotamia (Beynon-Davies, 2009a) which in turn gave rise to the invention of writing and the alphabet (Borgmann, 1999).

The inter-subjective dimension of information is also evident when one looks at language as the carrier of information. Language is arguably the primary means for exchanging information, be it through books, speeches, conversations or tweets. However, language is not a fixed system for exchanging information in which words have definitive and final meanings (Blair, 2006; Wittgenstein, 1953). As language changes so does the information contained in a particular text. Information can therefore be related to a hermeneutic understanding process (Chalmers, 2004). Another example of the inter-sub-

jective dimension of information is how similar words have different meanings and connotations in different languages despite the fact that they refer to the same thing. To demonstrate this, the 'information' that can be conveyed by the term *wood* differs from that conveyed when a French speaker uses the term *bois* or a Spanish speaker uses the term *madera* (Hjorland, 2007). In addition, examples from anthropology show how the development of written language shaped the way people memorized, structured or solved problems (Wright, 2007). Accordingly, what is considered as information will have changed along the way as well. Along these lines, one can also take the case of notation systems or formal mathematics and the effect they have had on the way that things are perceived as information and what and how things are perceived as information (Borgmann, 1999; Hjorland, 2007).

Finally, the application of Karl Popper's (1972, 1978) three worlds' approach to information also points in the direction of the inter-subjective dimension of information. Popper distinguished between the world of physical objects (world 1), the world of individual cognition (world 2) and the world of shared human understanding (world 3). While information is bound to a physical carrier (world 1), it is world 3 that is essential to human information. Popper's three worlds in regards to information were discussed by Bates (2010), Capurro and Hjorland (2003), Henrichs (2004) and Rudd (1983).

2.7 Discussion of Views of Information

The following section discusses and critiques each view of the taxonomy in relation to each other and through a particular understanding of IS as being simultaneously interested in social and technical aspects (Lee, 2001, 2010):

> [T]he 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 (Lee, 2001, p. iii).

Subsequently, the discussion of each view of the taxonomy considers the strengths and limitations of each view in regards to the social as well as the technical aspects and how these are covered by IS.

According to this understanding, IS are not interested in data processing devices in their own right, but in the relation of such devices to a purpose. The purpose for which information is created, disseminated and consumed is essential to IS. And so is the fact that

IS do not exist in a vacuum, but within organizational and societal settings. For this reason, any view of information that divorces information from its purpose and its social dimension will exclude important aspects of information for IS research.

Different views in the taxonomy conceptualize information differently, and this has clear consequences for the understanding of information in the IS context. Importantly, the five views differ in their understanding of the relationship between information and the world and how information can come into existence. Table 2.8 provides a comparison of ontological and epistemological differences, as well as how the different views relate information to data, knowledge, signs, human beings and social context. Table 2.8 also provides an overview of the following discussion in terms of the strengths and limitations of each view.

Table 2.8 Comparison of Views of Information

Depiction of information in regards to	Material View	Engineering View	Objectivist View	Subjectivist View	Inter-subjective View
World (ontological status, reality)	Information exists independently of a human observer as part of the physical world.	Information exists objectively in relation to basic physical properties as defined by humans.	Information exists independently of an observer in the sense of true facts or physical inscriptions of knowledge.	Information is created through a cognitive process resulting from an observation and often in regards to a purpose.	Information is shaped through sociocultural understanding of the importance of differences.
Condition for existence (epistemological status)	'Raw' information is acquired from the world.	Information is specified in regards to objective physical units.	Information exists only as an accurate representation of reality.	Information needs to be meaningful and relevant to a human being.	Inter-subjective agreement about meaningful difference within a specific context.
Strengths	- Considers physical aspects such as layout and structure in theorizing of information.	- Allows the unambiguous definition of information. - Information is measurable and manipulable.	- Allows information to be treated as a product or object. - Information can be quantifiable.	- Considers an individual's interpretation and cognition. - Can consider goal relevance and predispositions.	- Accommodates a wider sociocultural context. - Can consider historical context. - Points to an empowering and ethical dimension.
Limitations	- Abstract definitions are vague. - It is not clear how raw information can be acquired without any prior interpretation or understanding. - Humans or social contexts are not relevant.	- Does not consider purpose or meaning. - Limited application outside signal transmission. - Does not consider a wider social context.	- Disregards individual and sociocultural context. - Unclear how criteria for information can be established objectively. (Who is the ultimate judge of truthfulness?)	- Does not take into account a wider social context. - Neglects technical aspects. - Does not provide a clear difference to meaning.	- Has no clear boundaries for what is context. - Limited means for theorizing physical aspects.

Table 2.8 Comparison of Views on Information (continued)

Depiction of information in regards to	Material View	Engineering View	Objectivist View	Subjectivist View	Inter-subjective View
Data	Data are the result of recording 'raw' information.	Data are further specified information.	Data and information are often not clearly differentiable.	Data are the input from which information is generated.	Are physical inscriptions created on the basis of a particular social, cultural and technical understanding.
Knowledge	Is not considered.	Is not considered.	Information is atomic 'nuggets' of knowledge or physical inscriptions of knowledge.	Is created or altered as a consequence of information.	Is created through sociocultural interaction with the world and shapes how information can emerge.
Signs	Are not considered.	Are not considered.	Are the carrier of (contain) information in an objective sense.	Are interpreted into information.	Evolve as a result of inter-subjective agreement and affect what can constitute information.
Human beings	Are not considered.	Have to define which physical properties qualify as information.	Create meaning from information.	Are the creators of information.	Are creators or interpreters of information within a sociocultural context.
Social context	Is not considered.	Is not considered.	Is not considered.	May be present as a background.	Is considered an important aspect of information.

2.7.1 The Material View

Material approaches allow us to look at information as a human-independent, objective construct related to the physical world. Proponents of the material view argue that this allows all forms of information to be looked at and that material approaches therefore transcend understandings that limit the scope of information to a human-centric view. One strength of material approaches is that they have no problem with information existing in the physical world independently of human observers (Losee, 1997). The argument is that,

> information exists independently of living beings in the structure, pattern, arrangement of matter, and in the pattern of energy throughout the universe, and would do so whether or not any living being were present to experience the information (Bates, 2006, p. 1034).

Authors have argued that this understanding does not exclude but encompasses all forms of human information, and that it merely emphasizes that information can exist independently of humans (Bates, 2006; Wiener, 1961). However, there are two main points of criticism on the use of a material view of information in IS: firstly, inclusively-formulated abstract definitions of information are inherently vague, and secondly, some of the assumptions of observer-independent information are questionable.

More abstract definitions, such as the one provided by Wiener or those relating information to processes, have the benefit of being applicable in a wide set of circumstances. However, the benefit of such abstract and wide-reaching definitions is not clear as they do not indicate clear boundaries for the concept. For instance, defining information as a 'release mechanism' (Karpatschof, 2000) or 'the outcome of a process' (Losee, 1997) will evoke different understanding in different contexts and disciplines where people work with different theories and concepts (Capurro and Hjorland, 2003). This makes it difficult to adopt work on information across different domains even if identical definitions of information are used. It is therefore questionable how such general definitions can be used to develop deeper insights into the concept, especially from a unique IS perspective.

Moreover, material approaches attempt to argue for the existence of "raw" information independently of humans. Take the example from the first chapter in Brown and Duguid (2000) where the authors mention the Search for Extra Terrestrial Intelligence (SETI)

project to argue that the universe produces "raw" information. Firstly, in most cases, the matter of interest for IS is not the collection of data about the universe, but information that is related to human interaction, meaning-making, understanding and interpretation. In this context, information cannot be considered as raw in the same sense as cosmic background radiation could be considered raw. Information is the results of a process of human interaction where actors agree to emphasize certain aspects of the world (Cole, 2005, 2008). Moreover, things, objects and carriers of information are not information in themselves. This is similar to the concept of evidence, or information as evidence (Furner 2004). Things are always evidence for something. This requires a particular situation and context in which they can become evidence. Similarly, 'raw' information cannot be understood as information unless it is used by someone for something in some regard. Therefore, a number of authors argue that information is related to living beings (Scarrott, 1989) and that using information outside the context of humans should be seen as only a metaphoric usage of the term:

> use of the term information in both living and nonliving systems [is] acceptable *as long as one does not forget that the term is used as a metaphor*. Real information can come only from an informant. Information without an informant–without a person who tells something–is information in an only metaphoric sense. [... If any] messages and any acts of physical force can be indiscriminately called *information*, this term has lost much of its usefulness (Machlup, 1983, p. 657-658, emphasis in original).

Secondly, approaches to raw information are criticized from within the natural sciences themselves. Ontologically, the question is whether there can be such a thing as raw information or raw data in the first place, as any assemblage created to capture this "raw" information is inevitably based on certain sensors measuring certain properties while excluding others. The construction of such sensors and measuring instruments is based on a particular theoretical understanding which elevates some properties to the status of information while denying it to others. 'Raw' information or data are therefore not raw but already loaded with meaning which is ascribed to certain properties of the universe (Barad, 2007). Any account that argues that an IS is dealing with raw information will therefore be subject to these criticisms as well.

However, even though some have argued for the immateriality of information (Hayles, 1993, 1999), material aspects of information cannot be entirely discarded in the context

of IS (e.g. Mittleman, 2009). Firstly, materiality is closely related to some aspects of access to information: "[s]pace can serve physically to influence or constrain access to information along dimensions of distance and proximity, openness and security, and clarity or obstructions" (Rice et al., 2001, p. 69). Any approach to information in IS ideally would need to be able to include such aspects in its scope. Secondly, the materiality of information technology influences future possibilities for the development of systems. For instance, one of Blanchette's (2011) examples showed that traces of the original design of punch cards still affect the design of storage and storage concepts in modern IT systems.

2.7.2 The Engineering View

The ability to quantify information that resulted from Shannon's work had a widespread impact on the use of the concept in the sciences, including the social sciences, and far beyond electrical engineering, leading to a general increase in interest in the concept of information (Bates, 2005, 2010; Collins, 2007; MacKay, 1983). Much of the popularity of the concept in the 1950s, 1960s and beyond can therefore be credited to Shannon's work and Weaver's effort to highlight its applicability outside of signal transmission. For instance, Shannon's model of communication can be used to describe the consumption of mass media as a decoding and encoding process (Hall, 1980).

The fact that engineering approaches relate information to quantifiable entities makes information measurable and manipulable. This allows the comparison of information across different instances, contexts and over time. For instance, using an engineering view, it is possible to analyze how the amount of information stored in a system changes over time. The engineering view of information can thus be useful when researching growth patterns in information processing capacity (Moore, 1998) and information growth. Kallinikos (2006) used an engineering view of information to show that information growth is self-propelling and accelerating, thus explaining exponential growth patterns of (engineering-type) information. In addition, engineering approaches allow the processing of information. Information can be manipulated according to specific sets of rules in order to make it applicable in different circumstances. For instance, based on a specific input, trading systems can make 'decisions' and undertake actions, such as selling stock when the price falls below a certain point.

However, when looking closely at engineering approaches, what is actually quantified is not information but the signals that carry information. Regarding the mathematical theory of communication (MTC), Weaver highlighted that it only "deals with the carriers of information, symbols and signals, not with information itself" (Weaver, 1949, p. 12). The MTC and other engineering approaches to information, therefore, do not allow us to gain deeper insight into what information is. As a measurement, 'bit' can just as easily be applied to entities other than information such as 'bits of data' or to specify the capacity of an Ethernet cable. Describing something as consisting of 10 bits tells us as much about information as stating that a glass contains 10 ml of water tells us anything about the liquid. Boland (1987) therefore argued that the MTC is actually not about 'information' but about 'data'. Therefore, the label 'information theory' can be seen as an "unfortunate label" Floridi (2004a), and other labels such as the consistent use of Shannon's original label 'mathematical theory of communication' (MTC) or the 'theory of signal transmission' have been suggested instead (Capurro and Hjorland, 2003; Fugmann, 2008).

The biggest limitation of engineering approaches is that they do not allow us to capture the deeper meaning of information. Information is transmitted for a purpose and, when one is interested in meaningful communication, the quantification of the signals transmitted is less important than the effect that the information has on a receiver (Cornelius, 2002). Ironically, the strength of Shannon's MTC comes from the exclusion of meaning from his approach to information:

> information must not be confused with meaning. In fact, two messages, one of which is heavily loaded with meaning and the other of which is pure nonsense, can be exactly equivalent, from the present viewpoint, as regards information (Shannon and Weaver, 1949, p. 88).

This exclusion allowed Shannon to focus on the transmission of signals over a channel regardless of their content. If one is interested in purposeful human action, the concept of meaning cannot be excluded when human actors engage with the world. That what is stored and communicated through systems has to be meaningful to someone is central to the understanding of IS. It is irrelevant to an electrical engineer whether a message is meaningful to a recipient as long as it is an exact reproduction of the bits that were originally sent by or stored into a system. Whereas, for the recipients or users of those mes-

sages, it is crucially important that something received is meaningful as the reception of irrelevant gibberish may actually be more wasteful of an actor's resources than the reception of nothing. As a consequence, only looking at the signals transmitted does not fully address the concept of information.

Engineering approaches to information are of limited use to IS, however, as they are ill suited to accommodating the social aspects of information, and as they exclude meaning from information. For instance, Ngwenyama and Lee (1997) argued that the media richness theory employs a Shannon-type understanding that sees communication as a process of transporting a "material substance from one person to another person" (p. 150), interpreting recipients as a "passive receptacle of the transported symbols" (p. 150). This view sees the multiple meanings of a message to its different recipients not as legitimate but as "loss, due to noise, interference, or other deterioration in the 'signal' during the course of its transmission" (p. 149). Users of IS are therefore seen as passive recipients. However, meaning and context are central to developing a deeper understanding of IS, as Ngwenyama and Lee (1997) persuasively argued.

In addition, several problems arise when the MTC is shifted away from the transmission of signals to include the content of messages (Floridi, 2009b). For instance, Shannon's measure indicates that the less probable a message, the more information it contains. However, this observation makes no sense when it is applied to semantic content, as it implies that the less likely a sentence is, the more information it contains. The sentence 'Rex is a dog' would therefore contain less information than the sentence 'Rex is a mammal' as the latter is less likely to occur in common language (Miller, 1983). However, looking at both sentences from a semantic point of view, the second one contains less information as it does not state the species to which Rex belongs. For this reason, there have been attempts to extend the MTC to cover semantic content. For instance, Bar-Hillel and Carnap (1953; Bar-Hillel, 1955) argued that on the semantic level information refers to the number of possible states of the world that a sentence excludes.

A measure of information such as Harmon's (1984) 'inform' or Shannon's 'bit' cannot capture the wider context of information, and it is questionable whether it is possible to develop measures of information that can. Information has a social component, as was discussed in the material views above. This social nature of information (Alfino and

Pierce, 2001) "makes it impossible to quantify or measure" (Hofkirchner, 2011, p. 377) information. Taylor (1986) therefore suggested the use of 'chunk' as a unit of information instead:

> The 'bit' and 'byte' of information are not really useful as units [...]. Hence we have used the term "chunk" as a purposely ambiguous means of identifying any generalized unit of information, from single fact to complete report (p. 10).

Finally, it should be mentioned that through Shannon's work (1948) there is a link between the engineering view and the material view. Not only did Shannon spark interest in the concept of information in different branches of the sciences (Collins, 2007; MacKay, 1983) but his formula also showed a mathematical analogy to the physical formula of entropy (Rapoport, 1955). Subsequently, much of the work on thermodynamic entropy in regards to information is a result of Shannon using the term 'entropy' in his theory (MacKay, 1983). The influence of Shannon's work on the material view is possibly most evident in Wheeler (1990) who argued for the 'bit' to be the most fundamental physical unit.

2.7.3 The Objectivist View

Objectivist approaches to information shift information from the physical domain into the domain of human understanding, while providing a viewpoint that allows us to see information as objective entity. The key feature of this view is that information is seen as independent of individual recipients. This allows us to conceptualize information as more concrete than the conceptualizations put forward by other semiotic views of information. For instance, it allows us to regard information as a resource that can be acquired, accumulated, moved around, etc. (Cleveland, 1982). This view is further grounded in the observation that information can be exchanged for money, thus associating information with commodity (Kuhlen, 1991).

Indeed, a resource or commodity view of information is the foundation on which many notions of an 'information society' are built, as it allows us to see information in the context of other production factors (Parker, 1973). An information society is therefore a society in which information as a production factor exceeds other production factors in terms of importance, for example: "[p]hysical labor and industrial machinery are now secondary to the value added by information" (Toffler, 1983, p. 6).

However, a commodity view of information is not as solid as it seems. If information is a commodity similar to other commodities, it needs to have a value attached to it. However:

> The value of information is not fixed as it is for most commodities; it is contextually determined. Its full value is not known until it is used; this implies that assessment of information requires "upfront" costs and other information (Rice et al., 2001, p. 37).

It is therefore notoriously difficult to establish the value of information (Macgregor, 2005). While this does not invalidate objectivist approaches to information, it indicates that a commodity view is of limited use for investigating what information is as the concept of value in the context of information is both too general and too abstract (Price and Shanks, 2005). However, commodity-like views of information were influential in the early days of IS (cf. Boland, 1987; Taylor, 1986). Moreover, stating that something is a commodity does not describe anything about what it is. Labelling information as a commodity therefore sidesteps the problem of defining information, as many things of various nature can be labeled as commodities (Meadow and Yuan, 1997).

Objectivist approaches to information allow us to highlight certain aspects of information in IS research. For instance, objectivist approaches to information provide a particular understanding of the contents of IS in that they can argue that IS contain information. Such an understanding is necessary for approaches that argue for the manipulation, storage and processing of information by systems (Buckland, 1991; Rowley, 1998). Rowley (1998) even argued that information is something that can only be facilitated by IS when it is stored inside them. This necessitates an objective notion of information: "information systems designers [...] need to be able to impose structure on information to gather it into their systems and need therefore to treat information as an object" (p. 252). Therefore, notions of information explosion or information overload at least imply an objectivist or an engineering understanding of information. Moreover, according to objectivist views, it is possible to create objective information about the world through measurement and experiments (Zaliwski, 2011).

In contrast, the most severe criticism towards objectivist approaches to information is that they neglect the recipients of information. The recipient's condition, his/her background, prior knowledge, etc. are considered to be irrelevant. As Cole (1994), Dervin (1983) or Swift et al. (1979) have argued, users of systems are essentially seen as 'empty

buckets', to be filled up with a substance that "is squeezed from books like water from a sponge, and [that] can be stored and pumped around" (Fairthorne, 1975, p. 67).

Not only do objectivist approaches imply a simplistic account of information regarding users, they also overlook the point that information is always generated and exchanged for a purpose (Steinmüller, 1993). Information exchange can be, and often is, much more than the exchange of facts about the world that are relevant for decision making (March and Sevon, 1988). For instance: it can be a symbolic interaction; it can be the attempt to form collective understanding; it can be reassurance and reformulation of status between different individuals; it can be an act of socializing; it can act as social glue, etc. (Feldman and March, 1981; Romm, 1987). This is in contrast to information according to the objectivist view through which it is seen as "a form of knowledge alienated from human bodily experience" (Peters, 1988, p. 16).

Despite these limitations, objectivist approaches to information are prevalent in decision-making contexts as they transcend the individual in decision making thus portraying the process of coming to a decision as an objective process. This view has important consequences for IS as:

> In discussions of the design of information systems in organizations, the value of information is ordinarily linked to management in a simple way. We imagine that management is primarily a matter of making decisions and that a decision-maker chooses among several alternatives on the basis of information about consequences and preferences that are conditional on a choice. Additional information has value to the extent to which it can be expected to affect the choice (March and Sevon, 1988, p. 429-430).

Moreover, such an understanding of information provides authority in discourse, as arguments are based on 'hard facts' rather than 'subjective opinions' (Day, 2001; Introna, 1997; Romm, 1997). Information is therefore used to affirm competence, legitimacy and rationality: "decision makers and organizations establish their legitimacy by their use of information" (Feldman and March, 1981, p. 178). Managers are thus depicted or are depicting themselves as rational decision makers acting upon the information they receive, aiming to acquire 'perfect information' that will allow them to reach a maximal result (Philps, 1988; Sengupta, 1993):

> [I]nformation value of any data is measured in relation to its maximum possible value for the decision maker. The maximum possible value is the location in the decision space that would be reached with perfect information (Boland, 1987, p. 374).

However, the notion of 'perfect information' which is derived from game theory (Osborne, 2004; Rasmusen, 2007) overlooks the ongoing involvement of managers in the world (Introna, 1997).

Factual approaches to information are also unclear about the relation of facts to knowledge, as well as the role of context. Approaches that see information as a surrogate of knowledge cannot explain how *new knowledge* about the world can result from an encounter with *old information* that is stored in physical inscriptions. Moreover, the provision of factual information requires further information on the context of such facts (Spang-Hanssen, 2001). For instance, it is important to know from where facts have originated, how they were created or measured, how reliable was their source, etc. Moreover, objectivist approaches are criticized for failing to encompass the social and contextual aspects of information that are central to IS, as they

> effectively remove the human problems of action and meaning from our dialogue on information systems, and propagate an object-oriented approach to our research. This is doomed to failure, because information is not a thing, it is a skilled human accomplishment (Giddens, 1979). Information is not structured data. It is not an object that can be manipulated to design organizations. It is not an object that possesses intelligence. It neither gives nor brings power, and it is not perfectable. Information is found in the lived experience of the human condition and the fantasies which delude us into looking elsewhere will only lead us to search in vain (Boland, 1987, p. 370).

This criticism is echoed, for example, by Hjorland (2007, 2009) who highlighted the social dimension of information and by Brier (2004, 2008) who stressed that information crucially depends on an individual perspective.

Finally, objectivist approaches to information cannot provide a clear distinction between information and data. For instance, Mingers (1995) distinguished information from meaning but this raises the question of how data can be different from information when both are devoid of meaning. A common understanding in IS suggests that content stored in IT artifacts that is devoid of meaning is data (e.g. Bocij et al., 2008; Haag and Cummings, 2008; Laudon and Laudon, 2010; O'Brian and Marakas, 2009). Similarly, repre-

sentations of knowledge or stored messages may also be described as data. In this regard, it is not clear how such conceptualizations of information allow any deeper insight than using the concept of data.

2.7.4 The Subjectivist View

The central advantages of subjectivist approaches is that they can provide a clear explanation for the fact that the same message can be information for one person while it may be considered irrelevant by others. Subjectivist approaches, therefore, address the limitation of objectivist and physical approaches that excludes the perspective of an individual in the sense that "to think about information without in-formation, distorts our very ability to think about the larger world of human affairs" (Boland, 1987, p. 364).

Subjectivist approaches also highlight that "[i]nformation always has a *recipient* or user" (Introna, 1997, p. 50, emphasis in original) and therefore posit that information is always relative to the recipient rather than to the technology used for its transmission. From this, it follows that information has an effect on a recipient, in the sense that "information may *effect change* in the receiving system" (Introna, 1997, p. 50, emphasis in original) and that information always involves two different parties, as "[i]nformation is not self-referential; you cannot inform yourself" (Lenski, 2010, p. 82). However, this may be questioned when a temporal dimension is considered; for instance, entries in one's schedule may be created to inform oneself at a point in the future.

Often, subjectivist approaches are built on the observation that only something that is meaningful to a recipient can be information, with Introna (1997) even arguing that meaning is the most important characteristic of information: "[t]he *meaningful to the recipient* condition is necessary and sufficient" (p. 50, emphasis in original). As subjectivist approaches link information to meaning, they relate information to users rather than to technology. As Checkland and Holwell (1998) argued, meaning attribution is "at the very core of the concept 'information' when we use that word in its full sense, not simply as a synonym for 'data'" (p. 234). However, IT is incapable of obtaining meaning: "meaning is rooted in social-historical as well as embodied evolutionary processes that go beyond computational algorithmically [sic] logic" (Brier, 2004, p. 654; Wegner, 1997). Lack of awareness of this relationship between information and meaning is seen as causing confusion within the IS profession:

> ... there we have the root of much of the misunderstanding about information and information systems. For all the talk of significance and meaning, machines can only give us things. We humans must make them into meaning (Meadow and Yuan, 1997, p. 707).

However, the usefulness of definitions that relate information to meaning in the context of systems designed to provide information was questioned by Taylor (1986) who argued that information is better related to action relevance:

> In commonsense terms, information is the content of a message, the "meaning" that which informs or that which influences a decision. *Information resources*, on the other hand, are the services, the packages, and the support technologies and systems used to generate, store, organize, move, and display these packages. We manage information resources so that we can raise the probability that the content of formal messages, that is, the information, will be useful to a client or a group of clients sitting in a particular environment with particular kinds of problems (p. 8).

This, however, can be contrasted to Losee's (1997) view which argued against approaches that relate information to action relevance or usefulness. He argued that such approaches limit information to cognitive processes and instead suggested a more abstract definition of information (as discussed above):

> Requiring that all information be useful limits the domain of discussions about information to cognitive processes that can 'use' something; it excludes the information carried by a subatomic particle which is not sensed by a cognitive process (p. 256).

While arguments for or against different subjectivist approaches to information are brought forward by different authors, an undoubted contribution by subjectivist approaches is that they raise awareness of the recipient's dependence on information.

Thus, one of the important theoretical insights provided by subjectivist approaches is that they point towards the influence of predispositions present in different recipients (Kuhlen, 2004). This insight is vastly important for those seeking to provide information to others. As an informant cannot directly alter a recipient's predispositions, they have to adjust the message for a recipient in order to increase its chance of becoming information for that recipient. The possibility of providing information thus depends, for instance, on a recipient's 'ability' and 'willingness' to have their 'image altered' (Pratt, 1977, p. 211). The importance of predispositions for information is evident, for exam-

ple, in the concept of information literacy (Macgregor, 2005) or in Miller's (1956) observation that individuals can only retain a limited number of items when processing information. The implications of this include, for instance, the importance of building information literacy in the workforce (Bruce, 1999).

One way forward may thus be the use of approaches to information that take into account subjectivist concerns in the form of the predispositions of particular recipients. For instance, the approach expressed by Langefors (1980) and extended upon by Kettinger and Li (2010) raises awareness that it is necessary to engage with users' needs and traits. Moreover, by pointing out that users have certain predispositions that facilitate the appropriation of messages into information, they proposed an important path for IS research. Better understanding of how users become informed in specific settings will facilitate the development of more advanced IS that allow their users to become better informed by acquiring action-relevant knowledge more efficiently. IS research can, therefore, aim to better understand user-specific perspectives for becoming informed by identifying different sets of predispositions and how they facilitate information for different people.

One of the shortcomings of taking subjectivist approaches to information is that they are less discernible when it comes to the development of measurements for grasping information. However, approaches that relate information to a subjective process of understanding do not necessarily exclude the attempt to formulate a quantifiable approach to information. Tague-Sutcliffe (1995) argued that while information is subjective, it is important to ask what the benefits of something (messages, documents, records, etc.) are to a recipient. Thus, it is possible to ask 'how much' information a record provided to a user by investigating the benefits. The aim of such an approach is, for instance, to compare different ways of providing similar information to users; to investigate what parts of an information service are better for users; or to see if different user groups are served better than others. Take the case of a company directory which can be distributed in different forms or structured differently. While the use of such a directory will depend on each individual, different forms of providing information can be compared according to the benefits they provide for different user groups or purposes.

In addition, subjectivist approaches are criticized for neglecting wider sociocultural aspects affecting an individual's ability to be informed. What an individual can regard as information and even differentiate is related to his/her cultural background. To some extent, this is indicated by the notion of predispositions discussed above. In order to describe something or to make a distinction, an individual needs to have words that can describe this difference. However, the ability to differentiate is dependent on the language that a culture provides, thus the range of information that can be exchanged is influenced by a cultural and language context (Wittgenstein, 1953). Cognitive structure is even literally shaped by cultural setting (cf. Blair, 2006, p. 176). For instance, Brookes' (1980) "formula" discussed above was criticized by Cornelius (2002) for not recognizing the importance of social context, for providing little insight regarding the subjectivity of information and for not indicating how the change from information to knowledge takes place. Subsequently, it was criticized as being similar to the Augustinian language model (Frohman, 2004; Wittgenstein, 1953). Frohman argued that in order to understand information we have to look at the context in which it occurs. We need to understand the practice through which something becomes informing. Frohman (2004) thus criticizes the subjectivist view as a "simplistic idea that there is no more to the informativeness of a document than what happens in the mind of someone who understands it" (p. 16).

2.7.5 The Inter-subjective View

The relevance of taking an inter-subjective view of information stems from the fact that information needs at last two actors: "[i]nformation takes at least two persons: one who tells (by speaking, writing, imprinting, pointing, signaling) and one who listens, reads, watches" (Machlup, 1983, p. 645). Information is, therefore, generally an encounter of at least two social actors. However, often information involves multiple actors exchanging information. Acquiring information is thus a social process that requires a recipient to be aware of potential contacts and sources for information. Information, therefore, has a social component that is insufficiently captured by objectivist and subjectivist approaches. For instance, objectivist approaches aim to make information more accessible through the improved extraction of information from a pool of data, such as by providing better indexes, tables, summaries, etc. However, this misses the point that, depend-

ing on the context, information allows the neglect of certain details in certain situations rather than providing a more thorough summary of even more data: "[e]fficient communication relies not on how much can be said, but on how much can be left unsaid – and even unread – in the background" (Brown and Duguid, 2000, p. 205). Or, as Karl Weick stated in 1985: "[t]he value of an information system lies in what it withholds, as much as in what it gives" (Weick, 1985, p. 63). Of course, this depends on what types of questions an IS intends to address and for whom. Acquiring information is not simply a matter of the design of an IT artifact (~objectivist view) or the traits of a particular user (~subjectivist view) but, rather, that contextual factors play an important role. For instance, how fast and to what level of detail do users need to become informed about something in a given situation? This requires a shift from a subjectivist to an inter-subjective perspective in the sense that users have to be understood as social actors (Lamb and Kling, 2003). Depending on the situation, the breadth of sources that need to be consulted or searched will vary as will the level of depth to which sources need to be probed. Inter-subjective factors therefore play an important role in determining, not only to what extent information is constrained or enabled in particular settings, but also to what extent content provided by different sources is considered to be a valid, legitimate or authoritative source of information.

Moreover, perspectives of information that emphasize its technological dimension lose track of the purpose of information, that is, to inform people (Davenport, 1997) and instead focus on quantifiable stockpiles of data:

> What is the 'information' so crucial to this odd ideology, the icon now so greatly cherished? The kind of information upheld is not knowledge in the ordinary sense of the term; nor is it understanding, enlightenment, critical thought, timeless wisdom, or the content of a well-educated mind. If one looks carefully at writings of computer enthusiasts, one finds that 'information' is enormous quantities of data manipulated by various kinds of electronic media, used to facilitate the transactions of today's large, complex organizations (Winner, 1984, p. 95).

However, "information is, above and beyond its technical or computational aspects, a social phenomenon" (Kuhlen, 1991, p. 94). Therefore, employing a technical, behavioral or cognitive dimension risks ignoring or limiting the importance of the social dimension of information. For instance, Boland (1987) argued that objectivist approaches

"deny the importance of symbolic action, language practice and interpersonal dialogue" (p. 366), thus pointing in the direction of an inter-subjective dimension of information that goes beyond individual cognition. Rayward (2010) also noted the need to look at the social and cultural dimension of information, especially when employing a historic lens on information:

> what becomes of central importance to the historian of information are (to avoid too mechanistic an analogy) the cultural and social dynamics of these groups as they create and modify distinctive information handling infrastructures (p. 51).

Human interaction is central to what constitutes information for a particular group, and to how information is exchanged, stored, transported or signified. Information, therefore, needs to be investigated within its societal, cultural, political, technological and economic context (Ratzek, 2004). However, such aspects are often neglected when information is studied and, instead, a position is taken that generalizes actors and their information needs, as well as information itself (Hjorland 2007). In contrast, inter-subjective approaches to information point out that information is related to a wider context and that such a wider context cannot be ignored:

> The ends of information, after all, are human ends. The logic of information must ultimately be the logic of humanity. For all information's independence and extent, it is people, in their communities, organizations, and institutions, who ultimately decide what it all means and why it matters (Brown and Duguid, 2000, p. 18).

From this, it follows that information has an inherent ethical dimension (Goguen, 1997; Henrichs, 2004). Information allows us to participate in debates, to raise questions or to voice a standpoint. Information is, therefore, related to power and empowerment (Murdock and Golding, 1989). Having information allows us to question the status quo, to hold others accountable and to back up our decisions. However, information can also be abused if it spreads beyond a certain group, thus information may also require control, for example, the case of insider trading or knowledge about the construction of weapons of mass destruction. There has to be a balance between restriction and access to information. One fundamental problem in information ethics is, therefore, to determine what level of access should be granted to whom in what circumstances (Furner, 2010). In addition, information can have a liberating dimension (Fuchs, 2009). Information acts as vehicle against the concentration of power and can facilitate power-shifting (Romm,

1997). Furthermore, being able to obtain information is essential to democratic processes (Murdoch and Golding, 1989), enabling decisions based on open discussions (Romm, 1997). On an individual level, having information is essential for the development of self-determination and autonomy, and to partake in rational decision making (Kuhlen, 1991; Lievrouw and Farb, 2003; Marchionini, 1995; Wersig, 1993).

Moreover, while considerations of the wider social implications of an IS are the bedrock for the development of ethically-responsible, democratic and liberating IS, the consideration of social implications also holds the promise of developing IS that are more likely to strike a chord with their users:

> unless we start to respect the full range of values that make us human, the technologies we build are likely to be dull and uninteresting at best, and de-humanising at worst (Randall et al., 2007, p. 294).

Inter-subjective approaches to information shine the spotlight on these wider social aspects of information rather than sidelining them. Moreover, Hofkirchner (2011) alerted us to the point that it is not only necessary but essential for those interested in information to look into the wider aspects of information: otherwise, the critical and liberating potential of information is undermined: "[c]onceptualizations of information devoid of considerations about potential far-reaching impacts on society are prone to being subjected to dominating economic, political, military interests" (p. 376). For Hofkirchner, the main aim for engaging with information, however, was the benefit to society at large, particularly its ability to cope with challenges that threaten the longevity of human civilization and survival. Consideration of the social aspects of information provides, therefore, an antidote to blind trust in information technology as a liberating force and enabler of democracy. Winner (1984) defined this as 'mythinformation':

> mythinformation: the almost religious conviction that a widespread adoption of computers and communication systems and broad access to electronic information will automatically produce a better world for humanity (Winner, 1984, p. 91).

However, inter-subjective approaches to information can be criticized for not providing clear boundaries on which aspects of information should be considered as contextual and which aspects are closely related to information in a particular situation. This provides the strength as well as the weakness of inter-subjective approaches:

> In general, information cannot be fully context sensitive (for then it could only be understood when and where it is produced) nor fully context insensitive (for then it could be understood by anyone in any time and place) (Gougen, 1997, p. 32).

This leaves a researcher interested in information with the task of critically judging the boundaries of information. S/he has to decide what aspects are situational and therefore need to be included in the research and what aspects are contextual and thus can be omitted. In contrast, the burden of establishing boundaries is markedly lower for the other views of information.

Finally, the inter-subjective lens thus shifts the question from 'what is information?' to the question of 'how does something become informing?' (Frohmann, 2004). Institutions are charged with representing the modern world. For example, they create documents that contain 'information' about the world. So the organizational make-up of institutions and their role in our society define the 'information' generated by them. In order to understand how something becomes informative, we have to look at the social practice, institutionality, historicity and materiality of 'documents' (in the widest possible sense). In this way we can try to understand the practice through which documents become informing.

2.8 Exemplified Use of the Taxonomy for IS [redacted]

The usefulness of the taxonomy for IS can be demonstrated by applying it to shift our understanding of a particular research problem. When the understanding of information is shifted from one view to another, novel understandings of a phenomenon become possible. For example, researchers can employ a different view of information as an additional lens to look at a particular problem in order to generate additional insight into a research problem.

A study by Arazy and Woo (2007) has been chosen as an example. The reason for picking this study is that it is the most recent publication in *MIS Quarterly* identified by McKinney and Yoos (2010) in their survey of publications on information in IS. Moreover, McKinney and Yoos (2010) classified it under their 'token view' which they identified as the most prevalent view in IS research. The research by Arazy and Woo was motivated by the observation that "the use of information technology to manage documents remains one of the most important challenges facing IS managers" (p. 525). However,

current information retrieval (IR) systems are insufficient to cope with "the diversity and sheer volume of information" (p. 525), with a major obstacle being the problem of word ambiguity as words can have different meanings. To improve retrieval effectiveness and to cope with word ambiguity, the authors suggested that documents be indexed and retrieved based on the co-occurrence of words in documents, so-called collocations.

Arazy and Woo assessed collocations by comparing the performance of the different means for generating document representations in a vector space based on conventional term-based indexing as well as the different forms of collocation-based indexing. Arazy and Woo used two sets (disks 4 and 5) of the established Text Retrieval Conference (TREC) corpus to compare different approaches to the creation of collocation indexes. It is important to emphasize that the research done by Arazy and Woo (2007) stands in its own right and the purpose here is *not* to criticize the work done by the authors, but to show how a shift of the understanding of information can lead to *additional insights* on the subject.

Within the taxonomy of views of information presented here, the article by Arazy and Woo (2007) can be allocated to the objectivist view. While the paper does not define information, it provides a definition of ambiguity as: "the gap between the way in which people think about information, and the way in which it is represented in IR systems" (p. 526). This indicates that the authors have understood that a system contains content that stands for somebody in some regard; this firmly locates the paper within the semiotic perspective. Moreover, information is understood as existing objectively within a system independently from a subject or a wider sociocultural context, thus further allocating the paper to the objectivist view. This assessment of Arazy and Woo's understanding of information is further substantiated by their statement that the purpose of their research was to compare "the 'information' captured in the collocations to that captured by the single terms making-up the collocation" (p. 531).

The taxonomy can now be used to shift the understanding of information and thus to expand the research in further directions. This shift can occur on two levels; on a general level regarding the wider context of the research, or within the context of the research. For instance, within a wider context, a shift towards subjectivist and inter-subjective views raises, for instance, the question of whether the relevance of documents can be as

firmly established as has been done within the TREC framework used by the authors. TREC evaluations rely on a predefined set of queries establishing for each document a binary description of its relevance (whether it is relevant or not):

> Only binary judgments ("relevant" or "not relevant") are made, and a document is judged relevant if any piece of it is relevant (regardless of how small the piece is in relation to the rest of the document) (TREC, 2006).

Alternatively, the relevance of an individual document may be better described along a continuum from less to more relevant rather than as an all or nothing approach, or even as something that may change depending on a person or circumstances.

Furthermore, the usefulness of the taxonomy can be demonstrated by shifting the view of information within the frame provided by Arazy and Woo (2007). Continuing with our thought trial (Weick, 1989), what happens if a shift is made from an objectivist view to a subjectivist view or an inter-subjective view?

Central to Arazy and Woo's research was the use of collocations for indexing and retrieval purposes. The discussion therefore now shifts to a subjectivist view regarding information and collocations, followed by a discussion which takes an inter-subjective view. Table 2.9 provides a summary of Arazy and Woo's (2007) work as well as a comparison of the change in the understanding of information that results from a shift in the view of information.

One result of a shift from an objectivist view to a subjectivist view is that what is retrieved from a system is not simply depending on an algorithm, but equally on the users and their subjective understanding. Therefore, the information cannot be contained in a collocation independently of a user as it is something that is generated by a user rather than by an objectively-existing relationship between two terms. Subsequently, the assessment of retrieval system performance has to consider to what extent different means of indexing and retrieving a set of documents are efficient in providing users with the means of creating collocations that are *meaningful to them*. For instance, users could employ proximity operators in their searches, such as NEAR or ADJ, in order to search for collocations that are deemed important by them. Additionally, systems could guide their users in the use of collocations by providing term dictionaries that, through an "explode" function, allow the identification of different collocations related to particular

terms. Users can then select specific collocations that they assess as useful to them in their searches.

Table 2.9 Summary of Arazy and Woo (2007) and Comparison of Views of Information

Summary:	- Information retrieval is an important means for managing document collections; - Suggest the of use collocations (co-word) based indexing; - The basic premise is that collocations contain information about documents; - Assesses performance of different collocation-based indexing approaches.		
View:	**Objectivist (adopted by authors)**	**Subjectivist (alternative)**	**Inter-subjective (alternative)**
Assumption about information:	Collocations contain information in an objective way.	Information contained in collocation depends on the user of a retrieval system.	Information in collocations depends on a wider sociocultural context.
Research Question 1	"Does the artifact work?" (p. 531) By which the authors refer to: "examination on the effects of key parameters" (p. 531).	Does an artifact support users in creating collocations that are meaningful to them? Examine the effect of different indexing methods (e.g. performance when using proximity operators).	Does collocation-based indexing work on different sets of documents? Examine the effect of different collocation-based indexing techniques on different document collections.
Research Question 2	"What are the characteristics of the environment in which it works?" (p. 531) By which the authors refer to: "the extent to which collocation indexing enhances retrieval performance beyond traditional token-based indexing" (p. 531).	Can collocation-based indexing techniques support the generation of user-centered collocations? The extent to which the performance of collocation indexing is enhanced compared to traditional token-based indexing in regards to subjectivist retrieval techniques (e.g. clustering).	What are the characteristics of different document collections in the performance of collocation-based indexing? The extent to which performance of collocation indexing and traditional token-based indexing differ between document collections (e.g. language).

This shifts the problem when comparing the performance of different indexing techniques regarding their speed and scalability on a large document corpus. The research question would therefore have to consider if an artifact supports such functionality in an efficient manner and how the use of such functionality by users can be facilitated. From this angle, the more efficient systems are those that are flexible in allowing the use of collocations regarded as relevant by particular users. Different means for indexing and retrieving documents, such as term-based indexing or distinct collocation-based techniques may vary in their performance in this regard. For instance, it is important to understand to what extent indexing techniques differ in their responsiveness to queries employing proximity operators when used with large heterogeneous document collections.

Moreover, particular search terms may be used in different collocations within different groups of documents: clustering is one way of identifying such groups. However, different indexing techniques may vary in their ability to efficiently generate clusters of different groups of documents. Performance regarding clustering documents into groups is thus relevant, as clustering provides users with the possibility of refining their searches to instances in which terms are used in different collocations that are relevant to them in a particular context.

And what happens if we make a further shift towards an inter-subjective understanding of information that emphasizes that different groups will vary in their perception of information? While Arazy and Woo (2007) were interested in comparing indexing methods for large heterogeneous document collections, large document collections will still differ in their content depending on the context in which a retrieval system is employed. Moreover, collocations and terms may be used differently within among different groups, such as, across different domains. The use of language and the structure of documents will differ, for instance, in legal, medical or financial contexts from those in newspaper articles encompassing the bulk of the TREC material chosen by Arazy and Woo. However, algorithms for indexing a collection of documents are run identically, independently of the material they index. It is therefore possible that different collocation techniques may produce different results on different sets of documents that vary in structure, terminology and language. This is, for example, relevant in the context of comparisons of collocations across sentences, and when weighting the distance and directionality of different terms of a collocation, as done by Arazy and Woo (2007).

It is possible that the effectiveness of different indexing methods will vary depending on the corpus on which they are employed. The research questions raised by Arazy and Woo (2007) were "Does the artifact work?" and "What are the characteristics of the environment in which it works?" (p. 531). A shift from an objectivist to an inter-subjective view would therefore have to consider the effectiveness of term-based indexing techniques in comparison to different collocation-based techniques in regards to different document collections. This requires the testing of different indexing methods on different corpora. For instance, the performance of different approaches could be extended to a comparison in the context of different TREC corpora, such as the legal TREC or the medical TREC (TREC, 2012). In addition, the use and construction of collocations will

differ between languages. This indicates the necessity of extending the comparison of different means of indexing and retrieving documents to languages other than English in order to draw a more conclusive comparison.

As shown in the example of Arazy and Woo (2007), the taxonomy of information presented here can be used to shift the understanding of information to alternative views. Such a shift allows the generation of additional angles on a problem. It allows the formulation of novel perspectives for future research. The taxonomy is therefore not only helpful for IS to encourage engagement with the concept of information, but also has practical relevance for existing IS research as it allows us to extend the understanding of existing research.

2.9 Discussion and Conclusion

Information is a complex and diverse concept that potentially allows rich insights for IS researchers. However, IS research is often not grounded in an explicit and solid understanding of the concept of information (Lee, 2010) and, as a consequence, information is often treated differently by different researchers (McKinney and Yoos, 2010) without recognizing or reflecting on the differences. By providing an extensive overview of the literature on information and developing a taxonomy of different views of information, this essay therefore makes an important contribution to the understanding of the concept of information for IS. Moreover, the essay shows that different concepts of information are often based on varying views of the world as well as on varying epistemological assumptions about information that are often mutually exclusive. As a review, the essay is therefore "more than the sum of its parts, creating a meta-knowledge about a subject area" (Schwarz et al., 2007, p. 43). It provides an extensive overview of possible conceptualizations of information structured within the context of a taxonomy.

2.9.1 Theoretical Contributions and Implications

The main contribution of this taxonomy is that it provides a deeper understanding of the concept of information for IS. To date, discussions in IS about the concept of information are scant, despite the obvious importance of this concept for IS. While IS researchers frequently refer to 'information' in the context of their research (McKinney and Yoos, 2010), they rarely explicitly state what they mean by it. Subsequently,

Dretske's (1981) observation that "it is much easier to talk about information than it is to say what it is you are talking about" (p. ix) holds true for most IS research. This essay provides a means for overcoming this void by providing an overview of the concept. It has reviewed an extensive body of literature from within and outside IS, engaging with information on a theoretical and conceptual level. This review therefore potentially allows IS researchers to develop and express a more nuanced understanding of information within the context of their research.

The taxonomy introduced here is important as it provides an orientation to a vast body of literature. It helps to better understand the variety of existing conceptualizations of information and how they differ from each other. It therefore provides an answer to the questions: 'What is information?'; 'How is information seen differently by different approaches?'; and 'On what theoretical bases do approaches to information differ?'

Two main perspectives for conceptualizing information are distinguished. The first perspective encompasses approaches that relate information to the physical world. Within the physical perspective, information can be understood from a material view or from an engineering view. According to approaches taking a *material view*, information is seen as a property of the physical world: this includes approaches that argue that information is on the same level as fundamental physical constructs such as matter or energy. In contrast, approaches taking an *engineering view* understand information as an entity that can be measured in purely physical terms. The most notable example from this view is Shannon's mathematical theory of communication (MTC), often also called information theory.

The second perspective is labeled 'the semiotic perspective' as it encompasses approaches that relate information to the world of signs. Approaches relating information to signs can be further divided into three different views. According to the *objectivist view*, information is an objective property of a sign that exists independently of an observer. For instance, information is understood as true facts. In contrast, approaches taking a *subjectivist view* argue that information exists relative to a recipient. Approaches taking a subjectivist view, for instance, relate information to cognitive change or action relevance. Lastly, approaches taking an *inter-subjective view* have in common that they see information as relative, not in a primarily individual sense but within a wider socio-

cultural setting. For instance, what is considered as information by a particular group will depend on the group's norms and language.

The discussion of these five views has revealed that they all make different epistemological and ontological assumptions regarding information. This has consequences for how information relates to other concepts such as data, knowledge, signs, human actors, and social, cultural and historical contexts. As a result, these views differ in terms of strengths and limitations for theorizing information for IS. For instance, while the inter-subjective view can consider sociocultural aspects and allows the relation of information to ethical issues, it is less strong for looking at technological and material aspects of information that are better covered by views associated with the physical perspective of information. Conversely, objectivist approaches allow one to take a perspective according to which information can be extracted from a pool of data, such as by providing better indexes, tables, summaries, etc. However, this in turn misses the point that, depending on the context, information allows certain details to be neglected in certain situations rather than providing a more thorough summary of even more data: "[e]fficient communication relies not on how much can be said, but on how much can be left unsaid – and even unread – in the background" (Brown and Duguid, 2000, p. 205).

Consequently, an additional contribution by the taxonomy is that it can also be used for the generation of new insights into an existing piece of research. Used in this way, the taxonomy allows us to shift our understanding of a research problem when the perspective of information is changed. It may thus help to shift the level of analysis of a particular phenomenon. Within a particular view, information is understood in a specific way that encourages a particular look into a problem. A change in the view will thus lead to a different look at a problem. Take the case of information security as an example. If information is seen from an engineering view, securing the transmission of confidential information via means such as encryption will be important; however, from an objectivist view, security mechanisms such as password protection or access restrictions are important elements; in contrast, from a subjectivist perspective, secure handling of information by individual workers becomes important; whereas, from an inter-subjective view, organizational culture in regards to handling sensitive information becomes the focus of attention.

The main theoretical implication of the taxonomy is that it can encourage future IS research to develop a wider and more balanced picture of research problems of interest to IS. As the example of information security highlights, each view of information, especially those from the semiotic perspective, is important and relevant. However, considering all these aspects in one piece of research is often not possible. Explicitly stating the position regarding information can therefore help to more clearly specify the level of analysis taken in a particular piece of IS research. This will not only allow fellow IS researchers to expand more easily on a phenomenon, but will also allow IS to develop more balance in its research on phenomena of interest. For instance, approaches taking an objectivist view towards a particular phenomenon should be complemented by research taking a subjectivist view or an inter-subjective view. Overall, the semiotic perspective encourages a more holistic approach towards information in IS. Firstly, it encourages better understanding of the situational and social context in which users of systems become informed (inter-subjective view). Secondly, it raises awareness of the importance of how users of systems become informed through systems (subjectivist perspective). Finally, it encourages the investigation of what aspects of a technical system allow users to become informed (objectivist perspective).

2.9.2 Practical Implications

Regarding the practical implications of the taxonomy, it is important to note that the intended audience of the taxonomy is IS researchers in general. Therefore, the practice that this research seeks to contribute to is IS research practice and the practical relevance of this essay has to be seen in regards to IS research. The aim of this publication is therefore similar to, for instance, Gregor's (2006) work as it seeks to make a practical contribution to IS scholarship. Some practical implications of the taxonomy discussed above include: firstly, it allows a shift in understanding of different levels of analysis towards a particular phenomenon when different views of information are employed; secondly, it encourages diversity regarding a research problem and thus potentially allows deeper insight into a problem than research limited to one particular view of information; and thirdly, it stimulates an explicit consideration of information in IS research and a reflective attitude towards particular views. These can in turn lead to better under-

standing of different approaches to IS research and more insightful informing of IS research practice.

In addition, the taxonomy also has relevance to IS teaching and IS courses. It allows the introduction of the concept of information in a way that provides more depth when engaging with the concept than the often used data-information-knowledge triad (Boell and Cecez-Kecmanovic, 2012; Rowley, 2007). While the taxonomy exhibits a certain degree of simplicity in the way that it introduces different approaches to information, it does not simplify the conceptual richness associated with this concept. The two material views provide clarity regarding a vast body of literature on information within the natural sciences and Shannon's (1948) so-called 'information theory'. The three different semiotic views can be especially useful for educating IS novices that either view that understands information as meaningful or processed data, as a subjective encounter with data or as bound to social practice, is in itself only a limited view of information. Information for IS will need to encompass the whole range of these understandings.

Therefore, the taxonomy encourages diversity in our understanding of information rather than seeking some unifying approach. Information from a purely objectivist view is incommensurable with information from a purely subjectivist view. However, in the light of the taxonomy, both are equally valid approaches to information as both can provide important insights into the concept of information for IS. The taxonomy thus acts as a bridge that counters a particular entrenched view of information and encourages a pluralistic approach instead.

2.9.3 Limitations

Like any taxonomy, the taxonomy of the concepts of information presented here is limited. The aim of the taxonomy is to provide a general view of information and the range of available conceptualizations in the broad literature. Although the literature coverage is large, it is inevitably limited. While the taxonomy introduced a wide range of different approaches and also a discussion of the relevance of individual approaches for IS, further research is needed to explore the usefulness of individual approaches in the context of IS and to possibly provide a stronger link of individual approaches to IS practice.

2.9.4 Future Research

Research on how users become informed and engage with IS needs to encompass the full range of research methods currently employed in IS. For instance, through ethnographic studies, researchers can come to better understand how members in different social settings become informed as part of their everyday practices (Schatzki, 1997, 2006). Similarly, through case studies and interviews, researchers can investigate the range and extent of sources that particular user groups consider as informing them. Through quantitative studies, researchers can tease out what impact different sources and resources have in informing specific users. As the sociocultural context in which IS are used is in constant motion, so are the ways in which humans become informed. Organizational environments, their structures, hierarchies and (information) technologies are constantly evolving which, in turn, will alter the way through which, and the means by which, individuals within an organization become informed.

The possibilities for future research regarding information in IS are wide open and should embrace the full range of possible views of information. For instance, regarding the objectivist view, to date, IS have only made limited use of propositional approaches to information (p. 43). However, such approaches may prove to be relevant in the context of database design as they provide logical approaches that can potentially allow innovative approaches for data systems design. Future research in this direction could be built on Dretske's (1981, 1983) work, and thus follow a suggestion by Mingers (1996). Moreover, Devlin (1991), situation theory (Barwise and Perry, 1983), situation logic (Israel and Perry, 1990) and channel theory (Barwise and Seligman, 1997) made important contributions to propositional approaches to information. However, these theories are seldom picked up by current IS research.

Regarding the subjectivist view of information, future research should focus on the question of how individuals become informed through the use of systems. According to the subjectivist view, information may arise within an individual when they receive a message. Whether a message becomes information or not depends on the predispositions within the individual who receives the message. Importantly, informants cannot change the predispositions of the individual to whom they seek to convey information. From this, it follows that in order to become information, a message needs to be fitted to the predispositions of a recipient. One possible approach for future research in IS could

therefore be to gain better understanding of the predispositions of intended recipients of information in order to better understand how certain predispositions facilitate the transformation of messages into information, within a given situation and through the use of information technology.

Finally, the inter-subjective view also provides multiple avenues for future research. Within IS, Stamper (1991, 1992), Romm (1997), Goguen (1997) and Beynon-Davies (2009a, 2010) have engaged with information from an inter-subjective view. Here, the driving question is 'how are social actors informed and what role do IT artifacts and IS play in informing people or enabling their effective interaction and building shared understanding'? Regarding this overarching question, there is a need to build further understanding of how sociocultural aspects affect information. For instance, researchers could engage with the question of how different organizational styles affect what and how things are perceived as information. Such differences could explain why certain organizations are more or less likely to consider specific messages from the environment as noise rather than as information (and vice versa). Moreover, in-depth ethnographic research can shed light on how users of specific systems are informed in their everyday working environment. Insights from such studies may help in developing technologies that provide users with outputs and functionality that are information for them.

2.9.5 Final Remarks

The importance of this research for IS practice is that better understanding of information holds the promise of allowing not only the creation of advanced IS, but also a better understanding of IS within organizational practice. Organizations that better understand what constitutes information for them and their workers will be able to create systems that allow them to be more agile and better informed than their competitors. Thus, better understanding of information is not only crucial for the future development and advance of information systems (IS) but also for enhancing the intellectual core of the IS discipline.

Chapter 3 : Towards a 'Facets of Information' Theory

3.1 Summary

Information is an important concept for the discipline of information systems (IS). However, conceptualizations of information have so far failed for two reasons: firstly, conceptualizations such as the data-information-knowledge-wisdom (DIKW) hierarchy are simplistic and do not allow deeper theoretical insight for research and practice. Secondly, conceptualizations are ill equipped to deal with the interwoven character of sociocultural and technical/material facets of information that are all relevant in the context of modern information systems. To overcome these limitations, this essay builds on earlier semiotic approaches to information to which it adds a Wittgensteinian view of information. This allows one to approach the concept of information by describing facets of information that contribute to making information 'information'. Facets of information are, for instance, that information is trusted, novel, relevant to a purpose, comprehensible, adhering to structural rules, and that it is physically accessible. In total, 14 facets of information are introduced and discussed. Approaching information from this angle has the benefit of providing an integrative look at information that can simultaneously encompass empiric (physical), syntactic (rule-based), semantic (meaning-related) and pragmatic (sociocultural) facets of information. This therefore takes into account information's social and technological dimensions. This is of particular relevance to IS research which is simultaneously interested in the social and technological aspects of information and communication technology (ICT). Furthermore, from the relevance of the semantic and pragmatic dimensions of information, it follows that conceptual clarity regarding information can be built by distinguishing *intended information* that is captured and stored by ICT, *potential information* that is retrieved from ICT and *information-in-use* that is of actual use to an ICT user. The usefulness of the 'facets of information' theory is exemplified by showing that a facets approach to information allows an alternative understanding of the role of ICT and information in organizations.

Keywords: information; conceptualizing information; semiotics; information systems; Wittgenstein; IT; ICT; informational capabilities; information exchange.

3.2 Introduction

Information is an important term for information systems (IS) and is used throughout virtually every publication on IS. Moreover, information often also forms an important aspect of IS research. For instance, information is frequently combined in phrases that denote different aspects that are of interest to IS research (McKinney and Yoos, 2010). Such phrases include different areas for IS research such as: 'information requirements', 'information security', 'information retrieval', 'information flow' or 'information sharing'. In addition, these phrases can relate to broader concepts of interest to IS and its practice, such as 'information society', 'information industry' and, of course, 'information system'. These examples highlight that the term 'information' can be considered a phenomenon of primary interest to IS research.

While information is an important and central concept, it is nevertheless often neglected by IS researchers (McKinney and Yoos, 2010; Lee, 2010). While in the past few decades several IS researchers have emphasized the importance for IS research to look at information as a concept (Boland, 1987; Checkland and Holwell, 1998; Churchman, 1968; Galliers, 1987; Stamper, 1985; McKinney and Yoos, 2010; Mingers, 1996), information is often used by IS researchers in an unreflected way (Lee, 2004, 2010). As a consequence, the concept is often trivialized, such as being used as a near synonym to 'data' (Lee, 2004, 2010; McKinney and Yoos, 2010). Of course, there are attempts to differentiate information from data, and virtually every IS textbook introduces the so-called data-information-knowledge-wisdom (DIKW) hierarchy according to which information is the result of processing data (Rowley, 2007). However, this leaves many questions unanswered such as to what degree data need to be processed to qualify as information (Buckland, 1991) or why the same data can lead to different information for different recipients (Kettinger and Li, 2010). But, more importantly, the DIKW hierarchy approach to information is generally criticized for being imprecise (Davenport, 1997; Stenmark, 2001) and of limited use for theory and research (Bates, 2010; Stamper, 1985). What makes the situation even more problematic is that, apart from the hierarchical approach, there are literally hundreds if not thousands of different approaches to information (Bates, 2010; Capurro and Hjorland, 2003; Wersig, 1997) that often de-

fine information in ways that are incommensurable with each other (see Boell and Cecez-Kecmanovic, 2011a; Chapter 2 – Theorizing Information).

Therefore, IS research needs to develop a more thorough understanding of information and to engage in a discourse about information (Avgerou, 2010; Baskerville, 2010; Lee, 2010). What is of particular interest to such a discourse is the fostering of views on information that can embrace the diversity of IS research and, therefore, offer the possibility of contributing to an intellectual core for the IS field. More specifically, IS are simultaneously interested both in technological aspects as well as in social aspects of information (Alter, 2008; Checkland and Holwell, 1998; Galliers, 2003; Lee, 2001, 2004, 2010; Paul, 2010). Thus, the objective of this essay is to investigate the concept of information in a way that can embrace social, as well as cognitive, technological and material aspects of information. Importantly, these aspects of information are not to be understood as existing side-by-side but instead in an integrative way. This aim is achieved by drawing from the philosophy of language provided by the late Ludwig Wittgenstein (1953)[4]. Wittgenstein's understanding of language approached terms through descriptions rather than through definitions. In following Wittgenstein, the essay proposes a conceptual advancement of the notion of information by describing different facets of information. In doing so, it does not refer to attributes as 'attribute' implies that something is intrinsic to the nature of information and thus part of a defining property of information. In contrast, 'facet' is used here to emphasize that it is an angle or aspect of information that is of interest when the term 'information' is used. Facets therefore describe information in terms of how we use the term, while not defining 'information'. Typically, when we use the term 'information', it will have many facets at the same time.

More specifically, this essay makes three contributions towards understanding information for IS research and practice:

4 The difference between Wittgenstein's earlier work in the *Tractatus Logico-Philosophicus* and his later work in *Philosophical Investigations* is significant. Wittgenstein's earlier work was concerned with a logic-driven approach to understanding the relationship between words and the world. However, in his later work Wittgenstein rejected many of his earlier claims, particularly that the meaning of words is something that can be established independently of them. Instead, context (forms of life) and situation (language games) are seen as important dimensions for understanding language.

(1) It proposes a 'facets of information' theory that enables IS to simultaneously look at social/human as well as technological/material aspects of information.

(2) It identifies 14 different facets of information that describe a complex and fuzzy notion of information in different contexts and for different purposes thus allowing IS researchers as well as practitioners to further dissect the concept of information and the appropriate facets relevant to them.

(3) Finally, it exemplifies the usefulness of the 'facets of information' theory by re-analyzing the concept of 'informational capabilities' provided by Leonardi (2007).

The remainder of this essay is structured as follows. The next section provides further introduction of the concept of information and how it is used in IS and neighboring disciplines. The essay then introduces a semiotic framework for understanding information based on Stamper's (1991, 1992) work as well as discussing the implications of this framework for understanding information exchange. This is followed by a section that introduces all 14 different facets of information showing how they are related to different semiotic dimensions. After this, the use of a facets view of information is exemplified by drawing from Leonardi's (2007) case of SkyLabs, showing that it leads to additional understanding of information and informational capabilities in this case. The penultimate section then discusses the contributions made in this essay and the theoretical as well as practical implications that arise from them. The final section concludes the essay by summarizing its main contributions.

3.3 Overview of Approaches to Information [redacted]

Over the past few decades, the number of approaches within IS which have engaged with information on a conceptual level have been limited (for exceptions, see e.g. Beynon-Davies, 2009; Boland, 1987; Kettinger and Li, 2010; Mingers, 1995, 1996, 1997; Stamper, 1985, 1992). Moreover, these attempts are only trickles in both the sea of IS publications and the ocean of general interest in this concept by other disciplines (for literature reviews of information, see e.g. Bates, 2010; Capurro and Hjorland, 2003; Collins, 2007; Cornelius, 2002; Diaz Nafría et al., 2010; Fischer, 1993; Floridi, 2009b; Lenski, 2010; Martignon, 2001; Rice et al., 2001). However, IS have a primary interest

in 'information', a concept introduced in virtually every IS textbook (Boell and Cecez-Kecmanovic, 2012; Rowley, 2007) and used in dozens of different phrases in IS research (see McKinney and Yoos, 2010). Serious engagement with information at a conceptual level is therefore of importance to IS in order to start treating the concept with the same rigor that is expected from any other scientific concept in IS (Lee, 2010). In addition, the concept of 'information' is not only of increasing interest in the general academic discourse (Lin, 2010) but it also sits at the crossroads between IS and its neighboring fields, thus potentially allowing IS to offer specific insights via the concept of information to other fields.

To date, engagement with 'information' in IS often revolves around a hierarchical understanding of the term. A common notion is that of the data-information-knowledge-wisdom (DIKW) hierarchy (Bellinger et al. 2004; Rowley, 2007) mentioned above. In IS, this hierarchy is often ascribed to Ackoff (1989) even though a similar depiction can be found earlier by Cleveland (1982) and even, to some extent, in TS Eliot's (1934) famous chorus from 'the rock': "Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?" In this hierarchy, data commonly lead to information which in turn leads to knowledge and then wisdom. This relationship is variously described as increasing understanding (Bellinger et al., 2004), increasing order (Rowley, 2007), or as a summation over time (Houston and Harmon, 2002). In contrast, a reverse understanding of the hierarchy is also possible (Tuomi, 1999). However, hierarchical conceptualizations of information are generally insufficient both from a practical as well as from a theoretical point of view. In practice, the hierarchy implies that more data may potentially lead to more knowledge, thus encouraging the blind collection of vast amounts of data (Fricke, 2009). Also, as the DIKW hierarchy offers no practical insight into how data may become information, it is criticized as being imprecise (Davenport, 1997; Stenmark, 2001). More importantly, from a theoretical point of view, hierarchical approaches cannot explain why the same data can lead to different information for different actors (Fricke, 2009; Kettinger and Li, 2010) and, overall, hierarchical approaches to information lack explanations that go beyond commonsensical understanding. They are therefore insufficient for theoretical engagement and research (Bates, 2010; Stamper, 1985).

Looking beyond IS-specific and hierarchical approaches to information, various groupings on the understanding of information can be differentiated (see Chapter 2; Boell and Cecez-Kecmanovic, 2011a). On the one hand, there are conceptualizations that relate information to the physical world. On the other hand, there are conceptualizations that relate information to signs in a semiotic sense. These approaches therefore relate information to signs and thus see it as something that needs to stand to somebody for something in some regard (Peirce, 1955). The relationship between information and signs is important here: information is expressed through signs but not every sign can be considered to be information.

In approaching information from a physical perspective, different understandings can be distinguished. For instance, Brillouin (1951) and Stonier (1989) related information to the physical concept of entropy; Wheeler (1990) as well as Vedral (2010) argued that information is a fundamental physical concept. However, arguably the most well-known conceptualization of information in purely physical terms is Shannon's (1948) 'mathematical theory of communication' which is more commonly known under the name of 'information theory'. Shannon was interested in the transmission of signals and he argued that the smallest amount of information that can be communicated between a sender and a receiver is the difference between two states which he labelled a binary digit or 'bit'. As Shannon was primarily interested in the reliable transmission of signals through a channel (and the distortion of this signal by noise), it is widely argued that his interest was not primarily in information as such and that therefore the label 'information theory' is misleading (Capurro and Hjorland, 2003; Fugmann, 2008; Machlup, 1983; Floridi, 2004, 2009b; Scarrott, 1989). Moreover, Shannon explicitly excluded meaning from his conceptualization (Shannon and Weaver, 1949) which therefore does not allow it to be extended to semantic or pragmatic facets of transmitted messages (Beynon-Davies, 2010; Churchman, 1968; Floridi, 2009b; Hofkirchner, 2011; Kuhlen 2004; Konorski and Szpankowski, 2008). Succinctly put, from an information theoretic perspective, it does not matter if what is transmitted makes any sense to the recipient, as long as it is an accurate replication of what was sent.

In contrast, semiotic approaches to information are specifically interested in meaning and its relation to information. Broadly speaking, three subdivisions of semiotic approaches to information can be distinguished: objectivist, subjectivist and inter-subjec-

tive (see Chapter 2 – Theorizing Information). According to *objectivist* approaches, information is observer-independent such that meaning is only generated when information comes into contact with humans (Mingers, 1995, 2010). For instance, information is the physical surrogate of knowledge (Farradane, 1979; Lenski, 2010) or propositional facts about the world (Bar-Hillel and Carnap 1953; Ostale, 2009). In contrast, *subjectivist* approaches argue that information can only exist from the perspective of a subject who regards something either as information or not. Such approaches thus see information, for example, as inward-forming (Boland, 1987; Pratt, 1977), as changed knowledge structure (Brookes, 1980; Nonaka and Takeuchi 1995) or as relevant knowledge (Fischer, 1993; Furner, 2004; Wersig, 1997). And, finally, proponents taking an *intersubjective* stance argue that information is subjective but that what is information for somebody largely depends on a wider sociocultural background (Goguen, 1997; Hjorland, 2007; Romm, 1997). Information is, therefore, context dependent (Kuhlen, 2004); has a social dimension (Ciborra, 2002; Davenport, 1997; Rayward, 2011); is related to language (Chalmer, 2004); or is dependent on culture and practice (Feldman and March, 1981; Stamper, 1992).

3.4 Wittgenstein's Theory of Language [redacted]

While all the approaches to information discussed above differ vastly in their understanding of information, what they all have in common is that they employ a particular understanding of language to approximate the concept. They all approach the concept of information by defining or explaining what information is. However, this implies a particular understanding of language according to which words have a well-defined meaning that can be extracted from them in definitions or poured into them when they are learned. This understanding of language was critiqued by the late Ludwig Wittgenstein as the 'Augustinian' model of language (Wittgenstein, 1953). According to this understanding, words stand for specific concepts that, for example, can be learned by pointing at an object and then uttering the word that stands for this object.

However, this separates the word and concept as being two different things (Blair, 2006). In contrast, Wittgenstein argued that there is no additional layer or meaning beyond a word and how it is used: "[i]t is as if in imagination we put a thing into its own shape and saw that it fitted" (Wittgenstein, 1953, §216). Instead, Wittgenstein argued

that the main vehicle of thought is language itself. He added that language allows us to think about things and there is no additional or deeper layer that precedes it which is then reflected in language:

> When I think in language, there aren't 'meanings' going through my mind in addition to the verbal expressions: the language is itself the vehicle of thought (Wittgenstein, 1953, §329).

This, of course, does not deny that one may think in terms other than language, such as spatial imagination, but when one thinks in terms of language, language itself is the main vehicle of thought. The insight that meaning and words are inseparable has important implications for how terminology can be approached and analyzed. In particular, it cautions against the use of definitions:

> Remember that we sometimes demand definitions for the sake not of their content, but of their form. Our requirement is an architectural one; the definition a kind of ornamental coping that supports nothing (Wittgenstein, 1953, §217).

> We are unable clearly to circumscribe the concepts we use; not because we don't know their real definition, but because there is no real 'definition' to them. To suppose that there *must* be would be like supposing that whenever children play with a ball they play a game according to strict rules (Wittgenstein, 1958, p. 25, emphasis in original).

Language is fluid and developing where terms have no finite or clear meaning. In contrast, definitions are an attempt to draw a sharp boundary around a term to clearly specify what is included by the term and what is excluded. Wittgenstein, however, questioned the usefulness of such attempts:

> Is it even always an advantage to replace an indistinct picture by a sharp one? Isn't the indistinct one often always what we need? (Wittgenstein, 1953, §71).

> [m]any words [...] then don't have a strict meaning. But this is not a defect. To think it is would be like saying that the light on my reading lamp is no real light at all because it has no sharp boundary (Wittgenstein, 1958, p. 27).

Instead, what is of importance is how words are used and that they can be successfully used in communication. As Karl Popper noted:

> I do say it is for most problems quite irrelevant whether a term can be defined or cannot be defined, or how it is defined. All that is necessary is that we make ourselves understood (Popper, 1994, p. 18).

Blair (2006) further elaborated on Wittgenstein's account:

> This is not, of course, an argument for sloppy definitions. It is merely the observation that looking for definitions in this case gets us away from the true foundation of our ability to analyze and classify things like "games" [or information]. By trying to find a common set of properties that we can use to determine set membership, we are guilty of trying to make an 'indistinct picture into a sharp one' (p. 113).

Moreover, one central aspect of the term 'information' comes exactly from its fuzziness: "*information* is able to perform the work it does precisely because it fuzzes the boundaries between several genetically distinct categories of experience" (Nunberg, 1996, p. 114; emphasis in original). For instance, the term 'information' implies a "collapse of ontology and epistemology" as ontological information signifies that 'modes of being' are translated into 'abstractions of knowing' and thus epistemology (Lash, 2006, p. 581). However, at the same time, information also signifies that epistemological 'modes of knowing' increase ontological 'modes of being' (Lash, 2006). Subsequently, Frohman (2004) argued that: "[i]deas of information that enjoy the theoretical rigor of definitions and essences are not useful in understanding the phenomenon of information" (p. 388).

However, Wittgenstein indicated a way out of this dilemma. Instead of providing definitions, he suggested drawing from examples and descriptions to get closer to understanding a word: "[w]e must do away with all *explanation*, and description alone must take its place" (Wittgenstein, 1953, §109; emphasis in original). Consequently, an alternative approach to understanding 'information' is to provide descriptions of the ways in which the term is used. This allows one to look at the term without drawing a strict or rigid border around it which would inevitably restrict understanding to only specific facets of information. This, of course, does not mean that in specific situations a more restrictive definition of information could not be viable. For instance, Shannon's (1948) explicit reduction of information to the distinction of signals and thus the exclusion of meaning provided a powerful means for engineers concerned with the transmission of signals. However, as different approaches to defining information are built on mutually-exclusive assumptions about the nature of information, they cannot be reconciled and therefore prevent us from understanding information using different views simultaneously. For example, defining information in terms of Shannon's 'information theory' or in terms of subjectivist approaches as inward-forming implies a mutually-exclusive under-

standing of information that draws different distinct boundaries around the term and thus cannot be reconciled. Using a Wittgensteinian approach to look at information does not suffer from this shortcoming.

The rest of this essay, therefore, develops a Wittgensteinian approach to information. Instead of looking at definitions, the term is approached by looking at the ways in which it is used and described throughout the literature. Consequently, the emphasis is on references made to the facets that are related to 'information' without assuming that any facet provides in itself a definition of what information is. Importantly, the Wittgenseinian approach proposed here enables a clearer understanding of what makes something information, and allows simultaneous consideration of material and sociocultural facets of information.

3.5 A Semiotic Structure for Understanding Information

Before looking in detail at facets associated with information, Stamper's semiotic framework (1987, 1991, 1992) for understanding information is first introduced. Stamper contributed to the understanding of information in IS by providing a framework that allowed IS a more refined description of information and its use. Therefore, Stamper's approach to understanding information can be seen as aligned with a Wittgensteinian approach to language as his framework provides a rich description of information rather than a definition. By building on Stamper's framework, it is thus possible to develop a more refined description of information.

Generally, semiotics is the discipline of signs with the latter succinctly described by Peirce (1955) as: "[a] sign [...] is something which stands to somebody for something in some respect or capacity" (p. 99). According to a semiotic understanding of information, information is always expressed in the form of signs. Therefore, a general understanding of semiotics also has important consequences for the understanding of information. In the context of IS information, this can also be described as something that stands to somebody for something in some respect or capacity. One could therefore say that IS deal with signs (Beynon-Davies, 2009; Stamper, 1987, 1991, 1992) but that not all signs qualify as information. That is not everything that stands for somebody in some regard is also automatically information to them. In this sense, the semiotic dimensions described below apply to all signs. In contrast, facets of information described in the next

section are to be seen in addition to the semiotic dimensions of signs. For instance, novelty (further discussed below) is not a condition for signs to exist but the novelty of a sign is a condition for a sign to become information.

Of particular interest regarding semiotics, information and IS is the work by Ronald Stamper (1973, 1985, 1987, 1991, 1992). Stamper was probably the first IS researcher to work on information by drawing from semiotics (Stamper, 1973). Stamper's work on information provided the foundation for other IS academics (Beynon-Davies, 2009, 2010, 2011; Liebenau and Backhouse, 1990; Price and Shanks, 2005). Moreover, in his response to a call by Lee (2010), Baskerville (2010) suggested that Stamper's work should be revisited by IS to engage more seriously with the concept of 'information'.

Stamper's main contribution was to expand the semiotic triad established by Morris (1946) by adding a fourth dimension, thus providing a clear link between semiotics and Shannon's (1948) information theory. Morris' semiotics distinguished three different aspects of signs: The *syntax* of signs is related to rules governing the composition of signs, for instance, spelling and punctuation. *Semantics* is interested in the creation of meaningful expressions using signs (for instance, word order and how it affects the content of a sentence such as 'dog bites man' vs 'man bites dog'). And finally, *pragmatics* is interested in the purpose that signs fulfill in communication, such as giving orders or making a statement that something is the case. Furthermore, while different authors assumed that Shannon's information theory was dealing with information at the syntactic level (e.g. Bar-Hillel, 1955; Bar-Hillel and Carnap, 1953), Stamper realized that syntax presupposes that symbols can be differentiated, for instance, different letters of the alphabet or numbers. For this reason, Stamper (1987, 1991, 1992) added empirics as a fourth dimension to the three dimensions established by Morris (1946). According to Stamper, *empirics* is interested in distinguishing different signs with a high level of reliability, for instance, 'O' from '0' or '0' from '1'.

Stamper thus differentiated four dimensions of semantics: pragmatics, semantics, syntax and empirics. He argued that these four dimensions provide a link between the physical world and the social world and that this relationship can be expressed through what he called semiological steps (Stamper, 1991) or the semiological ladder (Stamper, 1992) as displayed in figure 3.1. According to Stamper, the physical world is the place where all

empirical phenomena take place. It involves material entities and flows which are seen or recorded as signals captured at the empiric level. In turn, patterns at the empiric level may be transformed into formal structures at the syntactic level. And further on, at the semantic level, formal structures have acquired meanings which are, for instance, associated with intentions at the pragmatic level. At the top step sits the social world of beliefs and culture which is created and shaped through language games taking place at the pragmatic level.

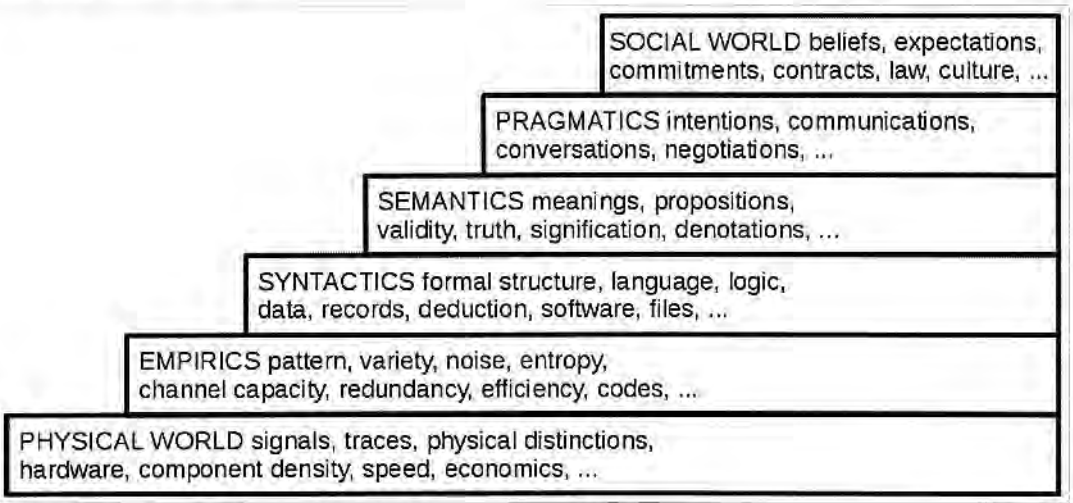

Figure 3.1 Stamper's (1991, 1992) Semiological Steps

Stamper, therefore, made an important contribution to understanding, on the one hand, the relationship of information to material aspects and to Shannon's (1948) so-called 'information theory' and, on the other hand, to social and pragmatic aspects. This posits the possibility of understanding why descriptions of information differ so vastly, why some describe information as objective entity and why others highlight the subjective and social nature of information. It seems that different explanations work at different levels of Stamper's semiotic steps. For instance, Shannon's (1948) work engages with information at the empiric level, while others such as Boland (1987) work at the semantic and pragmatic level, and yet others (e.g. Goguen 1997) at the inter-subjective level.

Furthermore, the relationship between information and semiotics is not limited to Stamper's work. Others have drawn from Stamper or developed alternative approaches. For instance, Beynon-Davies (2009, 2010) used Stamper's extension of Morris' (1946) semiotics to link the social with the technical (Beynon-Davies, 2009) and the social with the

physical (Beynon-Davies, 2010). In contrast, Steinmüller (1993) argued that Stamper's empirics should be considered as part of syntax and that a fourth dimension is instead what he called 'sigmatic', the relation of a sign to reality. Sigmatics is accordingly the extent to which a sign corresponds with the actual reality it is intended to represent. However, this leaves the question of how one can establish a link to reality independently of the signs used to communicate about reality as such a link would be necessary to evaluate the sigmatics of a sign.

Moreover, what all of these approaches share with Stamper's approach is that they imply an ontological separation between, on the one hand, the social and, on the other hand, the material. More specifically, Stamper's discussion of his semiological steps implies that signs have at some point a material or empiric dimension and that this dimension somehow comes before the other dimensions. Or, more generally, that lower semiological steps lie 'below' the other 'higher' semiological steps of a sign (figure 3.1). In this sense, each step builds on the step that lies below it. However, this view of signs overlooks the integrative nature of all of the different dimensions of a sign. A sign is not at some point physical, at another syntactic, semantic or pragmatic. For a sign to be a sign, it always needs to simultaneously relate to all four aspects related to a sign. This is also the main problem with Beynon-Davies' (2009, 2010, 2011) adaptation of Stamper's work as he used the different levels to differentiate between ICT systems, IS and activity systems. Of course, this implies that a sign could exist independently of its physical representation, for instance, at the semantic level or that physical tokens that have no meaning or purpose could still be regarded as signs even though they do not stand to somebody for something in some regard. Such an understanding of information is avoided by the 'facets of information' theory presented here. This is clearly at odds with Peirce's (1955) description of a sign (see above) which is considered fundamental to the approaches by Stamper and his followers. It is therefore important to note that the differentiation of the semiotic dimensions by Morris (1946) into syntax, semantics and pragmatics is only an analytical one and that, similarly, Stamper's addition of empirics has to be understood in the same way.

As discussed above, Wittgenstein's approach to language denies the separation between terms and their meaning. This understanding is similar to the criticism expressed here regarding an interpretation of different semiotic layers as existing independently of each

other. Both Stamper and Wittgenstein can thus be related to an ontological understanding that questions the inseparability, in one case, of words and meaning and, in the other case, of different aspects of signs. For instance, signs cannot be separated from their use by neglecting or removing their pragmatic aspects; similarly, the meaning of words is not something that can be understood independently of their use. This indicates that there is compatibility between Wittgenstein's philosophical position and assumptions underlining Stamper's framework. They both inform the further exploration of the concept of information proposed in the rest of this essay.

3.5.1 Reinterpretation of Stamper's Semiological Steps

Everyday information systems always relate to all four semiotic dimensions at the same time and thus do not allow us to see information at any particular level in isolation. Take the case of an arrivals board at an airport or train station. The purpose of the board is pragmatic as people consulting it presumably want to find out about particular arrivals. However, at the same time, it also has syntactic aspects as, for instance, its conventions that have to be known such as that things displayed in a row are related; and also semantic aspects as the meaning has to be understood, for instance, of the two blinking lights on an airport arrivals board or the time displayed in 12-hour or 24-hour format; and, finally, empiric aspects also have to be considered, for instance, that the board can be read clearly from different angles or that sun glare does not hit it at any point during the day, making it difficult to read the arrivals. As this example underlines, signs and thus the information that users derive from them will always simultaneously relate to all semiotic dimensions.

Information is thus related to empiric, syntactic, semantic and pragmatic aspects (figure 3.2). Information cannot be understood as, for instance, being at one point empiric and at another point pragmatic. The integrative relevance of these aspects at the same time is a quintessential aspect of information. If only a single aspect, say empirics, is emphasized instead, one is dealing with signals and their transmission but not with information. Importantly, this understanding of information posits an explanation for how information is related, on the one hand, to sociocultural facets through its pragmatic dimension and, on the other hand, to material and technical facets through its empiric dimension. Using the amended interpretation of Stamper's work as visualized in figure 3.2

thus provides an important means for understanding that information as a construct is socio-technical in the sense that it is intrinsically related to social and technical aspects at the same time.

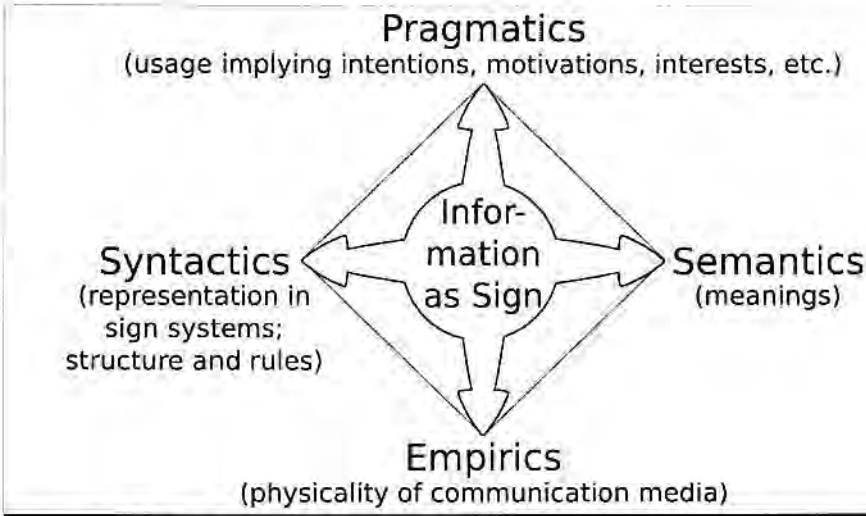

Figure 3.2 Semiotic Dimensions, Information and Its Relationship to Material and Sociocultural Aspects

3.5.2 Implications for the Exchange of Information

Generally, information involves more than one partner: "[i]nformation is not self-referential; you cannot inform yourself" (Lenski, 2010, p. 82)[5]. Information, therefore, requires an information provider, an information recipient and a message that is exchanged between those two (Cornelius, 2002; Meadow and Yuan, 1997). Also, the roles of provider and recipient are not fixed and will change frequently during a conversation. For instance, for an information provider to help an information seeker with her request, the provider needs to gain some information from the seeker about her information need.

One important conclusion that follows from this is that information is perspectival, that is, it depends on the perspective of the recipient. The assessment of something as information always depends on the background from which the recipient of a message judges a message to be, for instance, valid or relevant in a particular situation and thus fulfilling certain facets that are associated with information. From this, it follows that information cannot exist independently of the background from which it becomes information. Firstly, this includes a cultural understanding that provides background knowledge

5 There may be exceptions, for instance, if one leaves notes in one's diary to inform oneself in the future about an appointment.

and norms that act as a context within which certain claims are treated as valid while others are rejected at the outset. For instance, different (professional) languages allow those using them to express distinctions at varying levels of precision. Some domain-specific terminology may have many words for something thus allowing experts to draw fine distinctions. Secondly, this also includes technological understanding and conventions that allow certain technologies to be used for conveying information but only among those who can use these technologies. For instance, being able to convey information using email requires certain technologies and the capabilities to handle these technologies on both the side of the sender and the side of the recipient. And finally, this includes personal judgments as is highlighted, for instance, by the facet 'degree of trust' (discussed below). If, for instance, the recipient does not trust the sender of a message to be truthful or competent in providing an accurate assessment, the message conveyed by that sender will not be regarded as information by the recipient.

From this, it follows that what will be considered 'information' will differ between different actors. Different groups of actors operate within varying contexts and areas of expertise thus bringing diverse backgrounds to their understanding of problems and challenges. Consequently, what is considered to be information will vary between those actors. Every organization of minimal complexity will involve different actors who have, for instance, different background or training such as a workman manufacturing a product, accountants estimating the production costs of that product or a salesman marketing that product to a customer. While all work with the same product within the same organization, all of them will regard different aspects related to the product as information to them. For those manufacturing the product, replacement of a product component may involve a different supplier with shorter delivery times but a lower production capacity; for an accountant, it may have exactly the same price as before and, when marketing the component to a customer, it may require changes to documentation about maintenance. Another example is provided by the case from Faÿ et al. (2010) where the same data were understood differently by shop floor managers and central management. While shop floor managers were interested in minimizing sales forecasts, central management was interested in maximizing sales forecasts. Consequently, events that could have an influence on sales forecasts were understood as different information by each group.

Importantly, from the perspectival nature of information, it follows that information can only exist from the position of a recipient who accepts something as information. From this, it follows that what is conveyed by a provider of information cannot be regarded as information in itself but only as a proposition for information. Thus, what is stored into ICT can only be regarded as *intended information*. When ICT is used, parts of intended information that are stored within ICT are reproduced and conveyed to a recipient. This output can then be regarded as *potential information* that is proposed as information to a recipient. And finally, if potential information is accepted by a recipient and regarded as relevant, it becomes *information-in-use*. This relationship, as displayed in figure 3.3, allows the development of a deeper understanding of how ICT and users engage in exchanging information.

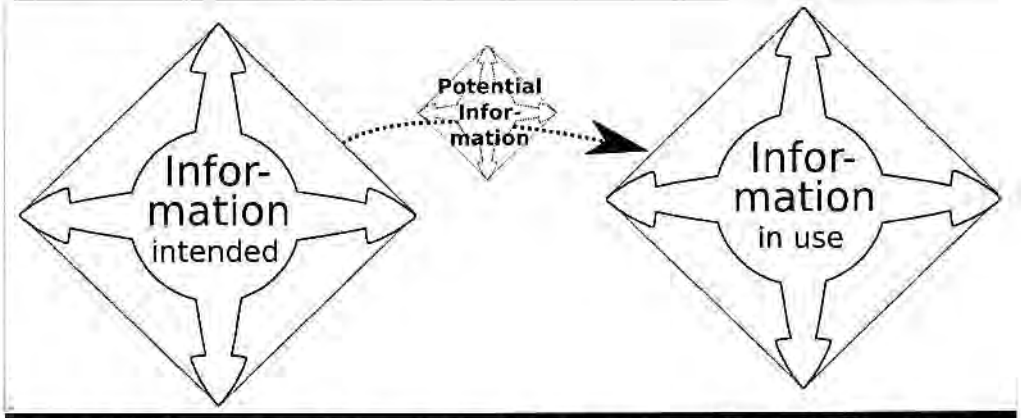

Figure 3.3 Differentiation between Intended Information, Potential Information and Information-in-Use

Information is related to different facets: the way these facets are understood depends on the perspectives of a provider and receiver of information. Looking at the facets of information introduced in detail below allows one to better grasp this perspectival nature of information and thus to better understand information exchange. For instance, a semiotic approach to information enables one to approach information exchange in a way that can help to better ensure the transition of intended information when a system is designed into information-in-use when a system is used in everyday activity. By going through each of the facets related to information, one can attempt to maximize the match between the information use that is envisaged and the way intended information is stored and reproduced. Moreover, while all facets are of relevance to information, different facets will come to the fore in different analyses while other aspects will revert to

the background. For instance, looking at information-in-use, pragmatic aspects may become prevalent while empiric aspects may be taken for granted. That is why the primary interest is in how information becomes relevant and useful rather than in how it is related to a communication medium.

3.6 Facets of Information

Looking at how information is described allows us to gain a better understanding of what information is. This is achieved by surveying facets that are evoked when information is described throughout the literature. Importantly, this approach which follows Wittgenstein, as presented earlier, is in contrast to attempts that seek to define information. While different facets are related to information, they do not define what information is. For instance, various authors have argued that information has a novelty character and that therefore something that is already known or understood cannot be information (Capurro and Hjorland, 2003; Kallinikos, 2006; Kuhlen, 1991, 2004; Machlup, 1983; Meadow and Yuan, 1997; Nauta, 1972). While this makes a statement about information conveying something that is new, it does not mean that everything that is novel will automatically be information. For instance, something can be new to somebody but at the same time may be considered to be as out of place or context. In this sense novelty is a necessary but not a sufficient condition for information to occur.

This approach therefore does not suffer from the limitation of the definitions discussed above, namely, that several mutually-exclusive definitions of information can exist. Also, describing different facets does not limit information to a particular facet. Nor are facets related to information additive, that is, in the sense that if multiple facets of information are fulfilled then something must therefore be information as this would introduce a definition of information through the back door.

And finally, it is important to stress that the emphasis here is on facets evoked throughout the literature to describe information. These facets of information were derived from the literature by expanding upon the four semiological dimensions derived from Stamper's work (1991, 1992) as discussed above. By closely following what different authors have stated about information regarding its empirics, syntactics, semantics and pragmatics, these dimensions could be further broken down into different facets that are associated with them (See appendix A for a detailed description of the methodology). In total,

14 different facets related to information were identified throughout the literature. An overview of these facets is provided in figure 3.4 and each facet is now discussed in more detail. Importantly, while the list of these 14 facets is based on an extensive survey of the literature on information (see Chapter 2 – Theorizing Information), I make no claim that this is an exhaustive coverage of all possible facets of information. Thus, future research may identify and add additional facets to those introduced here.

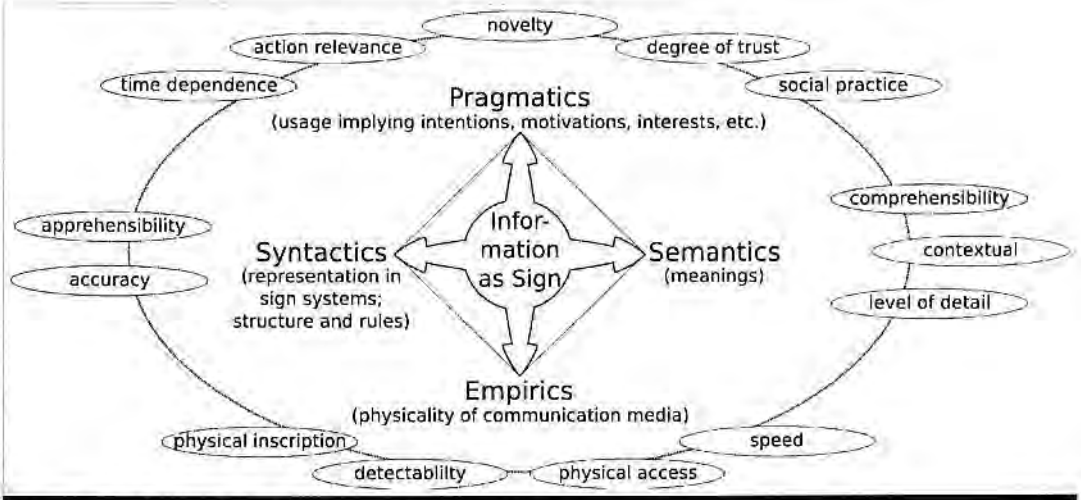

Figure 3.4 Overview of Facets of Information

3.6.1 Information at the Empiric Level

Facets of information at the empiric level are related to the physical or material nature of a medium which carries information as signs. At the empiric level, signs are bound to a physical medium thus enabling intended information to be stored, communicated and accessed by users. Four facets of information are related to empirics: physical access, detectability, physical inscription and speed. These four facets are summarized in table 3.1.

Table 3.1 Summary of Empiric Facets of Information

Facet	Description	About Information	Authors
access	Information needs to be physically accessible.	Physical access is necessary for intended information to be created or to become potential information.	Chopra and Dexter, 2008; Davenport, 1997; Mason, 1979; Rice et al., 2001
detect-ability	Information needs to be differentiable against background noise.	"The ability to discriminate between relevant information and "noise" in a given domain of action, by invoking both precepts and practice, is a part of what we recognize as expertise" (Suchman, 1987, p. 103).	Shannon, 1948; Shannon and Weaver, 1949; Suchman, 1987
physical inscription	Information is conveyed via sign-vehicles that are physically inscribed into a medium.	Information inscriptions need to be durable and transportable, both aspects require different properties from storage media (Taylor, 1986, p. 23).	Taylor, 1986
speed	Information is conveyed from a sender to a recipient within a specific time frame.	Historically, there is a clear trend towards faster transmission of information. If increase in speed enables new usages, it is called augmentation rather than acceleration (Taylor, 1986).	Beynon-Davies, 2009; Taylor, 1986

3.6.1.1 Access

In order for something to become information, physical access to that information is required (Chopra and Dexter, 2008; Davenport, 1997; Mason, 1979; Rice et al., 2001). Something that cannot be accessed cannot become information. Moreover, ease of physical access can even determine information use (Chopra and Dexter, 2008). Of course, there are several other aspects of access beyond physical access but the importance of being able to physically access information is evident. For instance, intended information stored in a database needs to be displayed in some form so that it can become potential information and subsequently information-in-use. Rice et al. (2001) provided an even finer-grained evaluation of physical access to information. They distinguished display, space, environment and ergonomics, as well as geography and demographics. Display includes, for instance, how something is presented on a screen or how a display can accommodate people who are vision impaired or blind. Space includes proximity or how access to a space may be secured, for instance, requiring a specific set of keys in order to access particular files or an archive. Environmental and ergonomic factors such as noise or light can hinder physical access, and geography or demography may limit

access to particular types of information that are available in a particular region. Physical access to information may thus be an important concern, for instance, in the context of using ICT for development (ICT4D) as any information intended to facilitate development can only have a desired effect if this information can be physically accessed by those for whom it is intended. And, of course, enabling access for people who are blind, visually impaired or deaf clearly requires the consideration of physical access as an important facet of information in the context of IS. Yet another example of the importance of considering physical access is a geographic IS that is to be used by a driver who is not able to lift her hands from a steering wheel while a vessel is in motion.

3.6.1.2 Detectability

Information needs to be detectable against a background or in the presence of noise. Detectability is therefore an important facet of information that refers to the ability to differentiate a sign from background or noise. Something that cannot be differentiated and therefore detected cannot become information. For instance, if someone is color blind, patterns of red and green cannot convey any information to that person as differences between these colors are not detectable. From the perspective of detectability, the simplest message that can be conveyed from a sender to a recipient is the difference between two states such as 'yes' or 'no', '0' or '1'. Shannon (1948) developed a calculus that takes into account the degree of noise a signal is subject to during its transfer over a channel from sender to recipient. He established a measure that allows engineers to determine the degree of certainty with which a signal that was sent at one end is detected correctly at the other end by a receiver (Martignon, 2001). Thus, he provided a means to maximize the efficiency of signal transmission. An easy-to-follow introduction to the mathematics of Shannon's work is provided by Floridi (2009b). Of course, the reliable transmission of signals is an important aspect for IS; however, it is one that in many cases can be taken for granted as being sufficiently covered by engineers developing IT. Nevertheless, as the example of the arrivals board above indicated, there may be circumstances where detectability of information may be an important concern for IS. This may require the investigation of situational aspects related to information, such as whether there are varying physical environments with extreme conditions such as loud noises or difficult light conditions that can hinder the detectability of information.

3.6.1.3 Physical Inscription

Physical inscription highlights that information as signs is always inscribed into a physical carrier medium (sign-vehicle). The characteristics of this medium are thus important physical inscriptions have different properties that affect how information as signs can be ingrained into them. Two important aspects in this regard are the difference between the durability and transportability of the medium carrying the information (Taylor, 1986). Importantly, both aspects require different properties from a medium. Durability refers to the ability of a medium carrying signs as potential information to withstand physical stress and destruction: it is of primary concern to ensure the continuing existence of important information over time. The means to ensure durability can be measures against the aging of documents or loss through incidents such as fire. In the case of digital information, having multiple copies at different places or copies on multiple hard disks can help to ensure durability. Durability is of particular importance in the context of archival content where durability is regulated by legal requirement. Here the longevity of storage media such as the lifetime of compact discs or other media may be important to IS. In contrast, transportability of information is often in direct competition to durability. As Taylor (1986) argued, transfer over space requires a carrier of intended information to be light and easy. However, if the transfer over time is of concern, then a carrier medium needs to be durable and possibly heavy. For instance, information on the Web is highly transportable; however, it is also prone to being compromised during this process. For these reasons, the Transmission Control Protocol (TCP) is used to ensure the integrity of the information transported. Physical inscription and the aspects of durability and transportability of information can thus be an important facet of information for IS.

3.6.1.4 Speed

Speed refers to the time that is required to convey intended information from an information provider to a recipient. Regarding speed, historically, there is a general tendency towards faster transmission of intended information from a sender to a recipient (Wright, 2007). Subsequently, the list of innovations to allow one to physically transport information faster is long and closely interwoven with military, economic and cultural developments as the speed by which information can be transported has obvious impor-

tance for military and business purposes (Wright, 2007; Chandler and Cortada, 2000). Taylor (1986) even argued that faster generation of information does not only accelerate but even augments possibilities. For instance, it may be possible to perform calculations that are done using computers without this technology but this would involve a time frame of weeks rather than seconds. In such cases, the speed by which information is generated has augmented new possibilities. Similarly, a modern-day global economy is unthinkable without electronic signal transmission via cable and satellite. However, Beynon-Davies (2009) argued that speed is not primarily a facet of information but of the channel instead. Nevertheless, the speed by which something is processed or transmitted has important consequences regarding whether something is or is not information. For instance, in the case of online trading where shares are sold or bought based on market data, even small fractions of time can make a difference regarding whether something may or may not be information.

3.6.2 Information at the Syntactic Level

At the syntactic level, facets of information are related to sign systems and the adherence to structures and rules associated with these sign systems. For something to be considered information, it has to adhere to the rules associated with the sign systems used to express this information. Two specific facets are associated with information at this level: apprehensibility and accuracy. Both are summarized in table 3.2.

Table 3.2 Summary of Syntactic Facets of Information

Facet	Description	About Information	Authors
apprehensibility	Information is expressed in accordance with the rules and character set of sign systems.	Recipient and provider of information have to understand the rules of a sign system in order to use it to convey information.	Introna, 1997
precision and accuracy	Information is expressed in accordance with the precision and accuracy provided by a sign system.	Sign systems differ in the accuracy and precision they enable and thus provide boundaries for how information can be expressed.	Davenport, 1997; Mason, 1979; McLeod and Schell, 2007

3.6.2.1 Apprehensibility

Information as signs needs to be expressed according to the rules and character sets of a sign system: these rules have to be understood by a recipient in order for the sign system to be able to convey potential information to a recipient. Similarly, an information

provider needs to be accustomed to the rules of a sign system to be able to use this sign system to convey intended information. For instance, an information provider needs to be familiar with Chinese characters so that '八三六九' can convey information in the same way as '8369' can to someone familiar with Arabic numerals. Apprehensibility therefore refers to the ability of the users of a sign system to understand these rules. To put it succinctly, information needs to be understood (Introna, 1997). Importantly, apprehensibility is different from comprehensibility. One may be able to apprehend the signs conveyed without being able to comprehend what these signs are meant to mean (e.g. due to lack of context). A common example of apprehensibility in the context of IS is the use of different character encoding. If character sets do not match, different scripts may not be displayed correctly or may not be available for input. For instance, potential information that is captured about a customer's name containing an 'Ä' may instead be displayed with something nonsensical such as '□'. Thus, if apprehensibility cannot be ensured, intended information may not be captured or potential information may not be conveyed.

3.6.2.2 Precision and Accuracy

Intended information needs to be expressed according to the precision and accuracy allowed by a sign system. The precision and accuracy with which intended information can be expressed and communicated depend on a sign system in the sense that a sign system determines the potential for precision and accuracy. Different authors have highlighted the importance of precision and accuracy in the context of information (Davenport, 1997; Mason, 1979; McLeod and Schell, 2007). Different sign systems allow different aspects to be captured at varying levels of detail, thus the potential to convey information depends on the accuracy that can be represented using a sign system. Precision and accuracy therefore refer to the ability of a sign system to be specific about certain details. In the context of IS, sign systems are the systems used to capture and express intended meanings via ICT. For instance, different programming or modelling languages can be regarded as different sign systems that are used for expression. Specific aspects that are of interest may be straightforward through being syntactically expressed in a particular sign system, while they can only be expressed in roundabout ways or possibly not at all by using other sign systems. Moreover, following development, data-

bases resulting from this development can also be seen as sign systems that syntactically provide specific precision and accuracy. Depending on the precision and accuracy provided, the clear expression of some aspects will be enabled while the database may be syntactically restricted in conveying others. If a database does not provide an appropriate field for some aspects in the first place, these data cannot be captured by that sign system at all (Weick, 1985). Thus, limited precision and accuracy provided by a sign system at the syntactic dimension may hinder the ability to convey the intended information or to derive potential information from an ICT artifact.

3.6.3 Information at the Semantic Level

At the semantic level, the relationship between signs and meaning is important. Artandi (1973) summarized the relevance of the semantic level regarding information as: "[a]t the semantic level the information conveyed depends on one's ability to perceive the relationship between the signs and the things or events they denote" (p. 245). Three facets can be differentiated: the comprehensibility, the contextuality and the level of detail of signs. These facets are summarized in table 3.3.

Table 3.3 Summary of Semantic Facets of Information

Facet	Description	About Information	Authors
comprehensibility	Information needs to be intellectually understandable.	Comprehensibility includes aspects of skills and literacy. Different recipients and contexts allow different degrees of complexity. Information may be easier or more difficult to understand.	Davenport, 1997; Introna, 1997; Kuhlen, 1991, 2004; Mason, 1979; Meadow and Yuan, 1997; Moore, 1996; Rice et al., 2001
contextuality	Information needs to be regarded as dependent on a wider social, historical and cultural context.	Information is related to a wider sociocultural context which determines rules for what can be expressed as information for whom and how.	Davenport, 1997; Dervin, 1981; Floridi, 2005; Goguen, 1997; Kuhlen, 1991, 2004; Meadow and Yuan, 1997; Rice et al., 2001
level of detail	Information needs to be expressed at a specific level of detail or completeness.	If something carries too little or too much detail, it can hinder information. "Specificity or depth. This refers to depth of coverage or degree of detail of the information in a message" (Meadow and Yuan, 1997, p. 708).	Blair, 2006; Brown and Duguid, 2000; McLeod and Schell, 2007; Meadow and Yuan, 1997

3.6.3.1 Comprehensibility

Information needs to be intellectually understandable. Comprehensibility is thus related to the ability to intellectually express and understand specific meanings of signs used for conveying information. This has been variously emphasized by views that information needs to be comprehensible (Meadow and Yuan, 1997); that it needs to be integrate able into a knowledge base (Kuhlen, 2004); or that it requires intellectual or cognitive access (Davenport, 1997; Rice et al., 2001). Something that cannot be expressed by a sender using signs or that cannot be understood by a recipient cannot convey information. Moreover, comprehensibility will vary depending on background knowledge and cognitive abilities of a recipient. This not only highlights that information is addressee dependent and that the same sequence of signs may convey different information to different recipients (Introna, 1997; Kuhlen, 1991, 2004; Moore, 1996), but it also highlights the importance of skills and capability in handling information (Rice et al., 2001). For instance, different levels of literacy or unequal skills for searching the Web or databases will affect what constitutes potential information and information-in-use for different individuals. Another example is the different comprehension of reports provided by ICT not only regarding their content but also regarding the process of their generation.

3.6.3.2 Contextuality

Information needs to be regarded as dependent on a wider social, historical and cultural context. Contextuality as a facet of information thus underlines that for something to be considered as information or not will depend on the wider context within which it is created and interpreted (Floridi, 2005; Kuhlen, 2004). In this sense, information

> cannot be understood at the level of the individual, that is, at the cognitive level of individual psychology, because it arises through ongoing interactions among members of a group (Gougen, 1997, p. 34).

Information is thus described as being related to a social background (Davenport, 1997) or a societal dimension (Kuhlen, 1991; Meadow and Yuan, 1997). Contextuality refers to the wider social context at a societal or inter-group level and a shared historic and cultural background which enables meaning to emerge. It thus includes deeply ingrained assumptions and beliefs about the world. Often these assumptions, beliefs and ways of

looking at the world are taken for granted among the members of a society or group. They can be seen as being related to the process of socialization which creates the possibility of shared comprehension among the members of a group, such as, shared language, mutual beliefs about the world, considerations about ethical behavior or a shared technological understanding. This aspect of contextuality is described by Wittgenstein (1953) as 'forms of life' or by Bourdieu (1976) as 'habitus'. It encompasses social, historical and cultural aspects that are deeply embedded in our self-understanding. For instance, social groups or cultures may differ regarding the extent to which they are open to new, challenging, controversial and potentially destabilizing information and thus to what they regard as information. Take the case of different organizational cultures in terms of what may be considered acceptable practices for innovating ideas and products. Contextuality of information thus indicates that information is related to socialization, class membership, social networks, education or experience (Rice et al., 2001). For instance, this facet of information is important for understanding how enterprise resource planning (ERP) implementation can be related to a historical and cultural dimension which affects how organizations in different cultural contexts are structured and how information is shared formally and informally among members of an organization (Zhang, 2011).

3.6.3.3 Level of Detail

Information needs to be expressed and received at a specific level of detail in order to be meaningful. Level of detail thus refers to the degree of detail that is expressed or can be expressed using particular signs. That is, information can be expressed with different degrees of specificity (Meadow and Yuan, 1997) or completeness (McLeod and Schell, 2007). While a higher level of detail allows more fine-grained distinctions, it also is more specific and thus less general. It is therefore important to note that more detail does not necessarily mean better information. Take the case of language: "if we were to talk always at a very detailed level of complexity it might be difficult for us to communicate at all" (Blair, 2006, p. 93); or "[e]fficient communication relies not on how much can be said, but on how much can be left unsaid – and even unread – in the background" (Brown and Duguid, 2000, p. 205). However, highly specialized areas will require, for instance, specific instruments or vocabulary that will allow experts to draw much finer

differences than is possible from everyday language or devices. The required level of detail will therefore depend on further aspects such as the circumstances in which information is exchanged, the recipients of information or the aim that is intended to be achieved with the information. Take the case of an emergency situation where additional detail in a signal to evacuate the building could potentially have detrimental consequences if it leads to a delay in the evacuation process. In the context of IS, appropriate level of detail is evident in examples such as responses to queries where users can, on the one hand, be so overwhelmed by the voluminous output of potential information that it may make them feel anxious about missing important details and thus restrict their ability to extract meaning from ICT. On the other hand, too little output can also restrict their ability to extract meaning from ICT. This demonstrates that the level of detail is an important facet of information in the context of IS.

3.6.4 Information at the Pragmatic Level

Facets of information associated with the pragmatic level describe the sociocultural dimension of information. Understanding information at this level highlights the importance of the sociocultural context, social actors and their goals and practices. At the pragmatic level, information is related to intentions, motivations, interests, goals, etc., with Artandi (1973) especially emphasizing the goal relevance of information: "[a]t the pragmatic level information is intrinsically related to the concept of a goal" (p. 245). For instance, what matters for potential information to be used, that is, become information-in-use, is its relevance for a situation (problem solving and action), novelty for a user, timeliness in terms of the dynamics of the situation, trustworthiness and embedment in a particular social practice. Thus, pragmatic facets of information are: action relevance, novelty, time dependence, degree of trust and social practices. These five aspects are summarized in table 3.4.

Table 3.4 Summary of Pragmatic Facets of Information

Facet	Description	About Information	Authors
action relevance	Information needs to be regarded as relevant and useful.	Information is related to goals, actions and decisions: "information is knowledge for the purpose of taking effective action" (Mason and Mitroff, 1973, p. 475).	Bateson, 1972; Capurro and Hjorland, 2003; Checkland and Holwell, 1998; Davenport, 1997; Fischer, 1993; Galliers, 1987; Kuhlen, 1991, 2004; Lewis, 1991; Machlup, 1983; Mason and Mitroff, 1973; Meadow and Yuan, 1997; McLeod and Schell, 2007; Scarrott, 1989; Steinmüller, 1993; Taylor, 1986, 1991
novelty	Information needs to be new or unexpected.	"Conveying something that is already known is to communicate no information." (Kallinikos, 2006, p. 101)	Capurro and Hjorland, 2003; Davenport, 1997; Kallinikos, 2006; Kuhlen, 1991, 2004; Machlup, 1983; Meadow and Yuan, 1997; Nauta, 1972
time dependence	Information needs to be regarded as existent in regards to a specific point in time.	What is regarded as information will change over time and depending on prior events: "Information believed to be correct at the time may well be regarded as misinformation at some later time–or vice versa." (Buckland 1991, p. 111)	Buckland, 1991; Davenport, 1997; Goguen, 1997; Kuhlen, 1991; McLeod and Schell, 2007; Meadow and Yuan, 1997; Steinmüller, 1993
degree of trust	Information needs to be accepted and believed.	"[N]o matter how accurate measurements and data are, if the manager who receives the information doesn't trust the source, then the data is of questionable accuracy" (Davenport, 1997, p. 117).	Davenport, 1997; Introna, 1997; Kuhlen, 1991, 2004; Meadow and Yuan, 1997; Rice et al., 2001
social practices	Information needs to be in accordance with social practices shared by a group.	"Information can only be fully understood in relation to the particular, concrete situation in which it actually occurs." (Gougen, 1997, p. 34)	Goguen, 1997; Kuhlen, 1991; Meadow and Yuan, 1997; Steinmüller, 1993

3.6.4.1 Action Relevance

Information needs to be regarded as relevant and useful to a specific action or problem. This facet of information thus enables an important means for differentiating information. Numerous authors have highlighted the facet of action relevance of information describing information variously as: providing guidance (Davenport, 1997); as being useful (Lewis, 1991; Machlup, 1983); as having to fix problems (Mason and Mitroff, 1973; Taylor, 1986); as being related to action (Checkland and Holwell, 1998; Scarrott,

1989); as having a purpose (Steinmüller, 1993); as being relevant to goals and plans (Kuhlen, 1991); as having an effect on actions and decisions (Kuhlen, 2004; Meadow and Yuan, 1997); as making a difference (Bateson, 1972); or as being relevant to a problem (Capurro and Hjorland, 2003; Fischer, 1993; Galliers, 1987; McLeod and Schell, 2007; Taylor, 1991). Information is pragmatic as it supports solving problems, enabling actions to be taken or decisions to be made. Consequently, even a correct answer to a question may not qualify as information if it does not help to address the problem that underlies the question. Moreover, action relevance of information is also associated with the concept of value in the sense that "[t]he value of information is related to decisions. If there were no choices or decisions, information would be unnecessary" (Davis, 1974, p. 140). Information is therefore also described as having instructional value or use value (Meadow and Yuan, 1997): it is important to differentiate this from monetary value, exchange value or the storage costs of data (Taylor, 1986). Importantly, the use value or instructional value of information can only be fully established in retrospect and thus has only limited use for describing information. Also, to a greater or lesser extent, anything can be described as being of value to somebody. This is a general shortcoming of any approach that describes information as a commodity or resource (Feeney and Grieves, 1994; Saracevic, 1999; Toffler, 1983; MacGregor, 2005; Kuhlen, 1991, 2004). In the context of IS, the importance of the facet of the action relevance of information is evident in the design of ICT components (databases, infrastructure, application programs) of an IS capable of producing certain types, forms and range of intended information: intended information is designed by analyzing how it might become information-in-use for the expected users. For example, the way risk is perceived by different members of an organization will affect how intended information about these risks is appropriated and stored into a risk management system (Drummond, 2011). The change in users' practices and contexts (e.g. risk recognition and management) will affect information use and might require change in the system's design.

3.6.4.2 Novelty

Information needs to be new or unexpected: several authors have highlighted that information has a novelty character and that therefore something that is already known or un-

derstood cannot be information (Capurro and Hjorland, 2003; Kallinikos, 2006; Kuhlen, 1991, 2004; Machlup, 1983; Meadow and Yuan, 1997; Nauta, 1972):

> In order to be informative, a message [...] must be able to add a distinction and confer something new on what is already known about the world. [...] Conveying something that is already known is to communicate no information (Kallinikos, 2006, p. 101).

However, this does not mean that everything that is new will be information (Fugmann, 2007) or that information may not require redundancy (Kuhlen, 1991). For instance, scientific or journalistic approaches often rely on acquiring the same results from different sources. Of course, this indicates that information is not merely dependent on the content that is conveyed but also the circumstances in which this content is conveyed. That is, information is not only what was said, but also where, when and by whom it was said. In this sense, independent sources providing similar content can still be understood to provide different information as different sources can be used to corroborate information (McKinnon and Bruns, 1992). For IS, it is therefore of interest to be able to infer if something is likely to be novel to particular users and thus if it has the potential to become information-in-use. Or, take Zuboff's (1988) notion of 'informating' which highlights that the implementation of ICT into organizations is not simply a means for automating processes and activities, but that ICT can facilitate new potential information that may lead to new and different understandings about an organization. Thus, it underlines that novelty is an important facet of information in the context of IS.

3.6.4.3 Time Dependence

Information needs to be regarded as existent in regards to a specific point in time. Information is not static and the same message may be regarded as information at some point in time while its meaning can be revised at another point in time: "information is always subject to revision, and is often revised as events unfold" (Goguen, 1997, p. 37). Several authors therefore identify time dependence as a facet of information (Buckland, 1991; Kuhlen, 1991; Meadow and Yuan, 1997; Steinmüller, 1993). For instance, something that is not up to date cannot be considered as information (Davenport, 1997); information needs to be timely, relative to the situation in which it is used (McLeod and Schell, 2007), that is, it needs to be available at the right time; and information can be contingent (Goguen, 1997) as a judgment of something as information will change when dif-

ferent events occur. Something that was not considered useful may thus suddenly become information and, vice versa, something may no longer be considered information. For instance, in the context of IS, Suchman (1987) looked at how users made sense of instructions provided by the help systems of copy machines. Her case description exemplifies how potential information provided by the help system is constantly reinterpreted as part of an ongoing interaction with the machine as part of the troubleshooting process. As a result, what is regarded as important and thus constitutes information is constantly changing.

3.6.4.4 Degree of Trust

Information needs to be accepted and believed. Degree of trust therefore refers to a recipient's belief in the reliability, accuracy, veracity, credibility, correctness or validity of the content of information as signs. Degree of trust is an important facet of information as something that is not trusted cannot be regarded as information:

> no matter how accurate measurements and data are, if the manager who receives the information doesn't trust the source, then the data is of questionable accuracy – whatever information professionals may argue (Davenport, 1997, p. 117).

Trust is therefore important for something to be regarded as information (Castelfranchi, 2001; Introna, 1997; Kuhlen, 1991, 2004; Meadow and Yuan, 1997). However, trust is rarely a clear-cut case, a matter of either being trusted and accepted or not; rather, it is a matter of the degree to which one can trust or not trust the potential information provided by, for example, ICT (Lucassen and Schraagen, 2011). Trust therefore is a facet that extends along a continuum from highly trusted to not trusted at all. There are two aspects of trust: on the one hand, trust is related to a source in the sense that some sources are trusted more than others (Churchman, 1968; Davenport, 1997). Internet users, for example, more or less trust potential information available in online marketplaces (Sun, 2010) or from recommendation agents (Komiak and Benbasat, 2008). On the other hand, trust is related to the affective dimension of a person (Rice et al., 2001). This dimension indicates the importance of emotions and moods such as confidence, attitude or comfort in regards to information. For instance, something towards which one has strong positive affective emotions is more likely to be regarded as trustworthy infor-

mation. The means for ensuring trust in potential information by a recipient can thus facilitate that information becoming information-in-use to him/her.

3.6.4.5 Social Practices

Information needs to be in accordance with the social practices shared by a group of social actors. What is considered to be relevant and valid and thus can be considered to constitute information is dependent on the shared social practices of the members of a group who are exchanging information. Practices (Schatzki, 1997) will affect what is considered to be information, as criteria for something to be information arise through the interactions of different actors in specific contexts (Goguen, 1997). Information is thus described as group dependent (Dervin, 1981); as situational (Steinmüller, 1993); as requiring familiarity with a domain of interest or subject matter (Rice et al., 2001; Meadow and Yuan, 1997); or as being bound to specific situations (Goguen, 1997; Kuhlen, 1991). The social practices in which individuals are involved thus affect how and why something is considered to be information and is used. Being part of, and emerging within social practices, information is affected by norms, status, power structures or legal aspects (Rice et al., 2001). Different members of an organization, such as lawyers, human resource managers or engineers engage in different social practices or, to use Wittgenstein's (1953) terminology, different language games. Thus, actors engaged in different social practices use language to signify different aspects as part of these practices. As a consequence, practices affect what intended information is shared as different aspects are regarded as potentially informing to the actors. For instance, intended information provided by an ICT system may be considered as different potential information depending on social practices: for example, different groups of managers in different functional areas might interpret it differently (Fay et al., 2010). Furthermore, depending on their social practices (e.g. in engineering, human resources), potential information will be more or less relevant and useful, thus affecting whether it becomes information-in-use.

3.7 Exemplified Use of the 'Facets of Information' Theory

In order to demonstrate how facets of information can be productively used in studying IS in practice, a case provided by Leonardi (2007) will now be discussed and analyzed.

In his paper, Leonardi (2007) made a contribution to our understanding of the relationship between IT and organizational change. His case is chosen because *it explicitly examines information* in the context of ICT use and, more specifically, 'information capabilities'. Leonardi departed from typical descriptions of ICT as being the cause of organizational change. Instead, Leonardi showed that ICT offers what he calls 'informational capabilities' that can facilitate organizational change in a sense that "the *information* created, modified, transmitted, and stored through the IT *itself* can lead to changes in the social structure of an organization" (p. 816; my emphasis). This is an important shift as it goes beyond the view of technology as a causal or mediating variable in regards to organizational change (Jones and Orlikowski, 2009; Leonardi and Barley, 2010). Instead, Leonardi (2007) showed that ICT provides new ways to handle information and that what matters to organizational change is the information enabled through ICT rather than the technology itself. In Leonardi's case, ICT enabled technicians to demonstrate their expertise to their peers and managers. This restructured the advice-seeking patterns from among technicians after they went from being organized hierarchically to being organized meritocratically (based on merits). While this is an important insight, it is not of interest to the discussion here. Instead, it is the notion and role of 'information' in Leonardi's case and his analysis of 'informational capabilities' that are relevant for the argument developed in this essay. The following analysis exemplifies how a facets view of information can be used to enrich the understanding of information and 'informational capabilities' in Leonardi's case.

The discussion of Leonardi's case is organized as follows: firstly, Leonardi's case and his findings are summarized. Then, the limitations of his understanding of information are discussed. These are then contrasted with a facets view of information showing how this leads to an enriched interpretation of how intended information captured and enabled by ICT can facilitate organizational change.

3.7.1 Summary of Leonardi's (2007) Case and Findings

Leonardi (2007) used the case of SkyLabs (a pseudonym) as an example. SkyLabs is a research institute that formerly structured its IT support according to administrative sections within the organization. A few months before Leonardi began his investigation, IT support was reorganized and combined from seven different administrative sections into

a single functional division called Network Engineering and Technical Systems (NETS). As a result, eight technicians who "were accustomed to work[ing] autonomously" (p. 816) for a particular administrative section were combined into the NETS division. The work undertaken by the technicians was described by Leonardi as similar to that described in other studies by Orlikowski (1996) and Zabusky (1996).

In total, Leonardi (2007) followed the work of NETS over a five-month period during which a new IT service management tool (ITSM) was introduced and appropriated by the NETS technicians. Leonardi divided the use of the ITSM into three phases. The first phase started one month after Leonardi began his observation. During this phase, technicians still worked according to their old structure, taking care of the needs of a particular administrative section with which they had been associated with before their restructuring into NETS took place. During this phase, the ITSM was introduced into NETS: technicians generally agreed that the ITSM was a helpful tool that allowed them to "track and manage help-desk requests" (p. 821), the so-called 'tickets'. However, in contrast to the way in which technicians previously organized their schedules, the ITSM stored tickets about help-desk requests on a central server "that was accessible by each NETS technician's personal computer" (p. 821). The ITSM was appreciated by the technicians as it allowed them to record and provide intended information about their work and the time that it took them to solve a request.

Phase two of the ITSM's use was initiated after one NETS member perceived her work as a waste of time. Searching the ITSM, the technician found that a problem similar to the one that she had been working on for two days was resolved by another technician one month earlier. The technician raised the issue during a staff meeting. The NETS technicians then agreed that from then on, one should search the archive of previous 'tickets' when a new help request arose as they realized the relevance of earlier tickets containing potential information about their colleagues' expertise. As a consequence, if a similar issue was resolved in the past, the issue should then be assigned to the technician who had previously resolved the similar issue. The ITSM was then used to assign jobs to NETS team members based on their expertise as evidenced by the tickets with which they had dealt in the past.

And finally, in response to a request from the division leader of NETS to document solutions to technical problems, phase three of the ITSM use was initiated. Originally, the division leader of NETS urged NETS technicians to write so-called project resolution outlines (PROs) and post them on shared folders on their server. Thus, PROs could be seen as sources of intended information for technicians for troubleshooting technical help-desk problems. However, this process was cumbersome both in terms of creating the intended information contained in PROs which required the creation of a new file in a text program and uploading it to the server, and in terms of accessing the potential information contained in PROs, requiring a separate search through those files. At a meeting, it was therefore suggested that the 'notes' field of the ITSM be used instead. Previously, the ITSM's notes field was unused and thus it provided the technicians with the possibility of posting additional details for each ticket. As a result, the ITSM was now also used for documenting successful solutions to problems. It thus enabled the creation of intended information and access to potential information about how colleagues had solved technical problems in a way that was more aligned with the work practices of technicians than previously.

3.7.2 'Information' in Leonardi's (2007) Case

Leonardi's (2007) case shows that ICT plays a vital role in organizational change due to the advanced 'informational capabilities' of ICT and the storage and availability of information. Leonardi regarded information as something that is contained in ICT and he therefore discussed information as an objective entity that is stored in, and manipulated by, ICT. Consequently, information is understood as a good or a thing that can be stored and accumulated similar to other goods as is evident in the expression that "[i]nformation is a valuable commodity" (p. 814). Therefore, ICT artifacts are similar to a container that stores information in an objective way and from which users can "mobilize the information in the tool in different ways" (p. 813). This understanding of information provides a clear role for ICT by regarding it as a repository for the content stored in and provided by it. Information was contained by the ITSM irrespective of the NETS technicians and could be 'activated' if the need arose: "appropriations of the technology's features activated the information stored in the tool into resources technicians

used" (p. 828). Thus, information existed independently of the technicians using the ITSM.

This understanding of information therefore provides a specific understanding of the role of ICT and the way ICT handles information. Information exists independently of its use and it can be activated when users learn "to cope with the artifact's material features [... and] the new ways in which the artifact handled information" (Leonardi, 2007, p. 813). Information is therefore a technical problem and the ability to derive information from the ITSM was one of learning the appropriate lever and switches provided by ICT. As NETS technicians learnt how to extract information from the ITSM, this information then led to organizational change. In Leonardi's case, the ITSM enabled information about the expertise of colleagues which in turn led to a change in advice-seeking patterns and therefore a change in organizational structure. This provides a clear role of information as part of organizational change according to which information is a well-defined entity as part of a causality chain.

Leonardi's (2007) understanding of information, however, does not allow us to probe more deeply into the use of ICT and the technicians' engagement with and interpretation of the content from the ITSM. It is not likely that all technicians interpreted the content the same way and derived the same information from the ITSM. Moreover, information is one element forming part of a causality chain implying that information contained in ICT leads to specific outcomes when it is 'activated'. This container view of information thus renders invisible the social interaction among the technicians in their practice, the subtleties of their engagement with ICT, how this led to a particular appropriation of technology and the capture of content that they considered to be information as part of their ongoing practice. Assuming that the information captured by the ITSM was an objective record (entity) did not allow the investigation of differences in interpreting "the same information" by technicians as their practices, expectations and goals changed.

One is prompted to question whether and how meanings and interpretations of information provided by the ITSM might have changed or emerged as practices changed and problem situations transformed. This is important in order to derive from Leonardi's (2007) case how ICT appropriation may differ in situations where different or more heterogeneous user groups are involved. For instance, by regarding information as some-

thing that is stored objectively in ICT, Leonardi could not explain how the same content produced by ICT may become different information for different users. Therefore, this prevents a more nuanced analysis of how something becomes useful information as part of a particular working practice and how social actors, ICT and practices are intertwined and continually co-emerging, implying a changing view of what is seen as useful information. Thus, this does not allow us to better understand how ICT enabled the NETS technicians to derive information from the ITSM and thus rendered the ITSM useful to them.

Leonardi's (2007) paper provides interesting and valuable insights into organizational change instigated by an ICT development and its use. However, the concepts of both information and ICT (and its informational capabilities) can be seen as simplified. Leonardi's concept of information therefore limits understanding as it cannot provide further insights into how information achieves organizational change and how the changes observed by Leonardi may differ in different organizational contexts, such as by involving bigger or more diverse user groups.

These limitations of Leonardi's approach to information are now discussed in the light of the 'facets of information' theory proposed in this essay.

3.7.3 Understanding Facets of Information in Leonardi's Case

Firstly, looking at the facets associated with information allows a more fine-grained analysis of how information was enabled by ICT in Leonardi's case. It highlights that information is simultaneously associated with material as well as sociocultural facets and that the introduction of the ITSM affected numerous facets of information. This, in turn, allows us a to reach a deeper understanding of why the changes regarding 'informational capabilities' observed by Leonardi (2007) became possible in his case and how his findings may be applicable to different contexts in which other facets of information may become salient as well.

Viewed from the empiric dimension, it can be seen that the ITSM led to considerable change in the facets associated with information. From the empiric dimension, information is associated with access, physical inscription, detectability and speed. Most of these facets are dealt with at a technical level; however, the potential information enabled by the ITSM was notably different to the previous way of keeping track of user

requests which was done by "using spreadsheets, or even paper and pencil" (Leonardi, 2007, p. 828). Facets of information related to the introduction of the ITSM were therefore different in terms of speed, physical inscription and access. By storing data on a central server, the ITSM enabled NETS technicians to keep a more reliable *physical inscription* of user requests to all technicians compared to the previous approach where each technician only had a private record of their own requests. The ITSM also enabled technicians to *physically access* requests that had been made to other technicians;[6] it affected the facet of *speed* as it allowed technicians to find out about past requests so that the time and effort required to solve similar new requests was much less than before.

The introduction of the ITSM also affected the syntactic dimension of information through the facet of *precision and accuracy* in regards to keeping track of user requests and solutions. It required requests for IT support to be lodged in the form of tickets that made it necessary to fill out specific fields containing particular details about the service request in a structured way. This had an effect on the precision and accuracy of how user requests were stored. While this was not discussed in Leonardi's paper, it is important to understand that the precision required by the ITSM allowed it to provide new potential information. For instance, the ITSM could also be used to analyze whether different departments of SkyLabs had disproportional IT service requests regarding specific technologies indicating, for example, that the printing equipment in one department should be renewed.

Comprehensibility, contextuality and level of detail are facets of information that are associated with the semantic dimension. Regarding *comprehensibility,* Leonardi did not report any issues arising through the introduction of the ITSM. Technicians shared a common language and understanding of IT problems and therefore comprehended the content of the ITSM in similar ways. Also, NETS technicians shared a common *context* as they all worked with IT service requests and were physically located at a single site of the organization. However, the introduction of the ITSM led to a considerable change in terms of the *level of detail* with which user requests were documented. "The basic requirement for creating a ticket consisted of entering into the fields at least five pieces of information" (Leonardi, 2007, p. 822). This increase in the level of detail stored about

6 Whether access itself created any issues among technicians or other users remains unknown from Leonadi's case description.

IT service requests was an important feature of the ITSM as it enabled technicians to search for problems that other technicians had dealt with in the past and to be "more reflexive about the time it took to resolve an issue" (p. 822). Also, using the ITSM to document solutions to problems changed the level of detail available about individual service requests and the troubleshooting undertaken by technicians. This provided technicians with the possibility of showcasing their expertise to their colleagues:

> I didn't realize she knew so much about network security but I saw she wrote sort of a mini treatise on it in the ITSM for one of her tickets. That was pretty impressive (p. 825).

And finally, at the pragmatic level, the facets of information are action relevance, novelty, degree of trust, time dependence and social practices. All of these are relevant to information in Leonardi's case. However, most were rendered invisible by the fact that the ITSM was shared by a small group of eight technicians who all worked on similar problems and who, due to the nature of their work, shared a similar understanding of ICT. The importance of the *goal relevance* of the ITSM to the technicians was one of the reasons that the ITSM was initially accepted by technicians as it enabled them to deal with information that was relevant to their activities. As one technician stated, "this is a good way of keeping track of tickets" (p. 822). Similarly, because the technicians were members of a small group, this facilitated the *degree of trust* that the intended information entered into ITSM by others was accurate. Moreover, technicians shared a common *social practice* that motivated them to appropriate an IT tool such as the ITSM for their work, to adopt shared norms and rules for how to use the tool, and to agree on adapting it to their changing needs.

However, two pragmatic facets stand out in Leonardi's case: novelty and time dependence. The ITSM allowed NETS technicians a *novel* way for looking at IT help-desk work. It allowed technicians to look at the service requests their colleagues had dealt with and to gain a better understanding of their colleagues' expertise. Regarding *time dependence,* the content enabled by the ITSM did not initially allow technicians to realize the work that others had done and thus their areas of expertise until the tool was used for some time. Only after tickets from service requests had amassed was it possible for technicians to realize that the ITSM allowed them to assign jobs to those who had

experience in troubleshooting particular technical issues. This also illustrates how useful information emerged through extended use of the system.

The above discussion illustrates how the 'facets of information' theory can be applied to provide a deeper insight into understanding how ICT changes what constitutes information for organizational members. Looking at different facets enables a refined understanding of how the ITSM changed what constitutes information for NETS technicians and how this understanding changed over time. Importantly, it also indicates that the interplay between information and organizational change investigated by Leonardi (2007) may differ in organizational settings where additional facets of information become more salient than in Leonardi's case. For instance, in complex organizations with more diverse user groups, appropriation of ICT may in addition be related to how the degree of trust in the potential information provided by ICT changes over time. Over time, while trust is being built into the potential information provided by ICT, these outputs are more likely to become information-in-use and thus to contribute to organizational change.

Secondly, as argued above, Leonardi's approach to information is limited in so far as he employed an objective understanding of information in the sense that ICT contains information in an objective way from which it is then appropriated and used. In contrast to Leonardi's understanding of information, the facets view of information highlights that information also depends on actors' understanding within a wider sociocultural context. Within this context, content becomes meaningful and important to members of a group as part of their practice. In Leonardi's case, gaining a better understanding of IT service problems and how colleagues solved them was of interest to other NETS technicians. This was done by seeking advice from colleagues who had experience in troubleshooting specific problems or problem areas, such as 'network security' (p. 825). An important consequence of this dimension of information is that informational capabilities are not contained in or provided by ICT and then 'activated' by users as Leonardi argued (p. 828). Instead, informational capabilities are enacted by those interacting with a particular ICT system. For instance, using the 'notes' field in the ITSM for documenting solutions was not something built into the ITSM but was something that the technicians enacted when they realized their need for documentation and the usefulness of being able to search through this documentation. Similarly, the idea of searching through older

tickets in order to locate the expertise of colleagues was not a functionality built into the ITSM but something that was enacted when the technicians realized its usefulness for their work. From this, it follows that information derived in different phases of the appropriation of the ITSM was not contained in the ITSM from the outset as Leonardi's notion of 'activation' implied. Instead, information arose over time through the interaction of NETS technicians and the possibilities provided by the technology. For instance, potential information about the expertise of colleagues was not available from the outset, but only over time as problem descriptions and details of the duration of time taken by different technicians to fix problems had amassed as a result of the continuous use of the ITSM.

3.7.4 Implications of the Facets View of Information

Leonardi (2007) made an important contribution by pointing out that organizational change is not related to technology itself, but instead to information that is enabled by ICT. However, Leonardi predominantly focused on information as an output of IT artifacts and thus depicted information as something contained in ICT in an objective entity. Leonardi's understanding of information was similar therefore to data contained in an IT artifact thus leading him to claim that 'informational capabilities' are something already contained in an ICT artifact at the time of its implementation. He added that informational capabilities are then activated through social processes over time and through this "new technology leads to organizational change" (p. 828). How this understanding of information can be contrasted with a facets view of information is summarized in table 3.5.

Table 3.5 Comparison between the Facets View of Information and Leonardi's Case

	Leonardi' (2007) Case	Facets View of Information
Role of ICT regarding information	ICT systems "create, modify, transmit, and store information" (p. 820).	ICT facilitates the exchange and provision of potential information. In Leonardi's case, important facets of information were: novelty; time dependence; level of detail; precision and accuracy; speed; durability; and access.
Understanding of information	Information is an objective entity in the sense that information "is a valuable commodity" (p. 814) and "a static phenomenon" (p. 828).	Information arises within a sociocultural practice that makes use of technology and material devices for communicating differences that are meaningful within this practice. Importantly, information can be differentiated into intended information when it is created, potential information when it is retrieved, and information-in-use when it is appropriated as part of practices.
Role of users	"[M]aterial features of the artifact will directly influence how [users] create, modify, transmit, and store the information that the IT enables" (p. 816).	Through their shared context, social practice, aims and mutual trust, technicians are able to use technology to derive information that is mutually understandable and relevant to them.
Informational capabilities	Are contained in ICT and 'activated' (p. 830) by users of technology. This process of activation happens over time.	Information capabilities are not given or fixed. They are enacted through users' engagement with ICT in their daily practices whereby the data stored in ICT are (re)interpreted, amended and reprocessed enabling them to create novel and useful information in support of changing work practices.

A facets view of information enables a more detailed analysis of information than in Leonardi's case and thus leads to additional and more subtle theoretical insights than those provided by Leonardi. Firstly, it highlights that different facets of information facilitate appropriation of ICT. From this, it follows that, in different circumstances, different facets of information may be relevant to the appropriation of ICT. For instance, in Leonardi's case, the user group was small and shared a common work practice which elevated facets of information related to comprehensibility, contextuality, social practice, goal relevance and degree of trust. However, in different circumstances, these facets of information may be an issue regarding the appropriation of ICT.

Secondly, from a facets view of information, it follows that work practices need to be flexible enough for information to emerge and thus to realize the potential of ICT. Realization of informational capabilities is not merely a matter of activating them in ICT as Leonardi argued, but it also requires that members of an organization are flexible and

motivated enough to contribute to the emergence of informational capabilities through the use of ICT. In this sense, organizational change is not a result of the activation of informational capabilities in ICT, but instead is an accomplishment arising from users and ICT interacting and co-creating new informational capabilities and organizational processes.

A facets view of information considers technical and sociocultural aspects as both being of relevance to information. Information is therefore not something that can be contained in technology in an objective way, but something that equally arises through practice that considers certain differences as meaningful and relevant. However, meaningful and relevant differences are not stored in technology itself but arise because technology allows differences that are meaningful and relevant to be made by a particular group of users within a particular sociocultural context. From this, it follows that when new ICT is implemented within an organization, the organization also needs to allow new social practices to emerge as well. Efficiency gains, such as through doing things faster or with less resources, can then be enabled if users have the freedom to reorganize their work practices and interactions according to affordances created though ICT. In Leonardi's case, technicians could only leverage the expertise of their colleagues to a greater extent because they were able to assign jobs to their colleagues. As a result, what was considered to be potential information for a technician changed as the awareness of their colleagues' expertise became important in order for them to assign jobs to their colleagues. As this example highlights, organizational change is not merely the result of the activation of informational capabilities contained in technology, but also something that co-emerges with informational capabilities in the first place. This underlines the interactional character of ICT and the practices in which users are involved in order for information to emerge.

And thirdly, in order to facilitate informational capabilities, technology itself needs to be flexible so that it can allow new and innovative uses of ICT. The ability of ICT to facilitate informational capabilities is thus linked to the ability to use an ICT tool differently. Hence, the same technology may be used differently with different implications in different contexts (Leonardi and Barley, 2010). Importantly, this is linked to the flexibility of a tool which is to be appropriated in different contexts according to the needs of users. As a consequence, ICT needs to be designed in a way that allows it to be used

flexibly and to be adjusted to the needs of users. In Leonardi's case, the ability to search through tickets generated by colleagues and the existence of an unused notes field, offered important flexibility in the use of the ISTM and thus allowed technicians to enact new informational capabilities for using the ISTM for their work.

For Leonardi, however, informational capabilities were built into ICT and then activated. For this reason, he argued that the ITSM use was finally appropriated in phase three as no new use of the ITSM emerged. However, a reason for this was that the ITSM no longer offered additional flexibility to be further adjusted by technicians' work practices and information needs. This does not mean that no further adjustments could be made that would allow the ITSM to be further appropriated for use by NETS. Instead, it indicates that the ITSM had reached a limit in terms of flexibility in how it could be adjusted. For instance, the ITSM still offered limited flexibility regarding assigning tickets to colleagues based on their expertise and could be further improved in this regard. Additionally, being able to classify help-desk requests into different broad categories, such as printing, network, etc., could help in accessing past solutions to problems when these were being sought. Moreover, even completely different appropriations of the ITSM could be imagined. For instance, the ITSM could be used by human resources when hiring new staff to use the ITSM in order to ensure complementary skill sets and expertise among staff. From this, it follows that the more flexible a tool, the more appropriations of it are possible and potentially, therefore, additional use can be achieved.

To summarize, Leonardi 'blackboxed' information as something that can be objectively contained in ICT. As a consequence, he argued that informational capabilities are contained in ICT from where they are activated. Activation of informational capabilities in turn then leads to organizational change (p. 828). In contrast, it is argued here that information is related to many facets, some of which are technical and some of which are sociocultural. From this, it follows that informational capabilities are not provided by the technology (and are thus not merely a technical issue), but that they are enacted through the interaction of users and ICT in a work or organizational context. In order for informational capabilities to be enacted, two things are necessary: firstly, work practices and interactions need to be flexible so that they can be adjusted to affordances that emerge as a result of some ICT. And secondly, it is also necessary that ICT offers flexibility so it can be adjusted by users in a way that allows them to use ICT to create information that

is relevant to them. From this, it follows that organizational change emerges together with new informational capabilities rather than merely being a consequence of them. This not only requires the freedom to adjust work practices, but also requires that technology is flexible enough to be adjusted.

3.8 Discussion

Information is an important concept for IS (Baskerville, 2010; Lee, 2004, 2010; McKinney and Yoos, 2010) that is difficult to approach in a satisfactory way through definition or explanation (Frohman, 2004). While some definitions emphasize the material and technical character of information, others highlight its sociocultural or subjective nature. Importantly, both sides cannot be reconciled into a single definition of information. This essay has made an important contribution to overcoming this limitation in the understanding of information. It has introduced a facets view of information that describes information rather than defines it. As a consequence, it allows IS to simultaneously relate information to material/technological as well as sociocultural facets.

3.8.1 Contributions

Generally, there is a lack of interest in information at a conceptual level: over the past few decades, several IS academics have encouraged the IS community to engage more seriously with information as a concept (e.g. Boland, 1987; Lee, 2010; Stamper, 1973). As a result of this lack of interest by the IS community, information as a concept is often not clearly expressed in IS research (Lee, 2004, 2010). Instead, an implicit 'token' understanding of information (McKinney and Yoos, 2010) that conflates information with data is dominant (Lee, 2010). One contribution made by this essay is thus that it raises awareness of the depth of information as a concept for IS research. It therefore encourages IS researchers to engage more seriously with this concept and to further develop the conceptual understanding of information within IS. This not only has implications for conceptual clarity regarding information within IS but also can provide the discipline of IS with an important means for interacting with its neighboring disciplines by having this concept at the crossroads between them.

Furthermore, this essay contributes to IS discourse about information by suggesting a 'facets of information' theory that extends Stamper's (1991, 1992) semiological frame-

work by following a Wittgensteinian approach to language. The 'facets of information' theory provides a description of the facets of information that enables a better understanding of the term 'information' without the limitations associated with attempts to define it. Generally, definitions aim to draw clear boundaries for the meaning associated with a particular term. However, this separates word and meaning from each other assuming that they are two different things. Wittgenstein (1953) questioned this idea and argued that instead of defining or explaining a term, one should look at the way that a word is used. This shifts the approach to understanding a term from definition to description. This essay employs this approach and extends Stamper's (1987, 1991, 1992) framework that discriminates four semiotic dimensions: pragmatics, semantics, syntactics and empirics. By further investigating these semiotic dimensions, this essay develops facets of information that provide deeper insights into these dimensions thus allowing a more refined understanding of the phenomenon of information in IS and beyond. This theoretical approach to information describes information in relation to action relevance, novelty, degree of trust, time dependence and social practices (within the pragmatic dimension); comprehensibility, contextuality and level of detail (within the semantic dimension); apprehensibility, as well as precision and accuracy (within the syntactic dimension); and physical inscription, detectability, speed and physical access (within the empiric dimension). Importantly, the 'facets of information' theory overcomes the limitation of definition-based approaches to information that result in mutually-exclusive understandings of information (as presented in Chapter 2).

In particular, the 'facets of information' theory provides an explanation of how information is, on the one hand, related to materiality through its physical inscription and, on the other hand, related to sociocultural facets through usage that implies intentions, motivations, interests, etc. Highlighting the sociocultural dimension of information, the 'facets of information' theory emphasizes how information becomes meaningful as part of ongoing day-to-day living (Boland, 1987) and how it is at the same time related to technical aspects. As IS researchers are simultaneously interested in technical aspects as well as in social aspects related to ICT (Alter, 2008; Checkland and Holwell, 1998; Galliers, 2003; Lee, 2001, 2004, 2010; Paul, 2010), this is of particular relevance as it simultaneously considers technological as well as social facets associated with information. Importantly, this is not a consideration of social and technical aspects side-by-side,

but instead sees them as inherently interrelated. As a result, a facets approach to information addresses a persistent problem in IS by integrating the material/technological and sociocultural nature of information. As a result, it offers a way to make the concept of information particularly useful to IS research.

And finally, this essay contributes to the understanding of information in the context of IS by highlighting that what users consider to be information and what is stored in and reproduced by ICT may not be the same. This insight is derived from the pragmatic dimension of information as interpretation and assessment of the output provided by ICT will vary depending on relevance, novelty, degree of trust, time dependence and social practices. Consequently, this essay differentiates three different understandings of information that are currently conflated by the term 'information'. Firstly, there is the content that is stored in ICT which can be more precisely labelled 'intended information'. Secondly, there is the output provided by ICT which can be labelled 'potential information' for a user. And thirdly, if the output is considered by someone to be useful to them, we can speak of 'information-in-use'. Importantly, from a facets view of information, it follows that potential information needs to have several facets in order to be considered information. Moreover, the necessity to differentiate between potential information and information ('information-in-use') was highlighted earlier (Brier, 2004; von Foerster and Schmidt, 1971; Weizsäcker, 1985). However, the 'facets of information' theory provides a clear distinction and argument for why and how these three concepts of information differ.

3.8.2 Theoretical Implications

The 'facets of information' theory provides a means for deeper engagement with the concept of information for IS. As argued above, hierarchical concepts of information such as the DIKW hierarchy suffer from a number of limitations. Hierarchical concepts of information lack explanations that go beyond commonsensical understanding and are therefore described as insufficient for theoretical engagement with information (Bates, 2010; Stamper, 1985). For instance, they cannot provide an explanation for how the same data can lead to different information for different people (Fricke, 2009; Kettinger and Li, 2010). In contrast, the 'facets of information' theory introduced here provides a means for engaging with information at a theoretical level. By showing that information

is simultaneously related to empiric, syntactic, semantic and pragmatic dimensions along which information can be described through facts, it contributes an important means for theorizing about information. For instance, the 'facets of information' theory provides a straightforward explanation for why the same data will lead to different information for different people. This difference can simply be explained by the fact that information is related to numerous facets that will differ between individuals. For instance, comprehensibility of information, but also novelty, or action relevance will vary between individuals. Moreover, it not only provides an explanation for *why* the same data can lead to different information, but also provides a means for better understanding *how* data can result in different information. The 'facets of information' theory thus provides an important means to engage more deeply with the concept of information as it can enable a more nuanced understanding of how potentially informing content provided by ICT can become information-in-use for specific actors. Looking more closely at different pragmatic facets of information can, for example, facilitate IS research to better understand how the output of ICT can become information-in-use in one case while it remains potential information in another.

This indicates that by describing a list of different facets associated with information, the 'facets of information' theory can facilitate analysis in IS research. Firstly, the 'facets of information' theory sensitizes IS researchers to facets that may be of relevance to their analysis and, secondly, it offers a means for simultaneously considering social and technical aspects associated with information. By describing a set of facets associated with different semiotic dimensions of information, the 'facets of information' theory thus allows future researchers to further break down their analysis of social and material aspects associated with information. This provides, for instance, a calculus for analyzing why similar ICT is adopted differently in different circumstances or, as exemplified by drawing from Leonardi's (2007) case of SkyLabs, how ICT is appropriated into an organizational setting.

The 'facets of information' theory thus shows that information is not something that can be considered as being captured and stored in ICT in an objective sense, but as something that arises through the use of ICT within a sociocultural setting over time. For instance, this provides a theoretical explanation for why ICT implementation into organizations is a continuous process that cannot be regarded as finalized at some point (Truex

et al., 1999). What is considered by social actors as informing them and thus what resources are of potential information to them continuously change and, as a result, the way in which ICT can be used as part of this is also continuously evolving. Importantly, the 'facets of information' theory provides one step towards a better understanding of how ICT facilitates information and how conditions for information may change over time. For instance, looking at Leonardi's (2007) case, it becomes apparent that information about the expertise of colleagues is not something that could be derived from data contained in ICT from the outset. Instead, information is something that is enabled over time as usefulness, relevance and the potential to become informed about these aspects through ICT become apparent and important to social actors. As Leonardi's case further shows, things become relevant as the result of a change in ongoing practice. In his case, the ability to assign help-desk requests to colleagues elevated the relevance of becoming informed about the expertise of fellow technicians. The 'facets of information' theory thus sensitizes analysis to how information needs change over time as ICT and work practices evolve.

3.8.3 Limitations and Future Research

This research is founded on Stamper's semiological framework from which it builds a new layer of understanding information – a facets view. However, it may be possible that this initial set of facets could be expanded further in the future. For instance, this initial set of facets offers only limited consideration of empathic aspects related to information. There is therefore a clear need to shed further light on this aspect of information in order to better take into account users' emotional responses and positive or negative attitudes towards sources of information (Van Kleef, 2008; Weick, 1985).

In addition, this essay provides only a first step in the direction of employing a Wittgensteinian approach to describing information in the context of IS. This can be extended to also look at information embedded in different activities and work practices or, using Wittgenstein's terminology, 'forms of life', to gain a better understanding of how potential information becomes meaningful and relevant within these contexts. As indicated in the discussion of Leonardi's (2007) case, several facets of information at the pragmatic level were invisible in the context of his research. For instance, all users shared common goals and engaged in a shared social practice. Looking at additional cases will allow IS

to build further understanding of how these facets are associated with information in the context of ICT.

Moreover, by relating information, on the one hand, to material facets and, on the other hand, to social facets, the 'facets of information' theory provides a means for understanding information as a sociomaterial phenomenon (Barad, 2007; Boell and Cecez-Kecmanovic, 2011; Orlikowski, 2007). It thus potentially provides a foundation for future research into the sociomateriality of information.

And finally, the scope of this essay did not allow further investigation of individual facets through empirical studies. Future research could therefore empirically explore different facets and their use in practice. Such studies need to be appropriately designed so as to reveal how each facet arises and is dealt with in practice and also how different facets of information may be interrelated, potentially influencing each other. To exemplify this, there is evidence that users prefer sources that are easily accessible to them or that are in close physical proximity to them (Chopra and Dexter, 2008; Rice et al., 2001). Therefore, one question arising from this would be whether ease of physical access to sources may increase the degree of trust in the (potential) information that they provide.

3.8.4 Practical Implications

This essay provides two major contributions that are of relevance to IS practitioners. Firstly, it enables a better understanding of information in practice by distinguishing three forms of information that are currently conflated when talking about information. The concepts of intended information, potential information and information-in-use thus enable the drawing of a meaningful difference that has important implications for IS practitioners, as well as for IS education and training. And secondly, it provides an understanding of information that enables the dissection of the concept into 14 different facets. Not only does this allow IS practitioners to understand how information is simultaneously a technological as well as a social problem, but it also enables them to appropriate facets of information that are of particular relevance in different contexts. The practical implications of both of these contributions are now further elaborated.

Firstly, the relevance of this research for practitioners as well as for IS education and training arises as it highlights the difference between intended information, potential in-

formation and information-in-use. This difference is an important one in practice as it enables a better understanding of how ICT operates in an organizational context. It underlines that ICT cannot provide by means of its design output that will automatically be considered information by users. ICT can only provide potential information or, to phrase it differently, propositions for information. What is equally important to the output provided by a system is the organizational discourse that renders that output meaningful and relevant to a particular group of organizational members. What is therefore of interest to management is the facilitation of a better understanding between those deciding about the data content of ICT and intended information at one end, and those members that interpret and use this information at the other end. For instance, meetings between different organizational members, practices such as staff exchanges, or shadowing of colleagues can facilitate better understanding of what each considers to be information. For instance, in the case of agile development, methodologies that specifically encourage frequent user feedback and thus enable developers to learn about context and practices can impact on the relevance of potential information provided by the ICT system that is to be developed.

Secondly, the different facets associated with information introduced here also allow practitioners to consider these facets when implementing ICT. Looking at facets of information allows one to better ensure that something that is intended to be information when it is created becomes potential information for users for whom it is intended. Generally, this shifts the understanding of information away from being a technical problem of storage and processing of data to the way in which output from ICT is used by different groups of actors in their practices and thus how it becomes information for them. Looking at different facets of information can, therefore, alert management so that it can better understand where new ICT may be hindered in unfolding its potential. The following questions are examples that highlight the relevance for management and developers. For instance, looking at facets of information provokes questions such as: How can it be ensured that users of (intended) information generated from ICT perceive it to be potential information and also relevant to them in their activities? Are the reports provided by ICT comprehensible and do they reflect the terms common to a particular work practice? Are there issues regarding the level of trust in the content provided by ICT, particularly across divisional boundaries? How can ICT systems be designed to en-

able economic adjustments to different work practices that they have aimed to support and facilitate? etc. From this, important considerations arise for systems developers looking at facets of information who can, for instance, probe a system: to investigate if there are ways to improve what was displayed to a user in order to maximize novelty or highlight changed or new data; to see if there are contextual clues such as indications of authorship that can facilitate trust into becoming potential information; to question what is considered to be an appropriate level of detail for a specific use; and to see if intended information can be summarized in order to shift the level of detail to one that is most appropriate for a specific-use scenario. Moreover, the use of facets of information to sensitize designers and users to different considerations, as the questions above illustrate, further suggests the potential value of the 'facets of information' theory to IS education and training.

Additionally, from a practical perspective, the view of information introduced in this essay highlights the importance of creating flexible ICT. Information arises from ICT when particular users consider the output provided by that ICT system to be meaningful and relevant to them. This has implications, on the one hand, for ICT development, implementation and use and, on the other hand, for users' education and training. In relation to the former, it is important to understand that what is relevant to users will vastly depend on the practices in which they are involved and their roles within these practices. It is therefore important that ICT is able to adjust the content in such a way that the output becomes more likely to be considered information (as exemplified in Leonardi's case). From this, it is therefore important to provide means that allow users to adjust the content of ICT in ways that facilitate the creation of outputs that are meaningful and relevant to them. As a consequence, the better that ICT can evolve with what is actually considered to be information by a particular group of organizational members, the more useful this ICT will be to these organizational members. Importantly this posits that competitive advantage can arise from continuous appropriation and adoption of ICT. Organizational members can be better informed if they have access to potential information that is highly likely to become information-in-use to them. The ability to provide such potential information must be understood as an ongoing achievement as what will be considered information will continuously change. The ability to provide in-

formation-in-use thus results from the continuous interaction between organizational members, ICT and its development.

3.9 Conclusion

Information is an important concept for IS that is currently not treated thoroughly by IS researchers (Avgerou, 2010; Baskerville, 2010; Lee, 2020). Treatment of the concept is insufficient both when it is used passively as a term in IS research and when it is actively discussed as a concept by IS researchers. IS research often uses 'information' in an unreflective way such that it may mean different things (Lee, 2004, 2010). Moreover, current conceptualizations of information often relate information to a hierarchical understanding of the terms, data, information, knowledge and wisdom. However, this understanding of information is limited in terms of its usefulness for research:

> Though this sequence may feel intuitively right, it is difficult to take it from its popular meaning and develop it into something sufficiently refined to be useful for research. Most discussions of DIKW really, at base, elaborate the intuitive understanding, and do not take theory much further (Bates, 2010, p. 2358).

Inspired by Wittgenstein's (1953) philosophy, this essay makes an important contribution to describing the concept of information through facets thus rendering it more useful to IS from three different angles:

Firstly, the 'facets of information' theory provides an approach that can simultaneously consider the social and technical aspects associated with information; such a theorizing of information provides a theoretical vantage point that is not only unique to IS and its intellectual core, but can also provide an IS understanding of information that is potentially useful to neighboring disciplines.

Secondly, from a research perspective, it enables IS researchers to better dissect the concept of information by providing a list of 14 different facets that are associated with information. This allows IS researchers to build on the research introduced here and to better understand what facets of information are relevant in a particular research context.

And lastly, it allows IS practitioners to better understand how users become informed through ICT in everyday organizational practice. Thus, by taking measures to better

align intended information that is stored by ICT, potential information provided by ICT and information-in-use that is considered to be meaningful and relevant by users, managers are better able to facilitate innovative use of ICT to achieve organizational improvements.

Chapter 4 : Theorizing Information Systems

4.1 Summary

The concept of information systems (IS) is of obvious importance to the IS field and there is a clear need to understand what an IS is and what it entails. However, in the current literature, the concept is often not clearly expressed and is used in a way that conflates IS with terms such as information technology (IT) or computer systems. After looking at the definitions of IS provided in a wide range of IS research literature (journals, conference proceedings, books) and established educational textbooks, five different views of IS are distinguished: a technology view emphasizing the technological aspects of IS; a social view emphasizing the sociocultural aspects; a socio-technical view emphasizing the interconnection of technology and social elements; a modelling view emphasizing the development process; and a process view emphasizing the activity orientation of IS. It is shown that each of these views makes important contributions to understanding IS. Moreover, these definitions of IS evoke seven key aspects related to IS: practices, social actors, technology, data, information, development and organizations. As each of these seven aspects is introduced, they reveal their relationship with each other. That is, each aspect is affected by and is affecting all other aspects in their becoming. As a result, an IS is understood as an entanglement of these aspects in the sense that each of them is in a continuous process of becoming through the others. Consequently, an IS can be comprehended as a sociomaterial and performative apparatus where each of these aspects cannot be understood as ontologically separate. This provides an additional view for understanding IS that can overcome some of the ontological limitations associated with other views. The contributions made by this essay are thus: identification of the seven aspects that an IS entails; showing that these aspects are entangled as they come into being and thus that they cannot be understood in isolation; and demonstrating that an IS can be understood as a sociomaterial apparatus emerging through the ongoing intra-action of these aspects thus continuously changing the whole and all of its aspects.

Keywords: information system; conceptualizing information systems; sociomateriality; representations; IT artifact; practice; entanglement; apparatus

4.2 Introduction

That information systems (IS) as a field is interested in information systems as a subject should be fairly obvious. Of general interest to the field of IS are all aspects of the development, deployment, implementation, use and impact of IS in organizations and society. IS are developed by assembling and appropriating a variety of information technologies (IT) such as computers, software, databases, communication systems, the Internet, mobile devices and much more to perform specific tasks, interact with and inform various actors in organizations or society. Importantly, the IS field is not concerned with the technical and computational aspects of IT per se but with their appropriation and instantiation that enable the realization of IS that fulfil actors' information needs and requirements. While this has been widely recognized in the IS community, the term 'information system' is used interchangeably with 'information technology' and even with 'computer system' (Lee, 2010, p. 339). Although foundational to the IS field, the concept of IS is typically taken for granted and is rarely explicitly defined and examined.

As a consequence, there have been calls to the IS community to further its engagement with core concepts that are central to the field and its research (Baskerville, 2010; Lee, 2010; Straub, forthcoming). In addition, the concept of IS is central to the debate about the field's identity and its aims (Benbasat and Zmud, 2003; DeSanctis, 2003; Galliers, 2003; Robey, 2003). For instance, understanding what an IS is has important implications for what IS researchers should research, what IS educational programs should contain and how they should be differentiated from IT programs or other business programs. Moreover, one aspect heavily debated in the discussion about the field's identity is the role of IT artifacts. While Benbasat and Zmud (2003) argued for the central importance of an IT artifact in order to establish an intellectual core for IS research, Lyytinen and King (2004) and Galliers (2003) rejected this idea arguing instead for diversity and trans-disciplinarity in IS research. Overall, there seems to be no consensus on what constitutes an IS and what role IT artifacts play in it.

Therefore, there is a clear need to further examine what an IS is and what it entails. Thus, the key objective of this research is *to advance understanding of IS*, firstly, by critically reflecting on how IS are conceptualized and the ways in which these conceptualizations limit our understanding of the nature and role of IS and, secondly, by propos-

ing an integrative conceptualization that overcomes these limitations. To engage with this objective, this essay critically examines a wide range of definitions of IS. Based on this examination, a new sociomaterial conception of IS is proposed that is founded upon the identification of seven entangled aspects relevant for understanding IS: practices, social actors, technology, data, information, development and organizations. This sociomaterial conception thus provides a clear account of different aspects that are of relevance in understanding IS. Moreover, it resolves some of the ontological limitations associated with and contradictions among alternative understandings of IS.

In order to achieve its objective, this essay makes three main contributions:

(1) It provides a review of five different conceptions of IS, critically examining the assumptions underlying these conceptions and the contributions and limitations of each of these conceptions.

(2) In addition, it identifies seven aspects of IS referred to by different definitions of IS and looks more closely at what each aspect entails and how they are related to each other.

(3) And finally, it shows that a sociomaterial understanding of the mutual co-construction of these aspects integrates these aspects in a meaningful way.

These contributions are important as they provide an overview of the different existing conceptions of IS based on which an integrative understanding of aspects associated with IS can be achieved. Current research generally looks at aspects of IS in separation, or only partially relates some of the aspects to each other, for instance, a socio-technical view of IS will include social as well as technical aspects. However, understanding of these aspects as part of IS overlooks the entanglement of these aspects in practice and how these aspects are ontologically entangled. The relevance of the proposed sociomaterial approach is exemplified in the context of decision support systems (DSS) and further underlined by discussing its relevance for IS research and practice.

The remainder of the essay is structured as follows. The next section provides a more detailed introduction to the research problem and the research approach. In particular, it introduces the research questions and how they are approached. The third section then provides a discussion of the definitions of IS identifying five different views of IS throughout the literature. The assumptions underlying each of these views, the contribu-

tions made by them and their shortcomings are discussed. A sociomaterial approach to IS is then developed in three parts in the fourth section: a general introduction into concepts of relevance to a sociomaterial ontology is provided; this is followed by a detailed discussion of seven aspects of relevance to IS; and then the sociomaterial conception is developed by highlighting the entanglement of all of these aspects. The fifth section then discusses the relevance of the sociomaterial approach to IS in the context of DSS. And finally, the theoretical as well as practical contributions made by this essay are discussed.

4.3 Background and Methodology

This section establishes the research problem with which this essay is engaging. It introduces the research objective and research questions addressed by this essay. It then develops the research approach and the ways of engaging with the concept of IS and, therefore, the means by which the research questions are addressed.

4.3.1 Research Problem

There is a need for IS to engage more closely with the concept of 'information system'. The reason for further engagement with this concept are threefold: firstly, there is a frequent conception of IS that sees them as a near synonym for IT:

> Whenever IS researchers and professionals have used the term 'information system,' one could substitute the term 'information technology,' 'computer system,' or simply, 'the computer' where the substitution would often make little or no difference. In retrospect, it is no exaggeration to describe most IS researchers as having used the term 'system' or 'systems' to refer to just about anything that involves electronic information technology (Lee, 2010, p. 339).

Such usage of the term is problematic as it blurs the distinction between IT, which is one defining notion of IS, and IS (see e.g. Hassan, 2011; Lee, 2004, 2010). It also undermines the importance of human, social and organizational aspects of interest to IS (Baskerville, 2010; Lee, 2004, 2010).

Secondly, defining IS has been identified as one of the main challenges for IS by Paul (2007):

> It could be a surprise that what an IS is is not established. On the other hand, since many people are studying IS from a variety of perspectives, maybe it should be no surprise that there are a variety of definitions. But then, how would Society know what IS is and what it can do if there is no clear understanding? (Paul, 2007, p. 194).

Defining IS is therefore also of interest to the IS community in order to establish common ground for understanding and researching IS that distinguishes IS as a field of inquiry. The expression of what an IS entails has therefore important consequences for understanding IS in a broader community, how different branches of IS relate to each other and what aspects are of concern to IS researchers.

The differences in the conceptualizations of IS also underlie the third reason. Namely, that there is an ongoing debate about the core and anti-core of IS. In a similar way to the research on IT in organizations (Orlikowski and Iacono, 2001), some conceptions emphasize the importance of technology in regards to IS. An example of this is provided by Benbasat and Zmud (2003) who argued that the IT artifact should be considered as the core of IS research. However, this 'IT core' view of IS was questioned within the IS community as sidelining the importance of the social aspects related to IT thus potentially leading to the development of IT without proper consideration of the social aspects that ultimately render an IT useful to an organization and to wider society (Alter, 2003a; De-Sanctis, 2003; Galliers, 2003; Lyythinen and King, 2004). What matters to organizations is the use of IT not IT in itself (Orlikowski, 2000). Similarly, Alter's (2003b; 2008) approach defining IS as work systems for processing information and Checkland's (2000) 'soft systems methodology' have both understood IT to be only one aspect of relevance within a much wider view of IS.

Given the breadth and diversity of the debate about IS, there is a clear reason to look more closely at different understandings of IS. A number of different approaches to conceptualize IS can be differentiated (Cecez-Kecmanovic, 2000, 2002, 2003). While some emphasize the process character of IS as transforming data into information (e.g. Alter, 2008), others emphasize the development and modelling of systems (e.g. Wand and Weber, 1990; 1995). Furthermore, yet others emphasize technology in regards to IS (e.g. Valacich and Schneider, 2012); however, this understanding is contrasted by those who see IS predominantly as social systems (e.g. Land, 1985). And finally, there are conceptualizations of IS that see them primarily as socio-technical systems (e.g. Lee, 2001).

Different definitions of IS thus emphasize different aspects in regards to IS. Importantly, some of these conceptualizations can clash with each other as they make different assumptions about the nature of IS and thus about what is of primary interest to IS. For instance, a technical view may be seen as concentrating on technical aspects which leaves little room for social concerns about IS, how they are accepted, rejected or appropriated. In contrast, a social view of IS may be characterized as failing to acknowledge how technological aspects play a role in IS acceptance, rejection and appropriation.

In addition to these clashes between different conceptualizations of IS, there is also a general notion underlying most conceptions of IS that sees them as representing an objective external reality (Boell and Cecez-Kecmanovic, 2011a, 2012; Kallinikos, 1995, 2012). The understanding of IS is therefore commonly grounded in a representational ontology that assumes the existence of an observer-independent reality that can be represented by IS. For instance: "[Data] is transformed into information, which can be defined as a representation of reality" (Valacich and Schneider, 2012, p. 22) or "[a]n information system is an artifactual *representation* of a real-world system" (Wand and Weber, 1990, p. 62, emphasis in original). This representational ontology is critiqued beyond IS (Barad, 2003, 2007; Rouse, 1996). It is contrasted by an alternative performative ontology that conceptualizes reality enactment as an ongoing process of becoming through performances (Feldman and Orlikowski, 2011). It thus "challenges the positioning of materiality as either a given or a mere effect of human agency" (Barad, 2003, p.827); instead, reality results from an ongoing becoming and any attempt at representing reality is already part of becoming reality and not independent of it.

In summary, contradicting definitions and usages as well as the lack of attention to foundational concepts in IS research are not helping the IS field's identity and legitimacy. These concerns re-emphasize the necessity for IS scholars to devote attention to and investigate the concept of IS as a fundamental concept. Therefore, there is a clear need to engage with the concept of IS. This necessitates a closer look at different understandings of IS as well as at what a representational understanding of IS entails. Thus, the objective of this essay is to advance the understanding of IS by critically reflecting on how IS are conceptualized, how these conceptualizations limit our understanding of the nature and role of IS, and to propose an integrative conceptualization that overcomes

these limitations. In order to achieve this objective, this essay seeks to answer the following research questions:

RQ 1: What is the nature of IS and how are IS conceptualized in the literature?

RQ 2: What are the contributions and limitations of the dominant IS conceptions?

RQ 3: What are the important aspects of IS that definitions of IS evoke?

RQ 4: How can these aspects be understood in an integrative and meaningful way?

4.3.2 Research Approach

To answer the research questions introduced above, a survey of the literature was undertaken. Based on the varying definitions of IS taken from the literature, the essay then engages in an analysis of these definitions:

- Definitions are analyzed with regard to how they define IS in order to identify groupings of the common approaches for defining IS (RQ 1).
- Groupings resulting from this process are then critically examined with regarding to contributions made by these different understandings of IS. (RQ 2)
- The analysis of definitions then looks at different aspects of IS that are evoked by these definitions and what they entail. (RQ 3)
- And finally, a sociomaterial understanding of IS is proposed that can integrate the identified aspects in a meaningful way. (RQ 4)

In order to identify the definitions of IS, a literature search was undertaken on the Web using *Google* and in *Scopus*, a large literature database covering articles published in 18,500 peer-reviewed journals (Scopus, 2012). Initial searches targeted the phrases 'an information system' or 'information systems are'. Literature found through these searches then enabled the search for further definitions using the hermeneutic approach to literature reviews introduced in appendix A (Boell and Cecez-Kecmanovic, 2010b). Furthermore, suggestions were sought from other IS researchers regarding additional literature containing definitions of IS. And finally, conceptualizations of IS were also taken from selected IS textbooks published in 2008 or more recently and appearing at least in their fourth edition to ensure their recency and acceptance for IS education. The reason for the inclusion of textbooks is that they play an important role in academic dis-

course as they form the initial conception about the IS field for novice researchers and future practitioners. Moreover, they are most likely to reflect some understanding that has been agreed upon in the wider IS community:

> A good way to find out the conventional wisdom in any field is to see what the introductory university-level student textbooks have to say on the subject. The task of such books it not to draw too much attention to the ambiguities and problems of the field – students will encounter those later – but to provide an account of the field in a straightforward way. Authors of such texts naturally give the account which embodies the more common conceptualisation of the field, the currently conventional view of it (Checkland and Holwell 1998, pp. 41-42).

Overall, 36 references were identified that explicitly defined the concept of IS. Moreover, definitions of IS were only selected if they met *all* of the following three criteria:

1. The definition appears in established scholarly publications. This includes peer reviewed journals, edited books, textbooks, and monographs;
2. The definition is an explicit statement about what an IS is rather than an indirect implied understanding; and
3. The definition is intended for the IS field.

These three criteria excluded, for instance, mathematical definitions of IS or definitions posted on institutional websites (e.g. UKAIS, 2012). For an additional listing of IS definitions which includes these types of definitions, see, for instance, Alter (2008).

A total of 36 definitions was selected (see appendix B). Approximately one half of these definitions came from academic research publications (journals and conferences) and one half from academic books (table 4.1). Most of the definitions appeared in academic journals (41.7%). Definitions found in books were split evenly between those appearing in research monographs as well as book chapters (25.0%) and academic-oriented educational literature (25.0%). The remainder of the definitions came from conference proceedings (8.3%).

Table 4.1 List of Sources of Definitions of Information Systems (Ordered by Source Type and Year)

Source	Source Type
Lee (2010, p. 340)	journal
Paul (2010, p. 379)	journal
Beynon-Davies (2010, p. 392)	journal
Alter (2008, p. 451)	journal
Paul (2007, p. 194)	journal
Lyytinen and Newman (2006, p. 4)	journal
Chae and Poole (2005, p. 20)	journal
Pant et al. (2001, p. 385)	journal
Lee (2001, p. iii)	journal
Wand and Weber (1995, p. 205)	journal
Davis et al. (1992, p. 297-298)	journal
Symons (1991, p. 181)	journal
Land (1985, p. 215)	journal
Land and Hierschheim (1983, p. 91)	journal
Mason and Mitroff (1973, p. 475)	journal
Lee (2004, p. 11)	chapter
Davis (2000, p. 67)	chapter
Goguen (1997, p. 28)	chapter
Land, F (1992, p. 6)	chapter
Land and Kennedy-McGregor (1987, p. 63)	chapter
Beynon-Davies (2009, p. 4)	conference
Stamper (1992, p. 32-33)	conference
Wand and Weber (1990, p. 61)	conference
Checkland and Holwell (1998, p. 110-111)	monograph
Falkenberg et al. (1996, p. 72-73)	monograph
Hirschheim et al. (1995, p. 13)	monograph
Taylor (1986, p. 15)	monograph
Valacich and Schneider (2012, p. 21)	textbook
Turban and Volonino (2010, p. 11-12)	textbook
Gardner and Grant (2010, p. 104)	textbook
Pearlson and Saunders (2010, p. 15-16)	textbook
Laudon and Laudon (2010, p. 46)	textbook
McNurlin et al. (2009, p. 2)	textbook
O'Brian and Marakas (2009, p. 631)	textbook
Bocij et al. (2008, p. 42, 678)	textbook
Moisiadis et al. (2008, p. 3)	textbook

The list of all definitions selected for the analysis is provided in table 4.1. The full quotation for each definition can be found in appendix B. Importantly, while the list seeks to reflect the diversity of available definitions of IS, it is not necessarily representative

regarding all available definitions of IS. In particular, it does not seek to correctly represent the statistical frequency of different IS conceptualizations introduced in the next section. Instead, the aim of the literature review was to reach a *saturation* point regarding the diversity of the range of available definitions rather than the relative frequency of their occurrence.

All 36 definitions were thoroughly analyzed with regard to each definition's main emphasis. Definitions generally put their emphasis on particular aspects regarding an IS. In particular, definitions emphasized: technological aspects, including the processing, storage and transformation of data; social aspects; socio-technical aspects; modelling aspects; and process aspects. While some definitions mentioned different aspects, for instance, the technological aspect and process aspect together, the classification of each definition was undertaken according to its most prevalent emphasis in regards to these five aspects. Generally, for a definition to be listed under the technology view, it needed to put its emphasis on the importance of technology in regards to IS. In contrast, definitions falling under the social view emphasized social aspects, while definitions classified under the socio-technical view emphasized the integrative importance of technological as well as social aspects. Furthermore, definitions allocated to the modelling view emphasized modelling and development aspects over other aspects. And finally, definitions listed under the process view emphasized activities and tasks performed and supported by IS. Each definition was then allocated to one of five different groupings of definitions. Of course, all definitions are embedded within a wider context and, depending on the context, definitions can alter their meaning (for instance, consider Wittgenstein's understanding of language as outlined in Chapter 3). However, to ensure a common ground for comparison, analysis of definitions was based on each definition as it was expressed on its own and as listed in appendix B where the view associated with each definition is also listed alongside the definition. The five views are discussed in detail in the next section.

In addition, to further scrutinize each definition of IS, definitions were also analyzed with regard to the aspects of IS that are evoked by them. This analysis was driven by the observation that definitions generally evoke more than one concept regarding IS as part of their definition. For instance, socio-technical views on IS generally evoke at least two concepts regarding IS: a technical aspect as well as a social aspect. Analyzing all defini-

tions in this regard resulted in the identification of seven different aspects of IS: practices, social actors, technology, data, information, development and organizations. While the importance placed on these different aspects varies between definitions, they provide a means for further analyzing what an IS entails. The seven aspects are discussed in detail further below and are then integrated into a sociomaterial understanding of IS in accordance with which these aspects continuously co-constitute each other.

4.4 Understandings of IS [redacted]

Five different groupings of conceptualizations of IS can be distinguished as a result of the analysis of all definitions:

(1) A technology view that emphasizes technological aspects thus indicating that IS are foremost technical systems;

(2) A social view that emphasizes that IS are intrinsically social systems;

(3) A socio-technical view arguing that IS include both social and technological components that are interrelated;

(4) A modelling view stressing the abstraction process by which real world entities are represented by an IS; and

(5) A process view that considers IS in terms of performing and supporting activities and processes.

These five views and, their contributions to understanding IS as well as their limitations are discussed below. For each view, firstly, the different definitions are summarized followed by a synopsis of its main rationale. The contributions made by each view to IS research are briefly introduced and the shortcomings of its underlying assumptions are discussed. Following the discussion of all five views, an alternative way of looking at definitions of IS in terms of the concepts evoked by them is introduced.

4.4.1 Technology View

The definitions of IS which take a technology view emphasize that IS make use of hardware and software, and more generally, IT:

> The system utilises computer hardware and software; manual procedures; models for analysis, planning, control and decision making; and a database. The emphasis is on information technology (IT) embedded in organizations (Symons, 1991, p. 181).

In particular, the definitions falling under the technology view stress the importance of IT in an organizational context (McNurlin et al., 2009; Symons, 1991; Valacich and Schneider, 2012) or the software used for the processing, storage and distribution of data and information (Laudon and Laudon, 2010; Moisiadis et al., 2008; O'Brian and Marakas, 2009; Pant et al., 2001). Definitions associated with this view do not generally deny the importance of other aspects regarding IS. For instance, definitions stressing the role of IT in organizations acknowledge the importance of organizations for IS. However, definitions associated with this view generally emphasize the importance of technology, especially IT, in the form of hardware, networks and software over other aspects. In this sense, organizations are seen as a context for IT (e.g. Symons, 1991).

The technology view of IS is generally driven by the observation that IT is important for organizations and that its importance has risen dramatically over the past few decades (Huber, 1990) being now ubiquitously present in virtually every aspect of organizational life (Dewett and Jones, 2001; Orlikowski and Scott, 2008). At the same time as the importance of IT is rising, so too is the range of IT used by organizations and the sophistication of that technology. For instance, enterprise resource planning (ERP) systems are complex software providing integrated support to business processes and decision making across an organization that are described as a necessity for conducting business in a modern-day economy (Kumar and van Hillegersberg, 2000). Furthermore, objects such as stock items or medical equipment are nowadays commonly equipped with radio-frequency identification technology (RFID). RFID is not only an example of the increasingly ubiquitous presence of technology, but also of the level of sophistication of IT that is used by organizations to keep track of their stock and, thus, of their efforts to control and optimize their asset management and the flow of goods and products.

Thus, the technology view points to an important aspect of IS, that is, the increasing importance for organizations to make efficient, effective and innovative use of IT. This particular need in organizational life is one that is addressed by IS research and practice as it occupies a gap between, on the one hand, computer science and, on the other hand, the business/organization. The technology view is therefore of obvious importance to IS

practice and thus makes an important contribution to IS education and training. This aspect is made evident by the particular presence of such definitions in IS textbooks. Moreover, the technology view has made important contributions to IS research by emphasizing the importance of technology and thus it urges IS researchers to focus on technology and its role for organizations. For instance, focusing on technology has led to research that identified the phases of IT adoption in organizations (e.g. Lyytinen, 1991); to research on the relationship between IT investments undertaken by organizations and organizational performance (e.g. Bulchand-Gidumal and Melián-González, 2011; Leidner et al., 2011; Sambamurthy et al., 2003); and to the succession process for different generations of IT (e.g. Baxter and Berente, 2011). Most importantly, the preoccupation of IS with technology has led to a widening in the conceptualization of technology (e.g. Markus and Robey, 1988; Orlikowski, 1992, 2010; Orlikowski and Gash, 1994; Riemer and Johnston, 2011) and to a vigorous debate on the importance of IT for the field of IS (e.g. Benbasat and Zmud, 2003; DeSanctis, 2003; Galliers, 2003; Myers, 2003).

Another important consideration in relation to the technology view is that the research which it informs locates agency in technology and, thus, leans towards an understanding that sees technology as a causal variable that, once implemented in an organization, leads to a specific outcome. This research philosophy is labelled 'technological determinism' (Jones and Orlikowski, 2009; Leonardi and Barley, 2010). However, it is well documented that the implementation of a particular IT has unplanned and often unpredictable outcomes implying that the same technology often leads to different outcomes in different contexts (Jones and Orlikowski, 2009; Leonardi and Barley, 2010). Consequently, technological determinism has proven to be problematic and technology is no longer seen as a sole independent variable but instead as a moderator (Orlikowski and Scott, 2008). For instance, IT investments do not lead directly to increased value or competitive advantage (Earl, 1992; Galliers, 2007) but, instead, the strategy by which IT is implemented and used is considered to be an important aspect (Leidner et al., 2011). Nevertheless, if technology is understood to be an independent or a moderating variable, the technology view is frequently grounded in

> an ontological commitment of a world of discrete entities that have some inherent and relative stable characteristics. [... things] are seen to be largely independent, but linked

> through uni-directional causal relationships, and having largely determinate effects on each other (Orlikowski and Scott (2008, p. 439).

However, alternative ontological positions are proposed that question the technology view of IS.

4.4.2 Social View

The definitions which take a social view emphasize the importance of the social nature of IS. Frequently, they also recognize the importance of technology (Land, 1985, 1992; Land and Hirschheim, 1983) but they generally consider technology to be subordinate to social aspects:

> an information system is a social system, which has embedded in it information technology. The extent to which information technology plays a part is increasing rapidly. But this does not prevent the overall system from being a social system, and it is not possible to design a robust, effective information system, incorporating significant amounts of the technology without treating it as a social system (Land, 1985, p. 215).

In contrast to the technology view which locates agency in technology, the social view puts agency on humans. Therefore, of key importance are the social institutions and organizations that enable and constrain human agency (Chae and Poole, 2005; Lyytinen and Newman, 2006) and the ways in which human actors create, share and interpret meanings by means of IS (Hirschheim et al., 1995). This is achieved by communicating and storing signs that are of potential value to social actors and their actions (Beynon-Davies, 2009b, 2010; Taylor, 1986).

The main rationale for the social view is that humans are the most important constituents of organizations. It is human activity that enables organizations to achieve their goals and, more importantly, goals themselves are set by humans when they form strategies for future development and make decisions regarding the allocation of resources towards these goals. While these processes may be supported by technology, what is of importance are the sociocultural meanings, social structures and organizational processes in which IT is embedded in order to achieve these goals. Indeed, general systems theory (von Bertalanffy, 1950, 1971) can be applied to understanding organizations or units within organizations without the need to refer to technology. Consequently, systems are the means of organizing which are created and maintained by social actors.

Thus Churchman (1968) described information systems as the organization of social actors drawing from resources that are available to them in order to achieve their goals.

The social view of IS highlights the importance of social context, social actors, social actions and social structure as part of an organization. It therefore motivates IS research to look in two directions. Firstly, it inspires IS research to look more closely at the social processes taking place in organizations which affect the development, implementation and use of IS. IS research that puts the agency on social actors, for instance, focuses on how social actors shape the adoption and use of technology in organizations (Leonardi and Barley, 2010). This understanding thus can answer the question that is puzzling the technology view: why is it that the same IT can unfold its potential in one social setting and not in another?

Secondly, as it emphasizes the importance of social actors, the social view encourages a closer look at the role of actors as both individuals and collectively. Thus, the social view of IS encourages research that contributes to the understanding of, for instance, the role of power and IT (e.g. Jasperson et al., 2002); the adoption of technology (e.g. Benbasat and Barki, 2007; Davis, 1989; Schwarz and Chin, 2007); or human computer interaction and usability (e.g. Phang et al., 2009; Zhang and Li, 2005).

The social view of IS thus encourages research that makes important contributions to understanding the roles of social actors and social forces in the ways that organizations implement, adopt and utilize IS and the effects of IS. However, this focus is associated with two limitations. Firstly, by putting the agency on human/social actors, research privileges the subjective interpretation of technology and assumes that human/social actors are the sole determinants of the use and impact of technology in organizations. This position is described as 'voluntarism' by Leonardi and Barley (2008) or 'social determinism' by Jones and Orlikowski (2009). In this sense, the social view of IS leans towards a similar ontological position of separate entities linked to each other by causality as in the position that was introduced above in the context of the technology view. The social view thus sees

> organizational change as driven by social forces upon which the technology has little, or no, influence. In this research, the properties and performance of the technology are assumed to be largely dependent on other organizational influences, for example,

> strategic choices, distributions of power, information processes, and local contexts of use (Jones and Orlikowski, 2009, p. 295).

Of course, this overlooks the point that different technologies provide specific abilities to an organization that can lead to a change in the way that work is undertaken or how organizational units are organized (Leonardi, 2011). The social view of IS generally underplays the role and importance of technology in IS adoption and use. And secondly, the social view tends to focus either on individuals at the micro level, often taking a behavioral approach for researching individual traits and perception; or it looks at social actors at a macro level, employing general categories and concepts. Research therefore either tends towards taking an individual focus or a totality focus (Schatzki, 1997) and, as a result, can overlook the role of social actors within a network of other social actors which is taking place at the meso level.

4.4.3 Socio-Technical View

The definitions which fall under the socio-technical view describe IS in terms of both social as well as technical aspects (Checkland and Holwell, 1998; Lee, 2001). IS thus consist of technological as well as social components:

> 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 (Lee, 2001, p. iii).

IS are neither technically determined nor socially determined, but technology and social aspects interact with each other in a sense that makes the resulting IS more than the sum of its parts. To borrow the molecular analogy from Davis et al. (1992), an IS is more like a compound than a mixture. This requires IS researchers to simultaneously look at the social and technical aspects and at the phenomena that emerge when they interact (Davis et al., 1992; Lee, 2001, 2004, 2010). According to the socio-technical view, IS include formal as well as informal aspects (Stamper, 1992; Paul, 2007) and may consider technology beyond IT including, for instance, paper-based systems (Goguen, 1997). The socio-technical view thus argues that agency can be seen as residing neither in technology nor in social actors but as emerging in their interaction.

The rationale for adopting a socio-technical view is twofold, pointing to the shortcomings of both the technology view as well as the social view. One of the original reasons

for the socio-technical view is thus the observation that IT tends to fail if social aspects are not adequately considered during the development process (Bostrom and Heinen, 1977). Similarly, social or cognitive aspects alone cannot determine the adoption and use of technology. Technology has an effect on the nature of work, how it is organized and carried out (Zuboff, 1988). Thus, the adoption and use of technology cannot be understood purely in social (constructivist) terms. As a result, social and technological aspects need to be researched in concert (Zammuto et al., 2007).

The socio-technical view has been very influential in IS and has made many important contributions to IS research (Mumford, 2006). For instance, a socio-technical understanding is the foundation for soft systems methodology that considers social actors and their use of technology in parallel (Checkland, 1981; 2000). In particular, socio-technical definitions of IS raise awareness that unidirectional relationships between technology and social actors and vice versa are insufficient for understanding the role of technology in organizations. Instead, they indicate that technology and social actors interact in multiple ways and that this interaction can be alternatively described by referring to structure or network as an analogy. The socio-technical view thus opens a space for the adoption of ideas from science and technology studies (Bijker, 1995; Bijker and Law, 1992; Callon, 1986), structuration theory (Giddens, 1984) and actor network theory (Latour, 1987; 2005) into IS research. For instance, concepts such as imbrication (e.g. Ciborra, 2006; Leonardi, 2011) or structuration theory offer ways for understanding the interaction of social and technological aspects in IS (e.g. Desanctis and Poole, 1994; Jones and Karsten, 2008; Orlikowski, 1992).

While the socio-technical view of IS opens a space for understanding the social and the technical in concert, it still assumes a social/technical split. Moreover, by focusing on and engaging with both the social and technological elements, the socio-technical view assumes an ontological separation between them:

> [W]hat remains unquestioned in this logic is the assumption that technology and humans (or organizations) are separate in the first place (Orlikowski and Scott, 2008, p. 455).

A socio-technical view of IS thus can overlook the importance of ongoing practice that questions this ontological separateness (Feldman and Orlikowski, 2011).

4.4.4 Modelling View

The modelling view defines IS in terms of their representation of a real world. An IS is a system that represents some part of a real world:

> An information system is an artifactual *representation* of a real-world system as perceived by someone, built to perform information processing functions (Wand and Weber, 1990, p. 62, my emphasis).

Technological aspects or social aspects are considered to be of limited importance to an IS (Wand and Weber, 1990). Thus, IS can be studied independently of their use or organizational and social context (Wand and Weber, 1995).

The rationale for the modelling view is that IS fulfil a purpose in organizations and that the purpose can only be achieved if systems are developed according to strict rules for determining their content. The key concern is the selection of relevant objects or entities to be represented in IS and the identification of properties and relationships that represent these objects/entities. The aim is to represent organizational processes accurately and completely so as to ensure the correct operation of the system. Therefore, of particular interest in this context is the modelling process that intends to identify relevant objects/entities and capture and represent their properties and relationships. While modelling can include social, technical and socio-technical elements (e.g. Lyytinen and Newman, 2006), the emphasis of the modelling view is on the process of representation. Models need to be developed in a way that minimizes the errors associated with this representation process which result from unclear relationships between entities existing in an organization and entities represented by a model. For instance, 'construct overload' occurs if a construct in a model refers to multiple entities existing in an organization (Milton, 2007).

The modelling view of IS highlights the development process as an important aspect of IS. While some modelling approaches such as entity relationship diagrams are particularly popular, alternatives such as Stamper's (1992) ontological modelling and numerous others exist (cf. Hirschheim et al., 1995; Milton, 2007). The modelling view contributes to IS by highlighting the complexity of modelling situations and, thus, how modelling situations can be assessed in order to better judge how many constructs are needed to represent situations without ambiguity and construct overload (Lyytinen, 2006). Furthermore, the modelling view highlights the necessity of assessing and comparing dif-

ferent modelling approaches (Burton-Jones et al., 2009; Recker et al., 2009). The ways of doing this are either to judge a model by how well it represents the underlying reality that it seeks to represent (Wand and Weber, 1990, 1995), or by comparing how well different modelling approaches can be applied during the development process (Dunn et al., 2011). More generally, the modelling view encourages IS scholars to engage with ontological assumptions underpinning the representation process and its implications for modelling outcomes (Johnstone et al., 2005; Wyssusek, 2006). And finally, the modelling view makes a significant contribution to the IS discipline by drawing attention to the importance of IS development and thus the relevance of design science for IS (Baskerville et al., 2011; Österle et al., 2011; Jungtal et al., 2011).

However, the focus of the modelling view on the design of artifacts is criticized as leading to an overly narrow view of design science (MacKay et al., 2012). Furthermore, an often-mentioned assumption of the modelling view is that it is possible to model an ontologically separate reality in an objective way. While this assumption is less problematic in the context of data recorded by machines (such as those that record the stock level in a warehouse), its limitation becomes apparent in contexts where the identification of objects or entities and their properties and relationships is not straightforward and reflects perceptions or judgments. For instance, the perception of risk determines how risk is 'represented' in risk management IS. Here, the assumption that a model can represent 'risk' in an objective way and that this representation can be objectively judged becomes problematic (Drummond, 2011). In addition, representational modelling approaches that claim objectivity, rigor and completeness disregard the interests and subjectivity behind any selection and design process (e.g. which objects, properties and relationships to include and which to exclude). The resulting model of a real world built in an IS is thus not an objective map that mirrors this world but a particular view of the world embedded in the IS. Moreover,

> representation always proceeds by (re)constructing the world from particular standpoints. Such a selective objectification is rendered possible through sets of initial assumptions that define and single out particular facets of the world, establishing distinct domains of investigation (Kallinikos, 1995:121).

This, however, generally questions the assumptions behind the modelling view that IS represent reality from a neutral point of view.

4.4.5 Process View

The definitions of IS which fall under the process view emphasize that IS are related to the activities they perform and support:

> An IS is a work system whose process and activities are devoted to processing information, that is, capturing, transmitting, storing, retrieving, manipulating, and displaying information (Alter, 2008, p. 451).

Activities supported by IS are described as the processing of data into information (Bocij et al., 2008; Turban and Volonino, 2010) or disseminating and delivering information (Davis, 2000; O'Brian and Marakas, 2009). This relates IS to action and use (Falkenberg et al., 1996; Paul, 2010; Pearlson and Saunders, 2010). IS are thus frequently understood as related to work activities (Gardner and Grant, 2010), serving organizational objectives (Land and Kennedy-McGregor, 1987) or problem solving (Mason and Mitroff, 1973).

The relevance of the process view stems from the fact that IS are not IS by themselves but that an IS always exists in regards to a purpose. In contrast to the social view, the technological view and the socio-technical view, the process view emphasizes the activity dimension associated with IS rather than technology, social actors or their mutual interaction. Central to understanding IS according to the process view are the activities that are supported by an IS. This is highlighted by definitions referring to aspects such as: use, storing, creating, exchanging, communicating, collecting, disseminating, transmitting, manipulating, providing, retrieving, etc. which are all associated with activities that are supported, facilitated or enabled by an IS. While some definitions indicate that technology or social actors are important aspects, the process view assumes that social actors and technology are secondary to the activities that they support.

As the process view emphasizes the activity aspect of IS, it leads IS researchers to look at how activities undertaken by social actors can be supported by technology. This encourages IS research to look at work activities and the use of technology in regards to these activities, such as how work processes can be supported, enabled or automated through the use of technology. For instance, technology is used to trigger orders at particular stock levels in a warehouse and to reorder optimal quantities so as to minimize costs (or stock-outs). In such a way, inventory management is optimized though automated decisions. Thus, the process view makes an important contribution to IS research,

for instance, by shifting attention to information flows and work flows and how they can be automated and optimized (e.g. Day et al., 2009; Soffer and Wand, 2007). This is a domain of IS that is of obvious importance to research such as supply chain management (e.g. Fang et al., 2008). Further examples of research encouraged by the process view are: research on human information behavior and how the process of fulfilling information needs can be facilitated through the use of technology (e.g. Johnstone and Tate, 2004); or how processes such as collaboration can be facilitated through technology (e.g. Chatterjee et al., 2009; Feldman and Horan, 2011).

One shortcoming of the process view is that it tends to assume a limited understanding of human activity. Human activity is seen in a way in which action (individual task) or a succession of actions (processes) is executed by humans and machines. This understanding, however, lacks an appreciation of the wider contexts in which the activities and processes are performed and of the continuous changes of these contexts, for instance, when legal or technological conditions change. Moreover, it lacks an appreciation of the sociocultural background relevant to these activities and processes (Bourdieu, 1976; Feldman and Orlikowski, 2011; Taylor, 2006): it does not recognize the relevance of material aspects to practice (Orlikowski, 2007; Schönian, 2011).

4.5 An Integrative View of Aspects: IS as Sociomaterial Apparatus

This section introduces a conceptualization in three parts of IS as sociomaterial apparatuses. In the first part, it briefly introduces concepts central to the notion of sociomateriality. These are the ideas of apparatus, intra-action, enactment, relationality, entanglement and intertwining. This is followed by the second part which looks more closely at the seven aspects identified above as being frequently evoked by definitions of IS. These aspects are discussed in more detail showing that each aspect does not exist on its own but is always relational, resulting from intra-action with other aspects. Based on this, the third part develops a sociomaterial approach to IS. According to this approach, aspects of IS are not only interconnected but they are ontologically non-separable and thus cannot be properly understood in isolation.

4.5.1 Apparatus, Intra-action, Enactment, Relationality, Entanglement and Intertwining

An alternative way of understanding IS is based on Barad's notion of apparatus (Barad, 2003, 2007). In her work, Barad introduced the idea of *agential realism* which rejects both naïve realism as well as anti-realist stances (Musgrave, 1985; Van Fraassen, 1980). Notably, her position also differs from alternative approaches offered by critical realism (Mingers, 2004) or structural realism (Worrall, 1989). Succinctly stated, Barad showed that any perception, observation, measure, etc. of the world is based on interaction or, to be exact, intra-action (as discussed below).

Every perception, observation, measurement, etc. is always mediated by devices that allow us to undertake these intra-actions with the world. Drawing from examples in biology and quantum physics, Barad (2007) showed that the devices used and the circumstances in which they are used affect the outcome of intra-actions. In addition, perceptions, observations and measurements become meaningless if they are divorced from the devices and circumstances that are used to create them.[7] As a result, what one can believe to exist (ontology) and the way in which one can obtain knowledge about things that exist (epistemology) are collapsed in Barad's framework into an onto-epistemological understanding.[8]

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7 To exemplify this, Barad (2003, 2007) drew from the position vs momentum "paradox" of a particle. According to Heisenberg's *uncertainty principle*, it is impossible to measure the exact position and momentum of a particle at the same time as measurement of one will affect the other. Of course, this understanding is grounded in an ontological position that regards reality as consisting of objectively-existing entities that have well-defined properties. Barad contrasted this view with the *undecidability principle* introduced by Nils Bohr who was awarded the Nobel Prize for his revolutionary model of the atom. According to the undecidability principle, it makes no sense to ascribe to a particle a momentum or a position without considering the device that is used to bring about this measure. After all, both measures are based *on conceptions about reality* and not *on reality itself*. As momentum and position require mutually-exclusive experimental settings, there is no paradox. The mistake is to ascribe the concept of momentum or position to the particle itself rather than seeing it as something that is brought about through the intra-action of a 'particle' and a device. Barad then introduced several further examples to show that empirical evidence in quantum physics is tilting the scales in favor of the undecidability principle rather than the generally more well-known uncertainty principle.

8 Actually, Barad introduced an 'ethico-onto-epistem-ology', as she further argued that there is also no objective position for making ethical decisions independently from what we believe exists and how we can find out about it, and thus our ability to manipulate it. However, for simplicity, I only refer to

From Barad's onto-epistemological framework, it follows that any description of reality is mediated and cannot be disconnected from the device used to arrive at a description. Barad called this the 'unity of devices' and the whole background in which they make sense, 'apparatuses'. In Barad's words, apparatuses are phenomena and

> not mere instruments serving as a system of lenses that magnify and focus our attention on the objective world, rather they are laborers that help constitute and are an integral part of the phenomena being investigated [represented]. Furthermore, apparatuses do not simply detect differences that are already in place; rather they contribute to the production and reconfiguration of differences (Barad, 2007, p. 232).

From this, a number of insights follow that are of relevance in developing a sociomaterial understanding of IS. Firstly, apparatuses are phenomena that allow us to draw meaningful differences rather than devices that merely detect differences that are already in place. Apparatuses thus not only include the means by which they draw distinctions, but also the background from which these differences become meaningful and relevant. Secondly, apparatuses neither reflect an underlying objective reality nor do they enable humans to create reality in a social constructivist sense. Apparatuses draw meaningful differences but these differences are neither arbitrary constructions of reality as social constructivists would have it nor do apparatuses provide access to an underlying objective reality as objectivists would have it. Rather, apparatuses are phenomena that, by presenting reality in a particular way (recording differences), at the same time 'enact' that reality (produce and reconfigure differences).

This can be illustrated by comparing the view of an IS as an instrument and as an apparatus. When an IS is seen as a technology artifact that represents reality, it reflects an instrument view: a technology artifact maps (records) events, properties of entities and their relationships with the real world and stores them as data (in databases). These data are processed to produce reports (output) as a representation of reality, which then serve as a basis for operations, work practices and decision-making. This view of an IS as an instrument conceals the point that any recording or mapping of reality in databases is performed from a particular position (implying interests, values, world views). However, by drawing from the "reality" represented in the technological artifact, users conduct their behavior and take actions to change reality. In other words, through their in-

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an onto-epistemological framework here.

terpretation of the technology output and their use of this output in practice, they 'enact' a particular reality. Thus, an IS cannot be seen as an instrument (in Barad's sense). Rather, an IS is an apparatus that involves not only technology and data (records) but also users who are involved in the production and interpretation of data and their actions in a particular organizing context and designers and coders who develop the system by embedding in assumptions, preferences and constraints. Being an apparatus, an IS contributes to the enactment (production and reconfiguration) of reality.

This concept of 'enactment' is important for understanding a sociomaterial approach to IS. Moreover, the underlying idea is developed and described by different authors using different terminology, such as 'entanglement' (Barad, 2007; Pickering, 1995), 'relationality' (Feldman and Orlikowski, 2011) or 'intra-action' (Barad, 2003, 2007). For instance, rather than using the term 'enacting', Barad introduced the term 'intra-action' to emphasize the co-constitution of the devices of observation and the observed:

> "intra-action" signifies the mutual constitution of entangled agencies. That is, in contrast to the usual "interaction," which assumes that there are separate individual agencies that precede their interaction, the notion of intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action. It is important to note that the "distinct" agencies are only distinct in a relational, not an absolute, sense, that is, *agencies are only distinct in relation to their mutual entanglement; they don't exist as individual elements* (Barad, 2007, p. 33, emphasis in original).

Likewise, the concept of relationality refers to a co-constitution of things:

> no phenomenon can be taken to be independent of other phenomena. Phenomena always exist in relation to each other, produced through a process of mutual constitution. The specific interactions of phenomena entailed by relationality vary among scholars (Feldman and Orlikowski, 2011, p. 1242).

As hinted by Feldman and Orlikowski, what is of concern are not the differences in terminology or connotations made by different scholars, but the commonality underlying them all: *that reality cannot be understood as consisting of singular entities, which have properties that can be established in an observation independent and objective way.*

Looking at the different views of IS as discussed above, however, implies such a separation of objects that are studied as IS and subjects that are interacting with them. How the views then differ is in what they regard as an object with a predetermined existence and

as subjects interacting with these objects. For instance, from a technology view, IT artifacts are regarded as existing irrespective of social actors and their interaction with them; from a social view, social actors exist irrespective of their interaction with technology; or, from a process view, routines and processes exist irrespective of the technology or social actors. However, in following Barad's (2007) views, IS can be seen as apparatuses that emerge as part of an ongoing intra-action of their components. The difference between objects and subjects that underlies the different views of IS is thus called into question. Technology, social actors or processes do not exist in themselves, but emerge through their ongoing intra-action with each other.

As a result, aspects of IS cannot be understood in isolation in a meaningful way as all of these aspects are 'intertwined' (Pickering, 1995), an idea that is further captured by the term 'entanglement' which refers to the inability to separate things without changing them.

4.5.2 Aspects of IS

The analysis of all identified definitions of IS above revealed five different views for defining IS. A closer look at each of these five views reveals that all views make important contributions to understanding aspects of interest to the IS field. These views variously provide deeper insight into the role of technology, social actors, their interaction, the development process, and the activities supported and enabled by IT. Thus, the question arises of how these views are related to each other. The answer to such a question can be provided by looking closer at aspects of IS evoked by individual definitions, such as the mentioning of social actors or technological artifacts as part of a definition. Looking at these caspects enables then to understand how different conceptualizations of IS are interconnected.

Such an understanding can be developed by looking at the definitions of IS from an additional angle. While each definition is related to one of the five different views (discussed above), definitions often refer to additional aspects that are of relevance to IS. For instance, the definition by Land and Hirschheim (1983) is classified under the social view as it defines IS as social systems:

> Information systems are *not* technical systems which have behavioural and social consequences, rather they are *social systems* which rely to an increasing extent on informa-

> tion technology for their function. Nevertheless, the technology is never more than a component of the information system (Land and Hirschheim, 1983, p. 91, emphasis in original).

Evidently, the authors regarded social actors as a central aspect of IS. However, a closer reading of their definition reveals that the authors regarded technology as an additional important aspect of IS. Hence, their definition points towards two aspects that are of relevance regarding IS: social actors and technology. A similar analysis conducted for all the definitions revealed seven aspects to which authors frequently refer in their definitions (table 4.2). Apart from social actors and technology, these aspects are organizing context, development, data, information and practice. An integrative understanding of an IS can thus be developed by means of these aspects as they provide links which criss-cross between the definitions associated with the five different views discussed above. This section introduces seven aspects associated with IS across different definitions of IS: practices, social actors, technology, data, information, development and organizing contexts. It shows that each aspect is in relationships with all other aspects, thus suggesting that they are continually entangled, a view which will be further developed in the following section.

Table 4.2 Aspects of IS Covered by Definitions

	Aspect identified						
Source	**Practice**	**Social Actors**	**Techno-logy**	**Data**	**Infor-mation**	**Devel-opment**	**Organizing Contexts**
Valacich and Schneider (2012, p. 21)		X	X	X		X	X
Lee (2010, p. 340)		X	X	X			X
Turban and Volonino (2010, p. 11-12)	X		X		X		
Gardner and Grant (2010, p. 104)	X						
Pearlson and Saunders (2010, p. 15-16)	X	X	X		X		
Paul (2010, p. 379)	X	X	X				
Laudon and Laudon (2010, p. 46)	X		X		X		X
Beynon-Davies (2010, p. 392)		X		X[1]	X[1]		
Beynon-Davies (2009, p. 4)		X		X[1]	X[1]		
McNurlin et al. (2009, p. 2)	X	X	X	X			X
O'Brian and Marakas (2009, p. 631)	X	X	X	X	X		X
Bocij et al. (2008, p. 42, 678)	X		X	X	X		X
Moisiadis et al. (2008, p. 3)	X		X	X	X		X
Alter (2008, p. 451)	X	X	X		X		
Paul (2007, p. 194)	X	X	X				
Lyytinen and Newman (2006, p. 4)		X	X	X[1]	X[1]	X	X
Chae and Poole (2005, p. 20)		X				X	X
Lee (2004, p. 11)		X	X				X
Pant et al. (2001, p. 385)			X				X
Lee (2001, p. iii)		X	X				
Davis (2000, p. 67)	X		X	X	X		
Checkland and Holwell (1998, p. 110-111)	X	X	X				
Goguen (1997, p. 28)		X	X		X[2]		X
Falkenberg et al. (1996, p. 72-73)	X	X		X	X		X
Wand and Weber (1995, p. 205)						X	
Hirschheim et al. (1995, p. 13)		X	X		X[2]		
Davis et al. (1992, p. 297-298)		X	X				
Stamper (1992, p. 32-33)		X	X				X
Land, F (1992, p. 6)		X	X				
Symons (1991, p. 181)	X	X	X		X		
Wand and Weber (1990, p. 61)						X	
Land and Kennedy-McGregor (1987, p. 63)	X		X	X			
Taylor (1986, p. 15)		X		X[1]	X[1]		
Land (1985, p. 215)		X	X			X	
Land and Hierschheim (1983, p. 91)		X	X				
Mason and Mitroff (1973, p. 475)	X	X		X[1]	X[1]		X

Notes: X[1]: The actual formulations used are: 'representations', 'semiotic elements' and 'signs'. Thus, the authors use connotations that can either be understood as referring to the aspects of data or to the aspect of information in an indirect way. X[2]: The authors indirectly refer to information by stating that an IS contains 'meanings'. However, meaning is frequently associated with information rather than data, e.g. "Information is the meaning produced from data" (Kettinger and Li, 2010, p. 415) or "information is meaning" (McKinney and Yoos, 2010, p. 330) or Floridi (2004b, 2005, 2009b).

4.5.2.1 Practices

An important aspect of IS is that they are related to human activity as, for instance, conveyed by claims that IS support or enable actions and organizing processes. This relates IS not only to a purpose, but also to the understanding of human actors of what is relevant to them in regards to this purpose. Thus, activity cannot be fully understood independently of the context in which it appears which is variously described as 'background' (Heidegger, 2002), 'habitus', (Bourdieu, 1976), 'forms of life' (Wittgenstein, 1953) or governing structure (Giddens, 1984). Practice theory (Feldman and Orlikowski, 2011) offers an understanding of human activity that can cover both the purpose and the context in regards to which a purpose exists. For instance, Schatzki (2006) argued that practices include four dimensions. Besides know-how and rules for acting, practices also include a general understanding of what it means to engage professionally in an organizational context, and a teleoaffective dimension encompassing affective aspects such as moods and emotions (Schatzki, 1997, 2006). Practice theory thus offers a way of understanding human activity and it underlines that practices are associated with other aspects of relevance to IS: practices are related to *social actors* who have a professional background and an affective dimension which will impact on their understanding and engagement with a practice (Schatzki, 1997, 2006; Orlikowski, 2002). Additionally, *technology* can shape how activities are undertaken, for instance, by making information available that is considered to be relevant for a particular practice (Schönian, 2011). As a result, practices can then be re-shaped in a way that allows those engaged in a practice to make better use of that *information* (Leonardi, 2007). *Development* can also lead to the creation of tools that allow organizations to make activities more efficient and effective and, as a consequence, lead to a change in the way in which practices are performed. Moreover, development can lead to automation of some tasks which creates, as a by-product, *data* about processes (Zuboff, 1988). These data, interpreted by social actors, can in turn facilitate a change in the way in which processes are organized. And finally, *organizing contexts* can shape how employees enact practices. How departments and units are structured and how power is exercised in an organization will affect how members engage in their practices.

4.5.2.2 Social Actors

It is not only definitions falling under the social and the socio-technical views that indicate that social actors are an important aspect of IS. In the context of IS, the understanding of social actors goes beyond an individual focus or a totality focus (discussed above) as social actors need to be understood as individuals and groups acting within a social context. Individuals in turn have a history that is evident in their expertise, personality, memory of past events, status and their position within an organization. Thus, social actors differ in the way in which they perceive themselves and in their ability to act. As a consequence, social actors are related to all other aspects of relevance to IS. *Technology* provides outputs (reports) and tools that shape the ability of social actors to be informed and to gain understanding of the organizing context of their interest and thus enables them to act which may encourage them to develop new skill sets associated with a particular technology. Importantly, technology as a tool not only requires social actors to learn how to use tools but also how to engage with tools to solve particular problems (Kent and Hoberman, 2012; Suchman, 1987). Also, social actors differ in what (kinds of) *data* are available to them (Rice et al., 2001) and how they interpret and derive meaning from reports (sets of structured data for a particular purpose) generated by a system. Additionally, the availability of *information* can lead to changes in self-perception, such as providing managers with a false sense of control (Drummond, 2011). Likewise, the *development* process models users in a particular way that can constrain or enable their abilities, for instance, through the removal of border resources from which users regularly draw but which were not captured as part of the development (Brown and Duguid, 1994). This, in turn, will have an effect on the self-perception of social actors such as being empowered or as being restricted in performing certain tasks. Similarly, the role that a social actor has in an *organizing context* will affect the execution of their work and their self-perception. For instance, social actors differ in their ability to access and redistribute resources and they are bound by organizational structure and rules. And finally, social actors engage in *practices* in accordance with certain rules, know-how, moods or professional understanding that enable or restrict their engagement with technology and data and their ability to be informed: this, in turn, will affect their perception of themselves and their ability to perform their work.

4.5.2.3 Technology

Technology is an important aspect of IS as is indicated in the majority of all definitions of IS (appendix B). In the context of IS, technology is generally understood to mean IT or an IT artifact; the more generic term, 'technology', is used here to emphasize that it not only includes devices such as hardware or network infrastructure, but also ways of doing things such as specific processes which may be encapsulated in software. Either way, if technology is looked at as techniques or technical devices, one commonality is that technology provides some capability to do things with regards to a specific purpose. From this, two things follow that are of relevance to technology in the context of IS. Firstly, technology is associated with some affordances that allow it to do certain things, such as a chair affords sitting (Norman, 2002); and secondly, that technology can be attributed to a purpose, such as being able to cope with the human body's tendency to tiredness. This puts technology in relation to all other aspects of relevance to IS: *[s]ocial actors* make use of technology in regards to a purpose. This can be a creative process where new functionality is attributed by social actors to existing technology (Leonardi, 2007). As part of its use, technology can generate *data* that can be used to reveal new ways to further elaborate the technology such as streamlining or automating (Zuboff, 1988). What is considered to be relevant *information* in a particular context or in regards to a particular practice can create the requirement for new or amended technology (Leonardi, 2011). Tools and technologies that are used during *development* can facilitate the creation of new and more complex technology. Whether applications are built in-house or bought as packaged software, *organizations* are in a constant process of adapting their software in the form of maintenance or updates to new software versions (Truex et al., 1999; Baxter and Berente, 2010). And finally, technology is related to *practices* as "technologies do not stand alone with certain inherent properties, but that their material characteristics and capabilities are relevant only in relation to specific situated practices" (Feldman and Orlikowski, 2011, p. 1249). For instance, the purpose for which technology is used can give rise to the need to develop new technology (Leonardi, 2011).

4.5.2.4 Data

An important aspect of IS is data that are stored in a storage medium according to specific rules governing its storage. In IT, one datum generally consists of a field and a value is associated with that field. As a result, data are not something that are pre-given when technology is used but something that are collected in accordance to rules that form an integrative part of understanding what is recorded or captured by that data (Kent and Hoberman, 2012). Thus, data are inseparable from the background that is used for collecting those data: "[a] white sheet of paper is not just the necessary background condition for the occurrence of a black dot as a datum, it is a constitutive part of the datum itself" (Floridi, 2004b, p. 43). Data in the context of IS can therefore be described as being created by some entity in accordance with specific rules in regards to a purpose. Thus, data are related to all other aspects associated with IS: *[s]ocial actors* can change what they consider to be relevant data, how data can be sufficiently captured or how accurately data needs to be represented. Specific *technology* only provides a particular means for recording data but it can miss important aspects that cannot be captured by it (Weick, 1985; Drummond, 2011). *Information* about the existence of sources or particular aspects of phenomena, activities, competitors, etc. and the attribution of relevance to them can amend the collection or processing of data. Decisions about data sets and their processing, for instance, what data need to be captured and how they are related are made during the *development* and modelling process. This process is undertaken by developers (either in-house or external to an organization) who acquire understanding of the organizing contexts and information needs of actors though analysis: the decisions about the types of data (entities and their relationships) and data structures and relationships are thus based on developers' understanding of the context and their perceptions of the purpose of technology (Kent and Hoberman, 2012). *Organizing contexts* can differ in the position taken towards data which can change what is considered to be data and how it is collected (Cole, 2005, 2008). And finally, depending on the *practices* through which data are viewed, it can be enacted differently (Faÿ et al., 2010) and thus can put different demands on the collection, structure or storage of data.

4.5.2.5 Information

The relevance of information as an aspect of IS is already implied by the term itself and further underlined by several definitions which mention information as a key aspect of IS. In contrast to data introduced above which are bound to a storage medium, information arises in regards to the perception of social actors who consider particular data as relevant to them as part of their practices (see 'information-in-use' discussed in Chapter 3). Thus, in the context of IS, information can be described as meaningful data, and exchanges with other social actors as part of the practices that are regarded as relevant for a particular purpose by a group of social actors. From this, it follows that information is observer dependent and perspectival (e.g. Boland, 1987; Stamper, 1991, 1992). As a result, information is related to all other aspects of IS: *[s]ocial actors* choose to represent specific aspects of the world selectively (Goguen, 1997; Kallinikos, 1995). As information requires a mode of representation, it is associated with *technological* devices that provide the means for representation at different levels of detail (Cooper, 1992). Also, *data* can change the perception of what is considered to be meaningful and relevant by a group of actors and thus what constitutes information to them. *Developers* decide what is represented and signified as part of the modelling process thus limiting what information can become potentially available to users. Additionally, *organizing contexts* construct the way in which information can be represented: "organizations are not merely organizers of information; they also construct the forms on which information appears" (Cooper, 1992, p. 255). For instance, information needs to be organized in a way that relates it to organizational structure. And finally, *practices* can change what is regarded to be relevant information for conducting a practice (Leonardi, 2007). For instance, decision processes may be legitimized by referring what different actors consider as information to them (March and Sevon, 1988).

4.5.2.6 Development and Modelling

Development is identified as one aspect of IS by some definitions and, obviously, IS practitioners and researchers are interested in development of which the modelling process is a part (e.g. Chakraborty et al., 2010; Hirschheim et al., 1995; Milton, 2007). Generally, development is undertaken in regards to a specific purpose as it is understood by developers. As a result, the development process creates a particular representation

of a domain (Kent and Hoberman, 2012). During the development, *social actors* convey their understanding of a domain to developers which is then modelled during the development process. The way in which social actors represent and understand their domain and activities will affect development (Hirschheim et al. 2012; Kirs et al. 2001; Siau et al., 2010). Similarly, the way in which developers interact with users (social actors) and the degree to which they involve them in the modelling process will affect the development, specifications of information needs, data sets and processes. Also, the use of *technology* during development has to adhere to rules and restrictions placed by these technologies. For instance, programming languages can differ in their functionality (Chopra and Dexter, 2008), modellers may use different modelling grammars and programmers can make use of different integrated development environments (IDE) or use code with specific functionality provided by libraries. All of these will have an effect on the development. Similarly, the availability of *data* on activities can lead to the development of IT that makes use of these data, for instance, by summarizing them or by enabling further automation of processes. Likewise, developers themselves require *information* about a domain which they intend to model. This includes an understanding of markets, organizations, contexts, actors, etc. The understanding of these aspects as parts of the development process will never be finite (Hovorka and Germonprez, 2011). In addition, *organizing contexts* innovate by developing technologies that are meaningful and useful to them and their activities (Baxter and Berente, 2010). Moreover, there are different ways for engaging in a *practice*, such as calling, emailing, messaging or asking a colleague to meet face to face. The way in which an activity is undertaken as part of a practice can affect software development. In addition, development itself can be undertaken using different practices, such as agile development methodologies (Conboy, 2009), that will affect the development and relationship with users.

4.5.2.7 Organizing Context

The final aspect of relevance to IS is organizing contexts. Organizations are themselves in a constant process of adaptation and change. For instance, they develop new products or services, gain and lose customers with specific needs, have staff that are in a constant state of flux, change divisions and departments, and are facing changing environments, competition, regulations, etc. Pettigrew (1999) therefore suggested that rather than using

the term 'organization', the term 'organizing' is more appropriate as it emphasizes this ongoing change:

> The use of the active word organising, instead of the passive term organisation is important. [... as it] recognises the dynamic, perpetual and simultaneous character of the process of changing. Organising also entails a much more inclusive process, with alterations in structural form being continuously shaped alongside movements in organisation process and boundaries (Pettigrew, 1999, p. 2).

From this, two points follow in regard to conceptualizing organizations as part of IS. Firstly, organizations are continuously becoming; and secondly, this highlights the relevance of the context in which organizations operate as the process of organizing indicates "a network of mobile and non-localizable associations instead of the static distinction between organization and environment" (Cooper, 1992, p. 260). This posits that the way in which boundaries are constructed between an organization and its environment or between departments within organizations is important, as "the inside and the outside world can reverse into one another very easily" (Latour, 1983, p. 154). Figure 4.1 visually exemplifies this switch with the view of, variously, a pair of faces or a vase appearing as an inside against an outside. Thus, organizations are not a passive backdrop for an IS but this 'background' is an intrinsic feature of what is highlighted as 'foreground' (Kant, 2007; Taylor C, 2006; Heidegger, 2002; Wittgenstein, 1953; etc.).

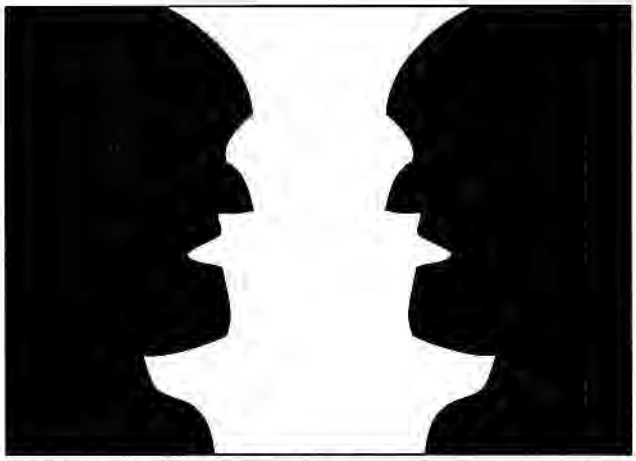

Figure 4.1 Shifting 'Inside' and 'Outside' – Faces or Vase?

Furthermore, organizations are related to all other aspects of IS: *[s]ocial actors* are members of organizations who make decisions, form strategies and execute them and, as part of this process, contribute to the changing of organizations and the construction of their boundaries. Social actors can also be external to organizations such as clients or

customers, partners or competitors. Furthermore, adoption and replacement of *technology* reshape how work is organized and carried out by organizations (Baxter and Berente, 2010; Leonardi, 2011; Zuboff, 1988). For instance, *data* generated in different units or as part of automation using IT can lead to a change in the way an organization is structured (Lilley et al. 2004). Also, looking at *information* raises the "fundamental question of how representation processes serve to construct organizations" (Cooper, 1992, p. 267), that is, what is considered to be relevant and meaningful to an organization constructs the organization itself in the eyes of its managers, workers, customers, competitors, etc. In addition, modelling of an organization as part of the *development* process will generate a representation of an organization that is generally already outdated the moment the modelling process is finalized (Hirschheim et al., 1995), also the development (and implementation) of a technology create the necessity for organizational change (Torvinen and Jalonen, 2000). And finally, *practices* can reshape the structure of an organization (Orlikowski, 1996), for instance, when new teams are created for specific projects or, generally, when organizations are restructured to be more efficient, capable or effective.

4.5.3 IS as Sociomaterial Apparatus

The discussion above of the seven aspects associated with IS suggests that all aspects are relational to each other. However, aspects are not only related to each other but they are in mutual dependence, co-producing each other. Take the case of a carpenter who may be described as a person using carpentry tools. Likewise, carpentry tools may be described as those tools used by a carpenter. Similarly, different aspects of IS are mutually dependent on each other or are co-created. For example, the self-perception of a social actor and their ability to act are intertwined with the technology they are using, while technology evolves through its relationships with social actors and the way in which they make use of it. This, however, questions the idea of the understanding of different aspects of IS, such as practices, technology or organizing contexts, as being pre-given. The relationality of these aspects indicates that they are not existent by themselves but, instead, emerge through their intra-action with each other. For example, technology shapes how practices are carried out, while practices shape how technology is developed and used. A relationship described by Leonardi (2011) in the context of crash

tests as part of automobile development used the concept of imbrication. In this case, imbrication refers to the mutual interconnection of two parts where both can be seen as depending on the other. In Leonardi's case, new generations of technology led to new ways of engaging in the practice of crash testing. In turn, the new practices of crash testing led to the development of new technology. Both the practices and the technology are the foundation for each other: neither comes first nor last.

This leads to the question of how all the different aspects of an IS need to be properly defined in order for them to be understood as co-constructing an IS. Of course, this requires capturing their relationality, that is, how they are related to other aspects so as to co-produce IS. As a consequence, a 'practice' needs to be defined as being performed by *social actors* making use of *technology* that is *designed* to support this practice within or in regards to an *organizing context;* practices make use of *data* in order to enable those social actors involved in a practice to become *informed* by content that is relevant to them in the context of this practice. Likewise, 'social actors' need to be defined in terms of the *practices* in which they are involved within an *organizing context*, the *data* they draw from through the use of *technology* and how they interpret the data and derive *information*, and finally, social actors are involved in the *development* of technology that provides the data. Similarly, all seven aspects of an IS are to be defined in terms of all of the six other aspects. Thus, 'technology' is dependent on social actors, data, information, development, organizing context and practice. All seven aspects of IS are entangled with each other thereby continually performing an IS.

Importantly, each aspect of IS is not only defined in terms of the others, but all aspects are part of a constant process of becoming through each other. As exemplified above by drawing from Leonardi (2011), in regards to the relationship between practices and technology, aspects are constantly changing as a result of their intra-action. Conceptualizing them as entangled thus also highlights that all aspects are continuously changing each other and that this ongoing change is part of what these aspects are.

This allows us to see IS as sociomaterial apparatuses in which all aspects (social and material) are entangled in a way in which they cannot be separated from each other when grasping the notion of IS. Hence, the spelling is 'sociomaterial' rather than 'socio-material'. Consequently, an IS can be defined as:

> An information system is an entanglement of practices, social actors, technology, data, information, development, and organizing contexts in which all of these aspects are in a continuous process of becoming through each other.

Importantly, these aspects are inseparably entangled as they are continuously reconfiguring each other. They are *not* ontologically separate but are interconnected entities. Thus, the entanglement of aspects of an IS with each other is part of what these aspects are. Take the case of technology which, for instance, without social actors for whom it is viewed as technology cannot be regarded as technology, just as a stick in a field only becomes a technology for hunting when it is used in that way. Likewise, a terminal server that is not used by anybody for anything is just a heap of matter. Thus, as an aspect of an IS, technology is inseparably connected to social actors. This reasoning not only applies to individual aspects and their entanglement with each other but also to IS as a whole. For instance, if social actors or any other aspect of an IS are taken out of the description, the result can no longer be fully understood as an IS. Of course, it is possible to analytically separate different aspects of IS in order to facilitate analysis of them as indicated in the above discussion of the contributions made by different views of IS. However, each of these views is in itself incomplete and only partial as is also indicated in the above discussion. An IS therefore needs to be understood as always consisting of all aspects simultaneously as the intra-action of these aspects with each other is part of what constitutes each of these aspects.

IS are thus both sociomaterial and performative. Emerging through the entanglement of various material and social aspects that define and co-constitute each other, an IS is a sociomaterial accomplishment. As a consequence, IS are also performative; they do not merely represent reality through the intra-action of different aspects, they contribute to enactment, that is, production and reconfiguration of reality.

4.5.4 Exemplified Use of a Sociomaterial Understanding of IS

The following section exemplifies the value of a sociomaterial approach to IS by showing that it can be used to challenge common conceptualizations of IS and therefore makes a contribution to the understanding of and research in IS. To achieve this, it looks more closely at decision support systems (DSS). DSS provide a good example as they are widely known and conceptually well elaborated, which is reflected by their common

inclusion in IS textbooks (see appendix C), and as technology supporting decision making is of particular interest to IS (Nevo et al., 2009). They also exemplify complexity and sophistication that require deep insights into all aspects that are of relevance to IS.

DSS are complex systems intended to support social actors in making decisions. They are variously defined as: "DSSs are designed to aid in decision making and decision implementation" (Alter, 1977, p. 40), as "a special purpose information system designed to support organizational decision making related to a particular recurring problem" (Valacich and Schneider, 2012, p. 255) or, at more length, as:

> A computer information system that provides information in a given domain of application by means of analytical decision models and access to databases, in order to support a decision maker in making decisions effectively in complex and ill-structured (non-programmable) tasks (Klein and Methlie, 1990, p. 148).

Valacich and Schneider (2012) posited an 'input-processing-output' model for DSS in which the input of a DSS consists of data and models. The processing is done by interactively applying models to data in order to produce alternative solution scenarios that decision makers can compare and assess. And finally, the output consists of textual or graphical reports as well as feedback to system operators. This and the definitions above thus identify the following aspects of a DSS: social actors (decision makers); technology (hardware and software producing outputs); data (models and values); information (in the form of relevant output); development (during which models are conceived and changed); organizing contexts (where decisions are made); and practices (the practice of making decisions). As this indicates, all seven aspects are relevant for understanding DSS; however, reference to these aspects is fragmented and not clearly expressed. In contrast, a sociomaterial view raises awareness of the relevance of all of these aspects in regards to DSS. It thus allows a more thorough conception of DSS that clearly includes all of these aspects in a straightforward way:

> DSS are systems where *decision makers* make use of *technology* as part of the *practice* of decision making. For this, DSS require *models* and *data* about processes that are of interest within an *organizing context*. Outputs that enable decision makers to make decisions will be *information* to them.

Compared to the three definitions above, this definition refers to all the different aspects of an IS as highlighted in italics. The result is a definition that is clear about the purpose of DSS and how they achieve this purpose.

The more important contribution of the sociomaterial view, however, is that it not only highlights the importance of all seven aspects, but that it stresses the entanglement of these aspects. Consequently, a sociomaterial conception of IS shifts attention to the entanglement of these aspects as part of a DSS.

This contribution can be illustrated by drawing from the example of a group DSS used to determine space shuttle launches as documented by Forrest (2005).[9] By following the relationality between some of the different aspects of an IS, the entanglement of these aspects as part of this IS is highlighted. The DSS was used before the Challenger disaster[10] to determine if the spacecraft should be launched. It was thus developed in regards to the practice of decision making about space shuttle launches. However, organizing contexts and the practice of decision making were relational in the sense that the decision-making practice was highly subject to a particular organizing context in which NASA managers were under extreme pressure from their environment: "the needs of political, commercial, military, international and scientific communities placed immense pressures on the Shuttle management team". Due to this pressure, the organizing context at NASA was highly politicized with the focus on delivering spacecraft launches on schedule. Social actors worked in an environment where any information that led to the delay was rejected, whereas information that a start was on schedule was met with positive support. Furthermore, decision making was supported by technology. This technology contained data and models about components, such as data about the performance of components and the temperature ranges recommended for their operation. Importantly, data were stored in the DSS based on the background of the organizing context and the work situation of social actors as described above and thus was affected by the desire to stay on schedule. Consequently, the interconnection between temperature forecasts for the scheduled launch day in January and the temperature recommended for op-

9 This example was chosen at random from a list of teaching cases on DSS provided on the website Decision Support System Resources (dssresources.com), a resource for DSS teaching cases referred to by the Association for Information Systems (AIS) DSS special interest group.

10 On 28 January 1989, the Space Shuttle Challenger exploded shortly after launch due to a hardware failure of a solid rocket booster (SRB) "O" ring, leading to the tragic loss of seven lives.

eration of components by the manufacturer was downplayed. Moreover, concerns by engineers who questioned data and models programmed into the IT artifact were not taken seriously. Ultimately, the decision to launch was made by disregarding information about the relationship between ambient temperatures and the performance of shuttle components, and by exerting social pressure on those social actors objecting to the decision to launch.

This example highlights that the DSS used to determine space shuttle launches was not a simple instrument that provided outputs enabling decision making. Instead, it reveals that different aspects of an IS were co-constituting each other and that the technology used to support decision making was operating as part of an intra-action of these aspects with each other. IS are therefore apparatuses where all aspects of an IS are in a constant process of becoming as they enact reality. In this case, the conception of IS as apparatus reveals that the data and models based on which technology was developed to support decision making were created in a background of organizing contexts, practices and social actors with the desire to stay on schedule. Moreover, it shows that information provided by technology is understood as part of a practice that was, in this case, under immense pressure from its organizing context. This pressure affected the way in which data were stored and interpreted and ultimately how decisions were made. This example thus highlights that IS as apparatuses are part of a process of performing reality rather than devices that represent an external reality in an objective way. It highlights the entanglement of the different aspects of an IS in regards to a particular DSS, showing that individual aspects are perpetuating and changing other aspects of an IS. What is of interest is how a DSS spirals forward through this constant process of change that led, in this case, to the dismissal of recommendations, data and models. A position that seeks to understand this entanglement is one that is proposed by a sociomaterial understanding of IS.

4.6 Concluding Discussion

The concluding discussion first addresses the theoretical contributions made by this essay. It then continues with the theoretical implications arising from this as well as the limitations and future research. The penultimate section then discusses practical implications followed by concluding remarks.

4.6.1 Theoretical Contributions

This essay has built its contribution by critically engaging with definitions from a wide range of sources covering IS research and education. These include refereed journal articles, conference papers, edited books and textbooks. From those sources, it identified five different views of IS and showed that each of these views makes an important contribution to IS research as each view emphasizes specific aspects in regards to IS. Moreover, by examining different aspects evoked by these definitions, it revealed seven aspects related to IS: social actors, technology, data, information, development, organizing context and practices.

The critical examination of these seven aspects revealed that they are all relational to each other. Each aspect is affected by all other aspects and, at the same time, affects all other aspects. Therefore, these aspects are connected in a process of entanglement where they are in a constant process of becoming through each other. Consequently, they cannot be regarded as ontologically separate but instead they need to be understood as ontologically inseparable aspects of IS. From this ongoing intra-action among all aspects, it follows that an IS can be understood as a performative, sociomaterial apparatus. The relevance and contribution made by this conceptualization of IS were then exemplified in the context of DSS.

This essay therefore also engaged with the ontological foundation for understanding IS. Rather than seeing IS as a combination of interrelated components that exist objectively by themselves, it argued that IS need to be understood from a different ontological position. It argued that agential realism as put forward by Barad (2007) offers such a position as it captures the ongoing becoming of IS and its aspects. According to agential realism, reality arises from a process that is neither arbitrarily constructed nor does it claim that it is possible to directly access an observer-independent reality. Instead, every depiction of reality is always the result of a process of intra-action. IS thus always exist in relation to organizations, technology, practices, etc. As a result, members of an organization are in a constant process of becoming but this process of becoming is neither determined by technology nor is it a process of social construction.

This essay thus contributed to the conceptualization of IS by proposing that IS can be conceived as sociomaterial apparatuses. In particular, this perspective overcomes the

ontological shortcomings of conceptions of IS. This includes the perspectives of technical determinism or social constructivism that can often be associated with the technical view or the social view of IS, but also the socio-technical view that instead can replace a one-way determinism with a two-way co-determinism. Moreover, the modelling view and the process view conceptualize IS as devices that represent processes that exist in a real world. They therefore also assume the existence of an observer-independent reality that can be captured in an objective way. In contrast, a sociomaterial account of IS highlights that any observation of reality is based on intra-action where the mode of observation and that which is observed are entangled. It thus provides an alternative understanding of IS that can embrace the relationality of all the different aspects of an IS with each other. In this sense, aspects are part of a process of continuous becoming of the IS through the intra-action of its aspects. This onto-epistemological view thus provides a contrast to the limitations associated with the ontology underlining other views of IS.

4.6.2 Theoretical Implications

A sociomaterial approach for understanding IS shifts theorizing from representational understanding to performative understanding. Representational approaches imply that there is a 'real' situation and a 'true' or 'false' representation of it. This assumes that an IS is a passive device containing representations of the real world that can vary in their accuracy and the completeness of their depiction of reality. The accuracy and completeness of representations are thus a main concern regarding IS. Representations of reality however are not simple and neutral mappings. They are value-laden and interest-based as they are always made from a particular position, as the DSS example regarding the Challenger launch highlighted. What matters therefore is not only what is represented but also how it is presented and what reality such representations are likely to perform. IS are not passive devices and a performative view highlights the active role of IS in the creation of personal, organizational and, indeed, societal reality. This shifts the importance away from the accuracy and completeness of representations and, instead, towards the intra-action of aspects involved in developing and maintaining technology as it supports an organizing activity. Moreover, it questions the possibility of being able to achieve an accurate representation as that which is intended to be represented is also part of this intra-active process of becoming.

As access to an observer-independent reality is not possible, what becomes of interest is the process of the ongoing intra-action and how it brings about certain phenomena. A sociomaterial understanding of IS emphasizes the entanglement of human actors as part of an IS. Understanding this process of entanglement becomes increasingly important the more deeply embedded our existence as social actors is in a world where information and IT become more and more profound as parts of our lives. A deeper understanding of how we are part of this entanglement is one that is offered by an understanding of IS as sociomaterial apparatuses. This essay thus has important implications for understanding and theorizing about the sociomaterial and performative nature of IS by questioning the common ontological position according to which IS consist of a set of ontologically-separate entities. Instead, IS are seen as coming into existence through a continuous performative process of their entangled aspects. Such an ability to engage with ontological questions concerning IS is of increasing importance as IS become broader, constantly present and more universal in a globalized world:

> This is precisely why the question [regarding the creation and perception of reality] is becoming more relevant today: the thrust of technology is to foster interaction among greater numbers of people, and to integrate processes into monoliths serving wider and wider purposes. It is in this environment that discrepancies in fundamental assumptions will become increasingly exposed (Kent and Hoberman, 2012, p. 173).

It is therefore important to engage and challenge fundamental assumptions underlying the conception of different types of systems. This essay provides a means to engage with these questions by providing an approach that enables IS researchers to better understand how IS are part of the process of reality creation. And finally, understanding IS as sociomaterial apparatuses that result from an intra-action of different aspects related to an IS requires the theorizing of these aspects of IS in combination. The understanding of IS as sociomaterial apparatuses thus provides a means for analyzing IS that goes beyond an understanding of IS as being predominantly IT (Lee, 2010). Instead, it offers a lens that sensitizes researchers to different aspects of IS beyond IT or social actors. By introducing seven aspects that are entangled as part of an IS, it provides in addition a means for understanding how IS are related to organizing contexts, to practices, information, development and data. This conceptualization of the intra-action of these seven aspects can thus facilitate analysis of IS. As was exemplified above in the context of the

Challenger case, understanding IS as sociomaterial apparatuses sensitizes researchers to different aspects as part of their analysis of an IS.

4.6.3 Future Research and Limitations

This essay provided the foundation for a sociomaterial and performative understanding of IS. It identified seven different aspects that are of relevance in understanding IS and introduced each of these aspects and their relationality to all other aspects. As the focus was on IS and the relationality of all aspects with each other, there was not enough room to examine each of these aspects in detail. Thus, future research is required that looks more closely at individual aspects and their relationality to all other aspects. Given the five views on IS identified above, there are already ongoing research programs looking more closely at most of these aspects. For instance, the technology view, the social view and the modelling view cover the aspects of social actors, technology, development or data. What is needed now is: firstly, to look more closely at existing IS research to identify how different research programs are related to different aspects of IS; secondly, to further relate and connect research on different aspects with each other; and thirdly, to look in more detail at individual aspects that currently receive disproportionally less attention by IS researchers. In particular, this seems to be two aspects, that is, organizing context and information. All of these points necessitate both additional theoretical work and empirical investigation.

While this essay argues for the relevance of practice theory for IS, it has only provided a limited introduction to practice theory. In particular, it only introduced the relevance of Schatzki's (2006) work on practice theory for IS. While Schatzki is recognized as having made an important contribution to practice theory (Feldman and Orlikowski, 2011; Suchman, 1987), additional theoretical lenses for conceptualizing practice such as the work of Latour (1987, 2005), Giddens (1984), Bourdieu (1976), Callon (1986), etc. have not been discussed. Future research could look at each of these in the context of an understanding of IS as sociomaterial apparatuses.

Also, the notion of organizing context as one of the aspects of IS can be seen as limiting the scope of IS as IS may be understood as occurring only in the context of organizations. However, this raises questions about other forms of systems that do not fit easily into the context of organizations, such as the hedonistic use of IT or social networks.

That such systems evolve through intra-actions is however obvious as they are vivid examples of constant changes in our everyday lives and our entanglement with technologies, practices and other aspects of IS. The concept of IS needs to be understood within a wider context than what is commonly labelled 'organization'. In order to do that, the concept of organizing context should be enlarged, perhaps drawing from more general notions of 'background' (Heidegger) or 'forms of lives' (Wittgenstein).

4.6.4 Practical Implications

The sociomaterial understanding of IS raises awareness of the process of the entanglement of the different aspects of an IS. It thus emphasizes that different aspects of an IS cannot be understood in isolation and that each aspect affects all other aspects. For instance, it highlights that bringing in new technology will affect all other aspects of an IS, such as changing the perception of social actors (e.g. Drummond, 2011) or the organization of practice (e.g. Leonardi, 2007, 2010). As Drummond's (2011) case highlighted, technology can change how users perceive the world and themselves. Furthermore, the idea of entanglement emphasizes how awareness of situations is always in the process of becoming and thus will always be incomplete. The aim is therefore to become aware of the process of becoming rather than aiming for completeness of representations. In contrast, if an IT artifact is seen as representing the world, it locks users into a particular understanding of the world as it is represented by the system. However, any particular representation mediated through technology is created in the first place on the basis of assumptions that highlight certain aspects that are represented while neglecting others that are not part of the representation.

This conception of technology and how it mediates an understanding of the world has further implications for development. In particular, a sociomaterial conception of IS shifts the focus of development from actions and processes to the identification of practices. A more appropriate way for developing IT architecture is thus not to look at the actions that IT is supposed to support but at the practices of which IT is a part. IT infrastructure that is designed around activities can be inflexible in adapting to change. Centering the development of IT architecture on practices instead is likely to result in software that is more flexible in regards to changing actions, for instance, when new technology becomes available or when new legislation is introduced.

And finally, a sociomaterial understanding of IS highlights the centrality of development as being a constant part of an IS and not something that is detached from it during a preceding development phase. A sociomaterial and performative conception of IS emphasizes that the ability to see the world (customers, suppliers, competitors) in a particular way is tied to the way in which an IS (IT, practices, users, etc.) performs a particular view of the world. For instance, awareness of trends that are relevant for developing popular products or the awareness of competitors are generally mediated to managers through an IS that is engaged in the practice of raising awareness of these aspects such as through the use of management support systems (Clark et al., 2007). For an IS to perform well in this regard not only are appropriate organizational structures or qualified staff relevant, but so is the ability to flexibly change technology. The skill to quickly and flexibly change technology, however, does not rest in the hands of all the social actors who are part of an IS. Thus, the ability to draw developers closer to other actors of the IS assemblage can enable organizations to more flexibly change IT artifacts, for instance, by implementing routines to process data ad hoc, or to adjust technology to better accommodate the expertise of different social actors. As a result, seeing development as an integrative aspect of an IS can enable an organization to gain a competitive advantage by enabling an IS to be more efficient when work patterns change or more effective by enabling innovative new ways for engaging with the world.

4.6.5 Concluding Remarks

This essay engages with an important issue for IS by critically examining how IS are conceptualized. It therefore addresses a need for IS researchers to engage with the concept of IS (e.g. Baskerville, 2010; Paul, 2007) which is fueled, on the one hand, by an ongoing debate about the 'core' of IS research especially regarding the role of IT and, on the other hand, by urging IS scholars to exercise conceptual clarity in regards to the terminology of 'system' and 'information system' (Lee, 2004, 2010). This essay contributes to this debate by identifying a range of definitions of IS and showing that they emphasize different aspects of relevance to IS. Based on a review of 36 definitions of IS from a wide range of sources encompassing journal articles, conference proceedings, textbooks, edited volumes and monographs, five different views of IS were distinguished: a technical view, a social view, a socio-technical view, a modelling view and a process

view. Each of these views makes important contributions to IS research; however, each is also based on assumptions that limit their insight into IS. After looking at aspects evoked by different definitions of IS, this essay then introduced seven aspects associated with IS: practices, social actors, technology, data, information, development and organizing context. Each of these aspects is not only associated with IS, it is also relational to all other aspects. As a consequence, an IS can be understood as an entanglement of these aspects and thus their ongoing becoming through each other. Thus, looking more closely at these aspects, this essay developed a sociomaterial conception of IS that provides a better understanding of the relevance and interconnection of these aspects with each other as they construct IS.

Chapter 5 : Conclusion

This thesis looked more closely at the central ingredient of IS, that is of course, 'information' itself. Understanding of what constitutes information, the question of 'What is information' has deep consequences for not only how information needs to be approached and researched, but also for what an IS entails. Fundamentally, I argued for a shift from an understanding that sees IS as devices that process, provide or produce information to an understanding or IS as arrangements as part of which social actors become informed.

5.1 Synopsis

This thesis engaged with the two central concepts for IS, the concepts of 'information' and the related concept of 'information system'. It thus followed calls by IS scholars expressed frequently over the last few decades to engage more thoroughly with the concept of information (Stamper, 1973; Boland, 1987; Galliers, 1987; McKinney and Yoos, 2010) and more recent calls to look more closely at the concept of information system (Baskerville, 2010; Lee, 2004; 2010; Paul, 2007). There is therefore a clear need to further engage with these concepts and to advance their theoretical development and use as constructs in IS research. However, as emphasized in the introduction, currently such a debate is scant in IS

In addition to a lack of debate, the relevance of this research stems from the fact that this lack of interest in these concepts can have potentially detrimental consequences for IS research. Typically these terms are taken for granted (Baskerville, 2010; Lee 2010), thus potentially leading to unreflective use that can condition research (McKinney and Yoos, 2010) or limit the range of ways in which information and IS are understood and used (Lee, 2010; McKinney and Yoos, 2010). For example, in IS, information is often used as a near synonym for data (Lee, 2004, 2010). However, as this thesis showed, there are numerous alternative ways for conceptualizing information and thus the potential to embrace a wider variety of conceptualizations. Embracing this variety can therefore potentially contribute to more diversity and richness in IS research (Lee, 2010; Rowe, 2012). Furthermore, a lack of conceptual clarity regarding information and IS can potentially hinder progress in IS research as the usage of these terms does not allow

IS to draw and clearly communicate meaningful differences (Checkland and Holwell, 1998; Lee, 2004, 2010). Also, current conceptions of information are often simplistic and follow a hierarchical approach that connects data, information, knowledge, and wisdom in the sense of increasing understanding and connectedness (Bellinger et al., 2004). This approach may allow one to draw a vivid distinction in textbooks (Rowley, 2007), but it has limited use for engagement in research, as it lacks explanatory power, precision, and the ability for deeper theorizing (Bates, 2010; Davenport, 1997; Fricke, 2009; Kettinger and Li, 2010; Stenmark, 2001).

Overall, the relevance of this research stems from the fact that contradicting definitions and usage, simplistic understanding as well as the lack of attention to foundational concepts in IS research are not helping the IS field's identity and legitimacy. These concerns reemphasize the necessity of IS scholars to devote due attention to and investigate its fundamental concepts.

The essays presented in chapter two to four contributed to this debate by furthering the discussion of the concepts of 'information' and 'information system'.

5.1.1 Essay 1 : Theorizing Information

Chapter two contains a first essay reflecting on information as a concept. It introduces a taxonomy of five different views and two different perspectives of information that relate information either to the physical world or to the world of signs. Both the material view and the engineering view relate information to the physical world, as the former understands information as property of the material world, while the latter seeks to establish a measurement of information in purely physical terms. In contrast, semiotic approaches relate information to signs that stand for somebody in some regard. Here, three views are distinguished. According to the objectivist view, information can exist independently of an observer in the sense of true facts about the world, whereas the subjectivist view necessitates a subject for whom something becomes information. Finally, the inter-subjective view highlights that what is considered to be information is dependent on agreement among a group of social actors. Subsequently, each of these five views differ in their assumptions regarding how information relates to the world (its ontological status), the conditions for its existence (epistemological status), and their strengths and limitations in terms of the insights that they allow for IS research.

Thus the first essay makes several contributions to understanding information for IS. First, by drawing from an extensive body of literature it introduces a vast range of possible conceptualizations of information thus contributing to more diversity (Rowe, 2012) and potentially better conceptual clarity. Moreover, by developing a taxonomy, it provides a means for orientation within this vast body of literature. Second, through critical engagement with different views of the taxonomy, it provides an overview of their theoretical foundations, general implications, as well as strengths and limitations for IS research. Third, it exemplifies the usefulness of the taxonomy for IS scholarship by showing that while understanding of information shifts from one view of the taxonomy to another, additional insights and meaningful paths for future research can be identified.

5.1.2 Essay 2 : Towards a 'Facets of Information' Theory

The second essay on information is presented in chapter three. Drawing from the philosophy of language of the late Wittgenstein it conceptually approaches information by means of description rather than definition. Accordingly it introduces 14 different facets that are associated with the description of information. Furthermore, by drawing from Stamper's semiology, these facets can be associated with the semiotic dimensions of syntax, semantics, pragmatics, and empirics. This view on information can thus reconcile different social and technological dimensions of information in a meaningful way. Accordingly, information is associated with physical inscription through the five aspects of: detectability, physical inscription, access, and speed. Similarly, information is associated with the rules of sign systems through apprehensibility and accuracy; to meaning through comprehensibility, contextuality, and level of detail; and to pragmatic aspects through the six facets of: time dependence, action relevance, novelty, degree of trust, and social practice.

This essay thus further contributes to the understanding of information for IS by providing an account that can accommodate social/human as well as technical/material aspects of information simultaneously. It thus provides an account that is of particular interest to IS as it embraces social and technological aspects related to information integratively. In addition, the facets view enables further dissection of the concept of information for IS researchers as well as practitioners. This enables IS to approach information by appro-

priating facets that are relevant in different contexts and for different purposes. Finally, this essay illustrates the usefulness of the facets approach to information by re-analyzing the concept of 'informational capabilities' provided by Leonardi (2007).

5.1.3 Essay 3 : Theorizing Information Systems

Chapter four contains the third essay engaging with the concept of information system. It critically analyzes definitions of IS from a wide range of IS literature, based on which it identifies five different views on IS: A technology view emphasizing technological aspects of IS; a social view that primarily sees IS as social systems; a socio-technical view that emphasizes the interactional character of social and technological aspects in regards to IS; a modelling view that focuses on the development and design of IS; and a process view that emphasizes that IS are related to activity such as goal directed purposes or the processing of data. The assumptions underlying each view, as well as their contributions to IS research and their limitations are discussed. In addition, a sixth view of IS is proposed that argues that IS can be understood as sociomaterial apparatuses. According to this conceptualization, IS are in a constant process of becoming through an ongoing entanglement of seven different aspects: social actors, technology, data, information, development, organizations, and practices.

The third essay makes several contributions to IS research and understanding of IS. First, it examines different definitions of IS, based on which it provides a review of five different conceptions of IS. Furthermore, it critically examines the assumptions underlying each of these conceptions as well as the contributions made by each view to IS research. In addition, by further analyzing the different definitions of IS it identifies seven aspects that are associated with IS. Investigating in more detail what each aspect entails and how they are related with each other it shows that these seven aspects are entangled with each other. Accordingly IS are conceptualized as sociomaterial apparatuses formed through mutual entanglement of these seven aspects, each of which is thus continuously transforming. IS are seen as performing reality.

5.2 Limitations and Future Research [redacted]

The thesis provides an extensive overview and discussion of conceptualizations of information and IS. By drawing from earlier IS research, it exemplifies how these concep-

tions can be employed in a way that is meaningful to IS research. While this thesis is theoretical in nature, it provides ample opportunities for application to various empirical setting. Subsequently, future research should seek to employ the theoretical ideas presented in this thesis in empirical settings. In addition, numerous ways to further the development of the ideas presented in each essay are already discussed by each essay. For this reason, the potential of the findings from this thesis for future research is only exemplified here: For instance, several paths of research can be associated with different views of the taxonomy presented in chapter two. The subjectivist view alerts IS researchers to look more closely at predispositions and how content can be presented so that it is more likely to become information to somebody. In addition, the inter-subjective dimension indicates that looking more closely at sociocultural aspects associated with information can support IS researchers and organizations in better understanding how and why something becomes considered to be 'informing' by a group of social actors. Furthermore, the second essay raises various ways of looking more closely at different facets of information and their interrelation with each other, such as how individual facets of information are affected by other facets. Such interrelations could exist, for instance between ease of physical access or comprehensibility and the degree of trust in information. Things that are in vicinity and more easily understood may be more likely to be trusted. Therefore, there seems to be a possibility that different facets of information can develop synergy in regards to something being considered to be information. This thus raises the potential for future IS researchers to better understand these facets and their effect on each other. In addition, the third essay indicates that a switch in ontological assumptions regarding IS and information has the potential to further understanding of these concepts for IS. Future research can be developed by questioning the assumptions that aspects of IS are existent in themselves and instead understand different aspects as continuously arising through other aspects. For instance, future research can look at what users as part of an IS entail if they are understood as social actors that emerge through their entanglement with other aspects of an IS. In addition, this creates the need to further understand how IS create and shape reality as they enable us to look at the world in particular and new ways.

5.3 Concluding Remarks

Dretske (1981) stated in regards to information that: "It is much easier to talk about information than it is to say what it is you are talking about" (p. ix). This observation certainly holds true for much of IS research (McKinney and Yoos, 2010; Lee, 2010). Therefore, this thesis seeks to contribute towards a debate about what information is in the context of IS. It argued that information and information system are two important concepts for IS and that IS needs to pay due attention to these concepts. However, the self regulation of IS research discussed in the introduction provides little incentive to IS scholars to engage with anything but “low risk” research. Unfortunately, engagement with information as a concept may be seen as more risky than engagement with other established IS phenomena such as the acceptance and use of technology, or the engagement with contemporary technological advances such as the spread of mobile technology in healthcare and business. Moreover, an additional reason for lack of progress in regards to information was put forward by Stamper (1973) stating that engagement with information may be more cumbersome than engagement with latest technological advances:

> we knew all about information technology but precious little about information it carried. We could produce bottles but we did not understand the wine. Information is the wine. Whereas the technology is relatively easy to grasp, information is a vague and elusive concept (Stamper, 1992:21-22).

IS researchers may therefore come to believe that there is little incentive for IS to engage with information as a concept. Not only can engagement with information be more cumbersome than engagement with technological advances, but this engagement can also be associated with higher risk during the review and publication process.

However, there are great opportunities for IS to further engage with this concept in its research and thus for taking this 'risk'. Not only is 'information' central to the IS field, but IS also has much to contribute when it comes to understanding and facilitating access and dissemination of information by means of technology. Whether information is considered as a concept in itself as in chapters two and three, or if one looks at IS as in chapter four, what becomes apparent is that information and IS are both related to social and technological aspects simultaneously. This posits IS as a field to be in a prime position to contribute to the understanding of these concepts and thus to further strengthen

its standing in relation to reference disciplines. In particular, by offering an understanding of the social and technical aspects of information it can make an important contribution to a concept that is not only of topmost interest to IS but one that is of general interest to numerous disciplines, phenomena and areas in the sense that: "Information is so crucial to almost every purposive human activity that we are tempted to say that information has a central importance to human affairs" (Alfino and Pierce, 2001, p. 476). Even more, information is not only central to human activity, it is also of essence to human existence and its survival in the sense that humans are "totally dependent for survival on [their] information handling skills" (Scarrott, 1989, p. 263). The importance of IS to contribute to the ability for humans to handle information cannot be overstated. Moreover, IS is uniquely positioned to contribute to the understanding of information and information systems that integrates both social actors and technology. This in some ways argues against a simplistic technological view of IS which Boland (1987) eloquently critiques as:

> we are fostering an image of the world in which the human meaning of knowledge and action are unproblematic, predefined, and prepackaged. The human being is not a necessary element in the *Information Age* (p. 365, emphasis in original).

In contrast, engaging with information and IS as concepts alerts IS researchers to both the social and technological dimensions of their endeavors. This posits that IS researchers should not be passive observers of the transformation processes taking place by means of technology around them, but that they (IS researchers) have an important role in the way how the future is shaped through technology. There is an impetus for IS to participate in shaping this future:

> As IS researchers we have the [...] responsibility to influence what future is enacted with those technological artifacts. [… in order not to] remain passive observers of the techno-social transformation process occurring around us (Orlikowski and Iacono, 2001, p. 133).

> If we really take this seriously then the design of 'information systems' that indeed 'inform' would be very different. [...] information, to be powerful, needs not only to be re-embedded but also, in a radical way, re-embodied (Fay et al., 2010, p. 40).

Currently we may make every aspect of our lives available online, digitize every part of human existence, populate the vector space of search engines and databases with tril-

lions of data points, increase the storage capacity of devices by orders of magnitude, accelerate the speed of processing devices exponentially, and build data highways that are wider and faster than ever before and accessible from every corner of the planet. However, while all this enables access to more content at higher resolution and in shorter times, what it cannot achieve is a better understanding of why it all matters and what is truly needed. A better understanding of why it matters and how it all becomes meaningful and relevant is associated with an increasing understanding of what the concept of information entails. The role information plays in our lives where every aspect of human existence is infused by information technology is in turn a question of information systems.

References

Ackoff, R. L. 1989. "From Data to Wisdom," *Journal of Applied Systems Analysis* (16:1), pp. 3–9.

Adam, A. 2012. "IS and its Agenda," *Journal of Information Technology* (27:2), pp. 102–103.

Adams, F. 2004. "Knowledge," In *The Blackwell guide to the philosophy of computing and information*, L. Floridi (ed.), Oxford: Blackwell, pp. 228–236.

Alfino, M., and Pierce, L. 2001. "The Social Nature of Information," *Library Trends* (49:3), pp. 471–485.

Alter, S. 1977. "A Taxonomy of Decision Support Systems," *Sloan Management Review* (19:1), pp. 39–56

Alter, S. 2003a. "Sidestepping the IT Artifact, Scrapping the IS Silo, and Laying Claim to 'Systems in Organizations'," *Communications of the Association for Information Systems* (12:1), Article 30.

Alter, S. 2003b. "18 Reasons Why IT-Reliant Work Systems Should Replace 'The IT Artifact' as the Core Subject Matter of the IS Field," *Communications of the Association for Information Systems* (12), pp. 366–395.

Alter, S. 2008. "Defining Information Systems as Work Systems: Implications for the IS Field," *European Journal of Information Systems* (17:5), pp. 448–469.

Alvarez, J. R. 2009. "Biosemiotics: Communication and Causation (Information Included)," *Triple C cognition communication co-operation* (7:2), pp. 172–178.

Alvesson, M., and Sandberg, J. 2011. "Generating Research Questions Through Problematization," *Academy of Management Review* (36:2), pp. 247–271.

Arazy, O., and Woo, C. 2007. "Enhancing Information Retrieval Through Statistical Natural Language Processing: A Study of Collocation Indexing," *MIS Quarterly* (31:3), pp. 525–546.

Artandi, S. 1973. "Information Concepts and Their Utility," *Journal of the American Society for Information Science* (24:4), pp. 242–245.

Aspray, W. 1985. "The Scientific Conceptualization of Information: A Survey," *Annals of the history of Computing* (7:2), pp. 117–140.

Avgerou, C. 2010. "Comments on Allen Lee's Article 'Retrospect and Prospect': Information Systems Research in the Last and Next 25 Years' From a Socio-Theoretical IS Research Perspective," *Journal of Information Technology* (25:4), pp. 355–357.

Avison, D., and Fitzgerald, G. 2012. "Reflections and opinions on 25 years with the ISJ," *Information Systems Journal* (22:3), pp. 179–193.

Bandara, W., Miskon, S., and Fielt, E. 2011. "A Systematic, Tool-Supported Method for Conducting Literature Reviews in Information Systems," In *ECIS 2011 Proceedings*, Paper 221.

Bar-Hillel, Y. 1955. "Information and Content: A Semantic Analysis," *Synthese* (9:1), pp. 299–305.

Bar-Hillel, Y., and Carnap, R. 1953. "Semantic Information," *British Journal for the Philosophy of Science* (4:14), pp. 147–157.

Barad, K. 2003. "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter," *Signs: Journal of Women in Culture and Society* (28:3), pp. 801–831.

Barad, K. 2007. *Meeting the Universe Halfway. Quantum Physics and the Entanglement of Matter and Meaning*, Durham: Duke University Press.

Barbieri, M. 2008. "What is Biosemiotics?," *Biosemiotics* (1:1), pp. 1–3.

Barrett, F. J., Powley, E. H., and Pearce, B. 2011. "Hermeneutic Philosophy and Organizational Theory," In *Philosophy and Organization Theory (Research in the Sociology of Organizations, Volume 32)*, H. Tsoukas and R. Chia (eds.), Bingley: Emerald Group Publishing Limited, pp. 181–213.

Barwise, J., and Perry, J. 1983. *Situations and Attitudes*, Cambridge: MIT Press.

Barwise, J., and Seligman, J. 1997. *Information Flows: The Logic of Distributed Systems*, Cambridge: Cambridge University Press.

Baskerville, R. L. 2010. "Knowledge Lost and Found: A Commentary on Allen Lee's 'Retrospect and Prospect'," *Journal of Information Technology* (25:4), pp. 350–351.

Baskerville, R. L. 2012. "Making Better Choices: a Response to Walsham," *Journal of Information Technology* (27:2), pp. 94–95.

Baskerville, R. L., and Myers, M. D. 2002. "Information Systems as a Reference Discipline," *MIS Quarterly: Management Information Systems* (26:1), pp. 1–14.

Baskerville, R., Lyytinen, K., Sambamurthy, V., and Straub, D. 2010. "A Response to the Design-Oriented Information Systems Research Memorandum," *European Journal of Information Systems* (20:1), pp. 11–15.

Bates, M. J. 2005. "Information and Knowledge: An Evolutionary Framework for Information Science," *Information Research* (10:4)Department of Information Studies, University of California, Los Angeles, Los Angeles, CA 90095-1520, United States, Paper 239.

Bates, M. J. 2006. “Fundamental Forms of Information,” *Journal of the American Society for Information Science and Technology* (57:8)Department of Information Studies, University of California, Los Angeles, Los Angeles, CA 90095-1520, pp. 1033–1045.

Bates, M. J. 2010. “Information,” In *Encyclopedia of Library and Information Sciences*, M. J. Bates and M. N. Maack (eds.), (3rd ed, , Vol. 35)New York: CRC Press, pp. 2347–2360.

Bateson, G. 1972. *Steps to an Ecology of Mind*, New York: Ballantine Books.

Bauknecht, K., and Zehnder, C. A. 1997. *Grundlagen für den Informatikeinsatz*, Stuttgart: Teubner.

Baxter, R. J., and Berente, N. 2010. “The Process of Embedding New Information Technology Artifacts into Innovative Design Practices,” *Information and Organization* (20:3-4)Elsevier Ltd, pp. 133–155.

Belkin, N. J., and Robertson, S. E. 1976. “Information Science and the Phenomenon of Information,” *Journal of the American Society for Information Science* (27:4), pp. 197–204.

Bellinger, G., Castro, D., and Mills, A. 2004. “Data, Information, Knowledge, and Wisdom,”.

Benbasat, I., and Barki, H. 2007. “Quo vadis, TAM?,” *Journal of the Association for Information Systems* (8:4), pp. 211–218.

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

Bendel, O., and Hauske, S. 2004. *E-Learning: das Wörterbuch*, Oberentfelde: Sauerländer.

Bensman, S. J. 2007. “Garfield and the Impact Factor,” *Annual Review of Information Science and Technology* (41), pp. 93–155.

Bernstein, R. J. 1983. *Beyond Objectivism and Relativism*, Philadelphia: University of Pennsylvania Press.

Bertalanffy, L. V. 1950. “An Outline of General System Theory,” *The British Journal for the Philosophy of Science* (I:2), pp. 134–165.

Bertalanffy, L. V. 1971. *General System Theory: Foundations, Development, Applications*, London: Allen Lane The Penguin Press.

Beynon-Davies, P. 2009a. "Information Systems as Socio-Technical or Sociomaterial Systems," In *AMCIS 2009 Proceedings*, San Francisco: Association for Information Systems, Paper 705.

Beynon-Davies, P. 2009b. "Neolithic Informatics: The Nature of Information," *International Journal of Information Management* (29:1), pp. 3–14.

Beynon-Davies, P. 2010. "The Enactment of Significance: A Unified Conception of Information, Systems and Technology," *European Journal of Information Systems* (19:4), pp. 389–408.

Beynon-Davies, P. 2011. *Significance. Exploring the Nature of Information, Systems and Technology*, Hampshire: Palgrave Macmillan, pp. 330.

Bijker, W. E. 1995. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*, Cambridge: MIT Press.

Bijker, W. E., and Law, J. 1992. *Shaping Technology/Building Society: Studies in Sociotechnical Change*, Cambridge: MIT Press.

Blair, D. 2006. *Wittgenstein, Language and Information. Back to the Rough Ground!*, Dordrecht: Springer.

Blanchette, J.-F. 2011. "A Material History of Bits," *Journal of the American Society for Information Science* (62:6), pp. 1042–1057.

Bocij, P., Greasley, A., and Hickie, S. 2008. *Business Information Systems: Technology, Development and Management*, (4th Ed.,)Harlow, England: Prentice Hall.

Boell, S. K., and Cecez-Kecmanovic, D. 2010a. "Attributes of information," In *Americas Conference on Information Systems*. Lima, Peru.

Boell, S. K., and Cecez-Kecmanovic, D. 2010b. "Literature Reviews and the Hermeneutic Circle," *Australian Academic and Research Libraries* (41:2), pp. 129–144.

Boell, S. K., and Cecez-Kecmanovic, D. 2010c. "Systematic Review and the Hermeneutic Circle of Literature Reviews," In *Research Applications in Information and Library Studies (RAILS) Conference, 22. January 2010.* (Vol. 18)Canberra: CSU.

Boell, S. K., and Cecez-Kecmanovic, D. 2011a. "Theorizing Information – From Signs to Sociomaterial Practices," In *Australasian Conference on Information Systems 2011*Sydney.

Boell, S. K., and Cecez-Kecmanovic, D. 2011b. "Theorizing Information – From Signs to Sociomaterial Practices," In *SIG Philosophy Workshop at ICIS 2011*Shanghai.

Boell, S. K., and Cecez-Kecmanovic, D. 2011c. "Are Systematic Reviews Better, Less Biased and of Higher Quality?," In *European Conference on Information Systems 2011*, Paper 223.

Boell, S. K., and Cecez-Kecmanovic, D. 2012. "Conceptualizing Information Systems: From 'Input-Processing-Output' Devices to Sociomaterial Apparatuses," In *European Conference on Information Systems 2012*Barcelona, Paper 20.

Bohn, R. E., and Short, J. E. 2009. *How Much Information? 2009. Report on American Consumers*, San Diego: University of California, Global Information Industry Center.

Boland, R. 1987. "The In-formation of Information Systems," In *Critical issues in information systems research*New York: Wiley, pp. 363–379.

Bonfadelli, H. 2005. *Einführung in die Publizistikwissenschaft*, Bern: Haupt.

Boote, D. N., and Beile, P. 2005. "Scholars Before Researchers: On the Centrality of the Dissertation Literature Review in Research Preparation," *Educational Researcher* (34:6), pp. 3–15.

Borgmann, A. 1999. *Holding on to Reality: the Nature of Information at the Turn of the Millennium*, Chicago: University of Chicago Press.

Bostrom, R. P., and Heinen, J. S. 1977. "MIS Problems and Failures: A Socio-Technical Perspective Part I: The Causes," *MIS Quarterly* (1:3), pp. 17–32.

Bourdieu, P. 1976. *Outline of a Theory of Practice*, Cambridge: Cambridge University Press.

Brier, S. 2004. "Cybersemiotics and the Problems of the Information-Processing Paradigm as a Candidate for a Unified Science of Information Behind Library Information Science," *Library Trends* (52:3), pp. 629–657.

Brier, S. 2008. *Cybersemiotics: Why Information is not Enough!*, Toronto: University of Toronto Press.

Briggs, R. O., and Nunamaker, J. F. 2012. "Special Section: Creating Value with Information," *Journal of Management Information Systems* (28:4), pp. 7–10.

Brillouin, L. 1951. "Maxwell's Demon Cannot Operate: Information and Entropy. I," *Journal of Applied Physics* (22:3), pp. 334–337.

Brookes, B. C. 1980. "The Foundations of Information Science. Part 1: Philosophical Aspects," *Journal of Information Science* (2:3-4), pp. 125–133.

Brown, J. S., and Duguid, P. 1994. "Borderline Issues: Social and Material Aspects of Design," *Human-Computer Interaction* (9:1), pp. 3–36.

Brown, J. S., and Duguid, P. 2000. *The Social Life of Information*, Boston: Harvard Business School Press.

Bruce, C. S. 1999. "Workplace Experiences of Information Literacy," *International Journal of Information Management* (19), pp. 33–47.

Bryant, A., and Land, F. 2012. "Discursive Formations and Trans-Disciplinary Agendas: A Response to Walsham," *Journal of Information Technology* (27:3), pp. 249–254.

Buckland, M. K. 1991a. *Information and Information Systems*, Westport: Greenwood Press.

Buckland, M. K. 1991b. "Information as Thing," *Journal of the American Society of Information Science* (42:5), pp. 351–360.

Bulchand-Gidumal, J., and Melián-González, S. 2011. "Maximizing the Positive Influence of IT for Improving Organizational Performance," *The Journal of Strategic Information Systems* (20:4)Elsevier B.V., pp. 461–478.

Burton-Jones, A., Weber, R., and Wand, Y. 2009. "Guidelines for Empirical Evaluations of Conceptual Modeling Grammars," *Journal of the Association for Information Systems* (10:6), pp. 495–532.

Callon, M. 1986. "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay," In *Power action and belief: a new sociology of knowledge?*London: Rutledge & Kegan Paul, pp. 196–233.

Capurro, R. 2009. "Past, Present, and Future of the Concept of Information," *Triple C cognition communication co-operation* (7:2), pp. 125–141.

Capurro, R., and Hjorland, B. 2003. "The Concept of Information," *Annual Review of Information Science and Technology* (37), pp. 343–411.

Castelfranchi, C. 2002. "The Social Nature of Information and the Role of Trust," *International Journal of Cooperative Information Systems* (11:3-4), pp. 381–403.

Cecez-Kecmanovic, D. 2000. "The Discipline of Information Systems: Boundaries Crossed, Boundaries Pushed," In *Transcending Boundaries: Integrating People, Processes and Systems, Brisbane, 6-8 September 2000*Brisbane.

Cecez-Kecmanovic, D. 2002. "The Discipline of Information Systems: Issues and Challenges," In *AMCIS 2002 Proceedings*, pp. 1696–1703.

Cecez-Kecmanovic, D. 2003. "ISD Discourses and the Emancipation of Meaning," In *Twelve International Conference on Information Systems Development*Melbourne, pp. 1–23.

Chae, B., and Poole, M. S. 2005. "The Surface of Emergence in Systems Development: Agency, Institutions, and Large-Scale Information Systems," *European Journal of Information Systems* (14:1), pp. 19–36.

Chakraborty, S., Sarker, Saonee, and Sarker, Suprateek. 2010. "An Exploration into the Process of Requirements Elicitation: A Grounded Approach," *Journal of the Association for Information Systems* (11:4), pp. 212–249.

Chalmers, M. 2004. "Hermeneutics, Information and Representation," *European Journal of Information Systems* (13:3), pp. 210–220.

Chandler, A. D., and Cortada, J. W. (Eds.). 2000. *A Nation Transformed by Information: How Information has Shaped the United States from Colonial Times to the Present*, Oxford: Oxford University Press.

Chatterjee, S., Sarker, S., and Fuller, M. A. 2009. "A Deontological Approach to Designing Ethical Collaboration," *Journal of the Association for Information Systems* (10:3), pp. 138–169.

Checkland, P. 1981. *Systems Thinking, Systems Practice*, New York: Wiley.

Checkland, P. 2000. "Soft Systems Methodology: A Thirty Year Retrospective," *Systems Research and Behavioral Science* (17:SUPPL.), pp. S11–S58.

Checkland, P., and Holwell, S. 1998. *Information, Systems and Information Systems: Making Sense of the Field*, Chichester: Wiley.

Chopra, S., and Dexter, S. D. 2008. *Decoding Liberation: The Promise of Free and Open Source Software*, New York: Routledge.

Churchman, C. W. 1968. *The Systems Approach*, New York, NY: Delta Book.

Ciborra, C. 2002. *The Labyrinths of Information: Challenging the Wisdom of Systems*, Oxford: Oxford University Press.

Ciborra, C. 2006. "Imbrication of Representations: Risk and Digital Technologies," *Journal of Management Studies* (43:6), pp. 1339–1356.

Clark, T. D., Jones, M. C., and Armstrong, C. P. 2007. "The Dynamic Structure of Management Support Systems: Theory Development, Research Focus, and Direction," *MIS Quarterly* (31:3), pp. 579–615.

Cleveland, H. 1982. "Information as a Resource," *The Futurist* (16:6), pp. 34–39.

Cole, C. 1994. "Operationalizing the Notion of Information as a Subjective Construct," *Journal of the American Society for Information Science* (45:7), pp. 465–476.

Cole, F. T. H. 2005. "The Discourse of Data: Exploring Data-related Vocabularies in Geographic Information Systems Description," *Journal of Information Science* (31:1), pp. 44–56.

Cole, F. T. H. 2008. "Taking 'Data' (as a Topic): The Working Policies of Indifference, Purification and Differentiation," In *19th Australasian Conference on Information Systems*Christchurch.

Colgate, S. A., and Ziock, H. 2011. "A Definition of Information, the Arrow of Information, and its Relationship to Life," *Complexity* (16:5), pp. 54–62.

Collins, A. 2007. "From H = log^n to Conceptual Framework: A short History of Information," *History of Psychology* (10:1), pp. 44–72.

Combs, J. P., Bustamante, R. M., and Onwuegbuzie, A. J. 2010. "An Interactive Model for Facilitating Development of Literature Reviews," *International Journal of Multiple Rearch Approaches* (4:2), pp. 159–182.

Conboy, K. 2009. "Agility from First Principles: Reconstructing the Concept of Agility in Information Systems Development," *Information Systems Research* (20:3), pp. 329–354.

Constantinides, P., Chiasson, M. W., and Introna, L. D. 2012. "The Ends of Information Systems Research: A Pragmatic Framework," *MIS Quarterly* (36:1), pp. 1–19.

Contractor, N. S., Monge, P. R., and Leonardi, P. M. 2011. "Multidimensional Networks and the Dynamics of Sociomateriality: Bringing Technology Inside the Network University of Southern California," *Journal of Communication* (5), pp. 682–720.

Cooper, R. 1992. "Formal Organization as Representation: Remote Control, Displacement and Abbreviation," In *Rethinking Organization: New Directions in Organization Theory and Analysis*, M. Reed and M. Hughes (eds.), London: Sage Publications, pp. 254–272.

Cordoba, J.-R., Pilkington, A., and Bernroider, E. W. N. 2012. "Information Systems as a Discipline in the Making: Comparing EJIS and MISQ Between 1995 and 2008," *European Journal of Information Systems* (21:5), pp. 479–495.

Cornelius, I. 1996. "Information and Interpretation," In *Proceedings of CoLIS 2: Second International Conference on Conceptions of Library and Information Science, Oct. 13-16*Copenhagen: The Royal School of Librarianship, pp. 11–21.

Cornelius, I. 2002. "Theorizing Information for Information Science," *Annual Review of Information Science and Technology* (36), pp. 393–425.

Dahlbom, B., and Mathiessen, L. 1993. *Computers in Context: The Philosophy and Practice of Systems Design*, Cambridge: Blackwell.

Daley, B. J., Conceicao, S. C. O., Mina, L., Altman, B. A., Baldor, M., and Brown, J. 2010. "Concept Mapping: A Strategy to Support the Development of Practice, Research, and Theory Within Human Resource Development," *Human Resource Development Review* (9:4), pp. 357–384.

Davenport, T. H. 1997. *Information Ecology: Mastering the Information and Knowledge Environment*, New York: Oxford University Press.

Davies, W. M., and Beaumont, T. J. 2007. *Literature Reviews Business*Melbourne.

Davis, F. D. 1989. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly: Management Information Systems* (13:3), pp. 319–339.

Davis, G. B. 1974. *Management Information Systems: Conceptual Foundations, Structure, and Development*, New York: McGraw-Hill.

Davis, G. B. 2000. "Information Systems Conceptual Foundations: Looking Backward and Forward," In *Organizational and Social Perspectives on Information Technology*, R. L. Baskerville, J. Stage, and J. I. DeGross (eds.), Boston: Kluwer, pp. 61–82.

Davis, G. B., Lee, A. S., Nickles, K. R., Chatterjee, S., Hartung, R., and Wu, Y. 1992. "Diagnosis of an Information System Failure: A Framework and Interpretive Process," *Information & Management* (23), pp. 293–318.

Davis, G. B., and Olson, M. H. 1985. *Management Information Systems: Conceptual Foundations, Structure, and Development*, New York: McGraw-Hill.

Davison, R. M. 2010. "Retrospect and prospect: Information systems in the last and next 25 years: Response and extension," *Journal of Information Technology* (25:4), pp. 352–354.

Davison, R. M. 2012. "Making a World of a Difference," *Journal of Information Technology* (27:2), pp. 100–101.

Day, J. M., Junglas, I., and Silva, L. 2009. "Information Flow Impediments in Disaster Relief Supply Chains," *Journal of the Association for Information Systems* (10:8), pp. 637–660.

Day, R. E. 2001. *The Modern Invention of Information: Discourse, History, and Power*, Carbondale: Southern Illinois University Press.

DeSanctis, G. 2003. "The Social Life of Information Systems Research A Response to Benbasat and Zmud ' s Call for Returning to the IT Artifact The IS Community of Practice," *Journal of the Association for Information Systems* (4:7), pp. 360–376.

DeSanctis, G., and Poole, M. S. 1994. "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory," *Organization Science* (5:2), pp. 121–147.

Debons, A. 1992. "Measurement of Knowledge," *Proceedings of the ASIS Annual Meeting* (29)Univ of Pittsburgh, Pittsburgh, United States, pp. 212–215.

Deetz, S. 2012. "Describing Differences in Approaches to Organization Science: Rethinking Burrell and Morgan and Their Legacy," *Organization Science* (7:2), pp. 191–207.

Dellinger, A. B. 2005. "Validity and the Review of the Literature," *Research in the Schools* (12:2), pp. 41–54.

Denning, P. J. 2001. "The IT Schools Movement," *Communications of the ACM* (44:8), pp. 19–22.

Devlin, K. J. 1991. *Logic and Information*, Cambridge: Cambridge University Press.

Dewett, T., and Jones, G. R. 2001. "The Role of Information Technology in the Organization: A Review, Model, and Assessment," *Journal of Management* (27:3), pp. 313–346.

DiMaggio, P. J. 1995. "Comments on 'What Theory is Not'," *Administrative Science Quarterly* (40:3), pp. 391–397.

Diaz Nafría, J. M., Pérez-Montoro, M., and Salto Alemany, F. 2010. *Glossary of Concepts, Metaphors, Theories and Problems Concerning Information*, (J. M. Diaz Nafría, M. Perez-Montoro Gutierrez, and F. Salto Alemany, eds.)León: Universidad de León, Bitrum.

Dilthey, W. 1957. *Gesammelte Schriften*, Stuttgart: Teubner.

Dong, Y. R. 1996. "Learning How to Use Citations for Knowledge Transformation: Non-Native Doctoral Students' Dissertation Writing in Science," *Research in Teaching of English* (30:4), pp. 428–457.

Dretske, F. I. 1981. *Knowledge and the Flow of Information*, Oxford: Blackwell.

Dretske, F. I. 1983. "Precis of Knowledge and Information Flow," *Behavioral and Brain Sciences* (6), pp. 55–90.

Drucker, P. F. 1993. *Post-Capitalist Society*, New York: HarperBusiness.

Drummond, H. 2011. "MIS and Illusions of Control: An Analysis of the Risks of Risk Management," *Journal of Information Technology* (26:4), pp. 259–267.

Dunn, C. L., Gerard, G. J., and Grabski, S. V. 2011. "Diagrammatic Attention Management and the Effect of Conceptual Model Structure on Cardinality Validation," *Journal of the Association for Information Systems* (12:8), pp. 585–605.

Dunne, C. 2011. "The Place of the Literature Review in Grounded Theory Research," *International Journal of Social Research Methodology* (14:2), pp. 111–124.

Earl, M. J. 1992. "Putting IT in its Place: A Polemic for the Nineties," *Journal of Information Technology* (7:2), pp. 100–108.

Eysenck, H. J. 1995. "Problems with Meta-Analysis," In *Systematic reviews*, I. Chalmers and D. G. Altman (eds.), London: BMJ, pp. 64–74.

Fairthorne, R. A. 1975. "Information: One label, Several Bottles," In *Perspectives in Information Science*, W. J. Cameron and A. Debons (eds.), Leyden: Noordhoff, pp. 65–73.

Falkenberg, E., Hesse, W., Lindgreen, P., Nilsson, B. E., Oei, H. J. L., Rolland, C., Stamper, R. K., Van Assche, F. J. M., Verrijn-Stuart, A. A., and Voss, K. 1996. *FRISCO: A Framework of Information System Concepts*, *System* (Web editio,)Leiden: International Federation for Information Processing.

Fang, F., Guo, Z., and Whinston, A. B. 2008. "Collective Outsourcing to Market (COM): A Market-Based Framework for Information Supply Chain Outsourcing," *Journal of the Association for Information Systems* (9:3), pp. 98–118.

Farradane, J. 1979. "The Nature of Information," *Journal of Information Science* (1:1), pp. 13–17.

Faÿ, E., Introna, L., and Puyou, F. 2010. "Living With Numbers: Accounting for Subjectivity in/with Management Accounting Systems," *Information and Organization* (20:1)Elsevier Ltd, pp. 21–43.

Feak, C. B., and Swales, J. M. 2009. *Telling a Research Story: Writing a Literature Review*, Ann Arbor, Mich: University of Michigan Press.

Feeney, M., and Grieves, M. 1994. *The Value and Impact of Information*, London: Bowker-Saur.

Feldman, M. S., and March, J. G. 1981. "Information in Organizations as Signal and Symbol," *Administrative sciences quarterly* (26:2), pp. 171–186.

Feldman, M. S., and Orlikowski, W. J. 2011. "Theorizing Practice and Practicing Theory," *Organization Science* (22:5), pp. 1240–1253.

Feldman, S. S., and Horan, T. A. 2011. "The Dynamics of Information Collaboration: A Case Study of Blended IT Value Propositions for Health Information Exchange in Disability Determination," *Journal of the Association for Information Systems* (12:2), pp. 189–207.

Fernández-Ríos, L., and Buela-Casal, G. 2009. "Standards for the Preparation and Writing of Psychology Review Articles," *International Journal of Clinical and Health Psychology* (9:2), pp. 329–344.

Finn, J. A. 2005. *Getting a PhD: An Action Plan to Help Manage Your Research, Your Supervisor and Your Project*, London: Routledge.

Fischer, R. 1993. "From Transmission of Signals to Self-creation of Meaning: Transformations in the Concept of Information," *Cybernetica* (36:3), pp. 229–243.

Floridi, L. 2002. "What is the Philosophy of Information?," *Metaphilosophy* (33:1-2), pp. 123–145.

Floridi, L. 2004a. "Open Problems in the Philosophy of Information," *Metaphilosophy* (35:4), pp. 554–582.

Floridi, L. 2004b. "Information," In *The Blackwell guide to the philosophy of computing and information*, L. Floridi (ed.), Oxford: Blackwell, pp. 40–61.

Floridi, L. 2005a. "Is Semantic Information Meaningful Data?," *Philosophy and Phenomenological Research* (70:2), pp. 351–370.

Floridi, L. 2005b. "Information Ethics, its Nature and Scope," *ACM SIGCAS Computers and Society* (35:2), pp. 3–3.

Floridi, L. 2009a. "The Information Society and its Philosophy: Introduction to the Special Issue on the Philosophy of Information, its Nature, and Future Developments," *Information Society* (25:3), pp. 153–158.

Floridi, L. 2009b. "Semantic Conceptions of Information," In *Stanford Encyclopedia of Philosophy*, E. N. Zalta (ed.), Stanford: The Metaphysics Research Lab.

Von Foerster, H. 2003. "On Constructing a Reality," In *Understanding Understanding: Essays on Cybernetics and Cognition*New York: Springer, pp. 211–228.

Forrest, J. 2005. "The Space Shuttle Challenger Disaste: A failure in Decision Support System and Human Factors Management," *DSSResources.COM.* Accessed September 30, 2012 from http://dssresources.com/cases/spaceshuttlechallenger/

Van Fraassen, B. C. 1980. "Arguments Concerning Scientific Realism. Taken from: Van Fraassen, Bas C. The scientific image. Oxford: Clarendon Press," In *Philosophy of Science: The central issues (1989)*, M. Curd and J. A. Cover (eds.), New York: W. W. Northon & Company, pp. 1064–1087.

Freeman, W. J. 2000. "A Neurobiological Interpretation of Semiotics: Meaning, Representation, and Information," *Information Sciences* (124:1-4), pp. 93–102.

Fricke, M. 2009. "The Knowledge Pyramid: A Critique of the DIKW Hierarchy," *Journal of Information Science* (35:2), pp. 131–142.

Frohmann, B. 2004. "Documentation Redux: Prolegomenon to (Another) Philosophy of Information," *Library Trends* (52:3), pp. 387–407.

Fuchs, C. 2009. "Towards a Critical Theory of Information," *Triple C cognition communication co-operation* (7:2), pp. 243–292.

Fuchs, C. A. 2003. "Quantum Mechanics as Quantum Information, Mostly," *Journal of Modern Optics* (50:6-7), pp. 987–1023.

Fugmann, R. 2007. "Informationstheorie: Der Jahrhundertbluff. Eine Zeitkritische Betrachtung (Teil 1)," *Information Wissenschaft und Praxis* (58:8), pp. 449–458.

Fugmann, R. 2008. "Informationstheorie: Der Jahrhundertbluff. Eine Zeitkritische Betrachtung (Teil 2)," *Information Wissenschaft und Praxis* (59:3), pp. 159–164.

Furner, J. 2004a. “Information Studies Without Information,” *Library Trends* (52:3), pp. 427–446.

Furner, J. 2004b. “Conceptual Analysis: A Method for Understanding Information as Evidence, and Evidence as Information,” *Archival Science* (4:3-4), pp. 233–265.

Furner, J. 2010. “Philosophy and Information Studies,” *Annual Review of Information Science and Technology* (44:1).

Gadamer, H.-G. 1975. *Truth and Method (2nd ed.): Translation of Wahrheit und Methode.*, London: Sheed & Ward.

Gadamer, H.-G. 1976. *Philosophical Hermeneutics*, Berkeley: University of California Press.

Galliers, R. D. 1993. “Towards a Flexible Information Architecture: Integrating Business Strategies, Information Systems Strategies and Business Process Redesign,” *Journal of Information Systems* (3:3), pp. 146–159.

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

Galliers, R. D. 2007. “Strategizing for Agility: Confronting Information Systems Inflexibility in Dynamic Environments,” In *Agile Information Systems: Conceptualization, Construction, and Management*, K. C. Desouza (ed.), Amsterdam: Butterworth-Heinemann, pp. 1–15.

Galliers, R. D. (Ed.). 1987. *Information Analysis: Selected Readings*, Sydney: Addison-Wesley.

Galliers, R. D., and Newell, S. 2003. “Back to the Future: From Knowledge Management to Data Management,” *Information Systems and e-Business Management* (1:1), pp. 5–14.

Gardner, M., and Grant, K. 2010. “Business IT/IS Alignment,” In *Strategic Information Systems Management*, K. Grant, R. Hackney, and D. Edgar (eds.), Hampshire: Cenega Learing EMEA, pp. 103–137.

Garfield, E. 1955. “Citation indexes for science: A new dimension in documentation through association of ideas,” *Science* (122:3159), pp. 108–111.

Garfield, E. 1987. “Reviewing Review Literature: Part 1, Definitions and Uses of Reviews,” *Current Contents* (18:May 4), pp. 3–6.

Geertz, C. 1974. “From the Native’s Point of View: On the Nature of Anthropological Understanding,” *Bulletin of the American Academy of Arts and Sciences* (28:1), pp. 26–45.

Gettier, E. L. 1963. “Is justified true belief knowledge?,” *Analysis* (23:6), pp. 121–123.

Giddens, A. 1979. *Central Problems in Social Theory*, Berkeley: University of California Press.

Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structuration*, Cambridge: Polity Press.

Glaser, B. G., and Strauss, A. L. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research*, New York: A. de Gruyter.

Glowalla, U. 2004. “Information und Lernen,” In *Grundlagen der praktischen Information und Dokumentation (5.Aufl.)*Müchen: Saur, pp. 711–715.

Goguen, J. A. 1997. “Toward a Social, Ethical Theory of Information,” In *Social science, techical systems, an cooperative work. Beyond the great divide*Londen: Lawrence Erlbaum Associates, pp. 27–56.

Goodfellow, J. 1995. “Constructing a Narrative,” In *Writing Qualitative Research*, J. Higgs (ed.), Sydney: Hampden Press, pp. 175–187.

Green, B. N., Johnson, C. D., and Adams, A. 2006. “Writing Narrative Literature Reviews for Peer-reviewed Journals: Secrets of the Trade,” *Journal of Chiropractic Medicine* (5:3), pp. 101–117.

Gregor, S. 2006. “The Nature of Theory in Information Systems,” *MIS Quarterly* (30:3), pp. 611–642.

Grover, V. 2012. “The Information Systems Field: Making a Case for Maturity and Contribution,” *Journal of the Association for Information Systems* (13:4), pp. 254–272.

Grover, V., Lyytinen, K., Srinivasan, A., and Tan, B. C. Y. 2008. “Contributing to Rigorous and Forward Thinking Explanatory Theory,” *Journal of the Association for Information Systems* (9:2), pp. 40–47.

Haag, S., and Cummings, M. 2008. *Management Information Systems: For the Information Age*, (7th Ed.,)Boston: McGraw-Hill.

Habermas, J. 1984. *The theory of Communicative Action. Vol 1: Reason and the Rationalization of Society*, Boston: Beacon.

Hakken, D. 1999. *Cyborgs@cyberspace? An Ethnographer Looks to the Future*, New York: Routledge.

Hall, S. 1980. “Encoding/decoding,” In *Culture, Media, Language: Working papers in cultural studies, 1972-79*Lundon: Hutchinson, pp. 128–138.

Hansen, H. R., and Neumann, G. 1978. *Wirtschaftsinformatik 1, Grundlagen und Anwendungen*, Stuttgart: Lucius und Lucius.

Harmon, G. 1984. "The Measurement of Information," *Information Processing and Management* (20:1-2)Information Science, Box 7576, University of Texas, Austin, TX 78712, United States, pp. 193–198.

Hart, C. 1998. *Doing a Literature Review. Releasing the Social Science Research Imagination*, Thousand Oaks: SAGE Publications.

Hartley, J., and Betts, L. 2009. "Common Weaknesses in Traditional Abstracts in the Social Sciences," *Journal of the American Society for Information Science and Technology* (60:10), pp. 2010–2018.

Hartley, R. V. L. 1928. "Transmission of Information," *Bell System Technical Journal* (7:3), pp. 535–563.

Hartmann, W., Näf, M., and Schäuble, P. 2000. *Informationsbeschaffung im Internet: Grundlegende Konzepte Verstehen und Umsetzen*, Zürich: Orell Füssli.

Hassan, N. R. 2011. "Is information systems a discipline? Foucauldian and Toulminian insights," *European Journal of Information Systems* (forthcommi), pp. forthcomming.

Hayles, K. N. 1993. "The Materiality of Informatics," *Configurations* (1:1), pp. 147–170.

Hayles, K. N. 1999. *How We Became Posthuman. Virtual Bodies in Cybernetics, Literature, and Informatics*, Chicago: University of Chicago Press.

Heidegger, M. 2002. *On Time and Being: A Translation of Sein und Zeit*, Chicago: University of Chicago Press.

Henrichs, N. 2004. "Information in der Philosophie," In *Grundlagen der praktischen Information und Dokumentation (5.Aufl.)*Müchen: K.G. Saur, pp. 739–743.

Heyman, B., and Cronin, P. 2005. "Writing for Publication: Adapting Academic Work Into Articles," *British Journal of Nursing* (14:7), pp. 400–403.

Hirschheim, R., and Klein, H. K. 2011. "Tracing the History of the Information Systems Field," In *The Oxford Handbook of Management Information Systems, Critical Perspectives and New Directions*, W. Currie and R. D. Galliers (eds.), Oxford: Oxford University Press, pp. 16–61.

Hirschheim, R., and Klein, H. K. 2012. "A Glorious and Not-So-Short History of the Information Systems Field," *Journal of the Association for Information Systems* (13:4), pp. 188–235.

Hirschheim, R., Klein, H. K., and Lyytinen, K. J. 1995. *Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations*, Cambridge: Cambridge University Press.

Hirschheim, R., Saunders, C., and Straub, D. 2012. "Historical Interpretations of the IS Discipline: An Introduction to the Special Issue," *Journal of the Association for Information Systems* (13:4), pp. i–viii.

Hjorland, B. 2007. "Information: Objective or Subjective/Situational?," *Journal of the American Society for Information Science and Technology* (58:10)Royal School of Library and Information Science, 6 Birketinger, DK-2300, Copenhagen S, Denmark, pp. 1448–1456.

Hjorland, B. 2009. "The Controversy Over the Concept of 'Information': A Rejoinder to Professor Bates," *Journal of the American Society for Information Science and Technology* (60:3), pp. 643.

Hjorland, B. 2011. "Evidence-Based Practice: An Analysis Based on the Philosophy of Science," *Journal of the American Society for Information Science* (62:7), pp. 1301–1310.

Hofkirchner, W. 2011. "Toward a New Science of Information," *Information* (2:2), pp. 372–382.

Houston, R. D., and Harmon, E. G. 2002. "Re-envisioning the Information Concept: Systematic Definitions," In *Emerging Frameworks and Methods: Proceedings of CoLIS4*, Greenwood Village: Libraries Unlimited, pp. 305–308.

Hovorka, D. S., and Germonprez, M. 2011. "Towards an Informativity Account of Design Research," *Sprouts: Working Papers on Information Systems* (11:2011), Article 137.

Huber, G. P. 1990. "A Theory of the Effects of Advanced Information Technologies on Organizational Design, Intelligence, and Decision Making," *The Academy of Management Review* (15:1), pp. 47–71.

Introna, L. D. 1997. *Management, Information and Power: A Narrative of the Involved Manager*, Houndmills, Basingstoke, Hampshire: Macmillan.

Israel, D., and Perry, J. 1990. "What is Information?," In *Information, language, and cognition*, P. P. Hanson (ed.), Vancouver: University of British Columbia Press, pp. 1–19.

Jacob, E. K. 2004. "Classification and Categorization: A Difference that Makes a Difference," *Library Trends* (52:3), pp. 515–540.

Jasperson, J., Buttler, B. S., Carte, T. A., Croes, H. J. P., Saunders, C. S., and Zheng, W. 2002. "Review: Power and Information Technology Research: A Metatriangulation Review," *MIS Quarterly* (26:4), pp. 397–459.

Johnston, R. B., Waller, V., and Milton, S. K. 2005. "Situated Information Systems: Supportitn Routine Activity in Organizations," *International Journal of Business Information Systems* (1:1), pp. 1–25.

Johnstone, D., and Tate, M. 2004. "Bringing Human Information Behaviour into Information Systems Research: An Application of Systems Modelling," *Information Research* (9:4), Paper 191.

Jones, M., and Karsten, H. 2008. "Giddens's Structuration Theory and Information Systems Research," *MIS Quarterly* (32:1), pp. 127–157.

Jones, M., and Orlikowski, W. J. 2009. "Information Technology and the Dynamics of Organizational Change," In *The Oxford Handbook of Information and Communication Technologies*, R. Silverstone, D. Quah, C. Avgerou, and R. Mansell (eds.), Oxford: Oxford University Press, pp. 293–313.

Junglas, I., Niehaves, B., Spiekermann, S., Stahl, B. C., Weitzel, T., Winter, R., and Baskerville, R. 2011. "The Inflation of Academic Intellectual Capital: The Case for Design Science Research in Europe," *European Journal of Information Systems* (20:1), pp. 1–6.

Kallinikos, J. 1995. "The Architecture of the Invisible: Technology is Representation," *Organization* (2:1), pp. 117–140.

Kallinikos, J. 2006. "Information out of Information: On the Self-Referential Dynamics of Information Growth," *Information Technology & People* (19:1), pp. 98(115).

Kallinikos, J. 2012. "Modelling Reality: Context, System and Meaning," In *European Conference on Information Systems 2012*, Paper 4.

Kant, I. 2007. *Critique of Pure Reason*, Basingstoke: Palgrave Macmillan.

Karpatschof, B. 2000. *Human Activity: Contributions to the Anthropological Sciences from a Perspective of Activity Theory*, Copenhagen: Dansk psykologisk.

Kearney, R. 1999. *Poetics of Modernity: Towards Hermeneutic Imagination*, Amherst: Humanity Books.

Keller, T., and Tergan, S.-O. 2005. "Knowledge and Information Visualization: An Introduction," In *Knowledge and information visualization: Searching for synergies*-Berlin: Springer, pp. 1–23.

Kent, W., and Hoberman, S. 2012. *Data and Reality: A Timeless Perspective on Perceiving and Managing Information in Our Imprecise World*, (3rd ed,)Westfield: Technics Publications.

Kettinger, W. J., and Li, Y. 2010. "The Infological Equation Extended: Towards Conceptual Clarity in the Relationship Between Data, Information and Knowledge," *European Journal of Information Systems* (19:4), pp. 409–421.

Khoo, C. S. G., Na, J.-C., and Jaidka, K. 2011. "Analysis of the Macro-level Discourse Structure of Literature Reviews," *Online Information Review* (35:2), pp. 255–271.

King, W. R., and He, J. 2005. "Understanding the Role and Methods of Meta-Analysis in IS Research," *Communications of the Association for Information Systems* (16:1), pp. 665–686.

Kirs, P. J., Kurt, P., and Kroeck, G. 2001. "A Process Model Cognitive Biasing Effects in Information Systems Development and Usage," *Information and Management* (38), pp. 153–165.

Kitchenham, B. 2004. *Procedures for Performing Systematic Reviews*, Keele, Eversleigh: Keele University and NICTA, Technical Report.

Van Kleef, G. A. 2008. "Emotion in Conflict and Negotiation: Introducing the Emotions as Social Information (EASI) Model," In *Research Companion to Emotion in Organizations*Cheltenham: Edward Elgar, pp. 392–404.

Klein, M., and Methlie, L. B. 1990. *Expert Systems: A Decision Support Approach: With Applications in Management and Finance*, Wokingham: Addison-Wesley.

Kogut, B., and Zander, U. 1992. "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology," *Organization Science* (3:3), pp. 383–397.

Konorski, J., and Szpankowski, W. 2008. "What is Information?," In *2008 IEEE Information Theory Workshop, ITW*, pp. 269–270.

Kuhlen, R. 1990. "Zum Stand Pragmatischer Forschung in der Informationswissenschaft," In *Pragmatische Aspekte beim Entwurf und Betrieb von Informationssytemen, Proceedings des 1. Internationalen Symposiums für Informationswissenschaft Universitat Konstanz Konstanzer Schriften zur Informationswissenschaft (Vol. 1)*Konstanz: Universitatsverlag, pp. 13–18.

Kuhlen, R. 1991. "Information and Pragmatic Value Adding: Language Games and Information Science," *Computers and the Humanities* (25:2), pp. 93–101.

Kuhlen, R. 1999. *Die Konsequenzen von Informationsassistenten*, Frankfurt: Suhrkamp.

Kuhlen, R. 2004. "Information," In *Grundlagen der praktischen Information und Dokumentation (5.Aufl.)*Müchen: Saur, pp. 3–19.

Kuhn, T. S. 1962. *The Structure of Scientific Revolutions*, Chicago: University of Chicago Press.

Kumar, K., and van Hillegersberg, J. 2000. "ERP experiences and evolution," *Communications of the ACM* (43:4), pp. 22–26.

Kwan, B. S. C. 2008. "The Nexus of Reading, Writing and Researching in the Doctoral Undertaking of Humanities and Social Sciences: Implications for Literature Reviewing," *English for Specific Purposes* (27:1), pp. 42–56.

Kwan, B. S. C., Chan, H., and Lam, C. 2012. "Evaluating Prior Scholarship in Literature Reviews of Research Articles: A Comparative Study of Practices in Two Research Paradigms," *English for Specific Purposes* (in press)Elsevier Ltd, pp. 1–14.

Lamb, R., and Kling, R. 2003. "Reconceptualizing Users as Social Actors in Information Systems Research," *MIS Quarterly* (27:2), pp. 197–235.

Land, F. F. 1985. "Is An Information Theory Enough?," *The Computer Journal* (28:3), pp. 211–215.

Land, F. F. 1992. "The Information Systems Domain," In *Information Systems Research: Issues, Methods and Practical Guidelines*, R. D. Galliers (ed.), Oxford: Blackwell, pp. 6–13.

Land, F. F., and Hirschheim, R. 1983. "Participative Systems Design: Rationale, Tools and Techniques," *Journal of Applied Systems Analysis* (10), pp. 91–107.

Land, F. F., and Kennedy-McGregor, M. 1987. "Information and Information Systems: Concepts and Perspectives," In *Information Analysis: Selected Readings*, R. D. Galliers (ed.), Sydney: Addison-Wesley, pp. 63–91.

Landauer, R. 1991. "Information is Physical," *Physics Today* (44:5), pp. 23–29.

Landauer, R. 1996. "The Physical Nature of Information," *Physics Letters, Section A: General, Atomic and Solid State Physics* (217:4-5), pp. 188–193.

Langefors, B. 1980. "Infological Models and Information User Views," *Information Systems* (5:1), pp. 17–32.

Lash, S. 2006. "Dialectic of information? A Response to Taylor," *Information Communication and Society* (9:5), pp. 572–581.

Latour, B. 1983. "Give Me a Laboratory and I will Raise the World," In *Science Observed: Perspectives on the Social Study of Science*, K. D. Knorr-Cetina and M. Mulkay (eds.), London: Sage Publications, pp. 141–170.

Latour, B. 1987. *Science in Action*, Cambridge: Harvard University Press.

Latour, B. 2005. *Reassembling the Social: An Introduction into Actor-Network-Theory*, Oxford: Oxford University Press.

Laudon, K. C., and Laudon, J. P. 2010. *Management Information Systems: Managing the Digital Firm*, (11th ed,)London: Pearson.

LePine, J. A., and Wilcox-King, A. 2010. "Editors' Comments: Developing Novel Theoretical Insight from Reviews of Existing Theory and Research," *Academy of Management Review* (35:4), pp. 506–509.

Lee, A. S. 2001. "Editor's Comments," *MIS Quarterly* (25:1), pp. iii–vii.

Lee, A. S. 2004. "Thinking About Social Theory and Philosophy for Information Systems," In *Social Theory and Philosophy for Information Systems*Chichester: Wiley, pp. 1–26.

Lee, A. S. 2010. "Retrospect and Prospect: Information Systems Research in the Last and Next 25 Years," *Journal of Information Technology* (25:4), pp. 336–348.

Leff, H. S., and Rex, A. F. (Eds.). 2003. *Maxwell's Demon 2: Entropy, Classical and Quantum Information, Computing*, (Vol. 35)Philadelphia: Institute of Physics Pub.

Leidner, D. E., Lo, J., and Preston, D. 2011. "An Empirical Investigation of the Relationship of IS Strategy with Firm Performance," *Journal of Strategic Information Systems* (20:4)Elsevier B.V., pp. 419–437.

Lenski, W. 2010. "Information: A Conceptual Investigation," *Information* (1:2), pp. 74–118.

Leonardi, P. M. 2007. "Activating the Informational Capabilities of Information Technology for Organizational Change," *Organization Science* (18:5), pp. 813–831.

Leonardi, P. M. 2011. "When Flexible Routines Meet Flexible Technologies: Affordances, Constraint, and the Imbrication of Human and Material Agencies," *MIS Quarterly* (35:1), pp. 147–167.

Leonardi, P. M., and Barley, S. R. 2008. "Materiality and Change: Challenges to Building Better Theory About Technology and Organizing," *Information and Organization* (18:3), pp. 159–176.

Leonardi, P. M., and Barley, S. R. 2010. "What's Under Construction Here? Social Action, Materiality, and Power in Constructivist Studies of Technology and Organizing," *The Academy of Management Annals* (4:1), pp. 1–51.

Levy, Y., and Ellis, T. J. 2006. "A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research," *Informing Science Journal* (9), pp. 181–212.

Lewis, P. J. 1991. "The Decision Making Basis for Information Systems: The Contribution of Vickers' Concept of Appreciation to a Soft Systems Perspective," *European Journal of Information Systems* (1:1), pp. 33–43.

Liebenau, J., and Backhouse, J. 1990. *Understanding Information: An Introduction*, London: Macmillan.

Lievrouw, L. A., and Farb, S. E. 2003. "Information and Equity," *Annual Review of Information Science and Technology* (37), pp. 499–540.

Lilley, S., Lightfoot, G., and Amaral, P. 2004. *Representing Organization: Knowledge, Management, and the Information Age*, Oxford: Oxford University Press.

Lin, S. 2010. "Information – A New Open Access Scientific Journal on Information Science, Information Technology, Data, Knowledge and Communication," *Information* (1:1), pp. 1–2.

Losee, R. M. 1990. *The Science of Information: Measurement and Applications*, San Diego: Academic Press.

Losee, R. M. 1997. "A Discipline Independent Definition of Information," *Journal of the American Society for Information Science* (48:3)Univ. of North Carolina-Chapel Hill, Manning Hall, Chapel Hill, NC 27599-3360, United States, pp. 254–269.

Lotka, A. J. 1926. "The Frequency Distribution of Scientific Productivity," *Journal of the Washington Academy of Science* (16:12), pp. 317–323.

Lucassen, T., and Schraagen, J. M. 2011. "Factual Accuracy and Trust in Information: The Role of Expertise," *Journal of the American Society for Information Science* (62:7), pp. 1232–1242.

Lyytinen, K. 1991. "Simple Stage-Models of IT Penetration," *Scandinavian Journal of Information Systems* (3), pp. 87–109.

Lyytinen, K. 2006. "'Ontological Foundations of Conceptual Modeling' by Boris Wyssusek — A Critical Response," *Scandinavian Journal of Information Systems* (18:1), pp. 81–83.

Lyytinen, K., and King, J. L. 2004. "Nothing At The Center?: Academic Legitimacy in the Information Systems Field," *Journal of the Association for Information Systems* (5:6), pp. 220–246.

Lyytinen, K., and Newman, M. 2006. "Punctuated Equilibrium, Process Models and Information System Development and Change: Towards a Socio-Technical Process Analysis," *Sprouts: Working Papers on Information Systems* (6:1), Paper 1.

MISQ. 2006. "Objectives of the MISQ Theory and Review,".

MacKay, D. 1969. *Information, Mechanism and Meaning*, Cambridge: MIT Press.

MacLure, M. 2005. "'Clarity Bordering on Stupidity': Where's the Quality in Systematic Review?," *Journal of Education Policy* (20:4), pp. 393–416.

Macgregor, G. 2005. "The Nature of Information in the Twenty-First Century: Conundrums for the Informatics Community?," *Library Review* (54:1), pp. 10–23.

Machi, L. A., and McEvoy, B. T. 2009. *The Literature Review: Six Steps To Success*, Thousand Oaks: Corwin Press.

Machlup, F. 1983. "Semantic Quirks in Studies of Information," In *The Study of Information: Interdisciplinary Messages*New York: Wiley, pp. 641–671.

Machlup, F., and Mansfield, U. 1983. *The Study of Information: Interdisciplinary Messages*, New York: Wiley.

Mackay, D. M. 1983. "The Wider Scope of Information Theory," In *The Study of Information*New York: Wiley, pp. 485–492.

Madden, A. D. 2004. "Evolution and Information," *Journal of Documentation* (60:1), pp. 9–23.

Mahler, G. 1996. "Quantum Information," In *Information: New Questions to a Multidisciplinary Concept*, K. Kornwachs and K. Jacoby (eds.), Berlin: Akademie Verlag, pp. 103–118.

March, J. G., and Sevon, G. 1988. "Gossip, Information, and Decision Making," In *Decisions and organizations*New York: Blackwell, pp. 429–444.

Marchionini, G. 1995. *Information Seeking in Electronic Environments*, Cambridge: Cambridge University Press.

Markus, M. L., and Robey, D. 1988. "Information Technology and Organizational Change: Causal Structure in Theory and Research," *Management Science* (34:5), pp. 583–598.

Marradi, A. 1990. "Classification, Typology, Taxonomy," *Quality and Quantity* (24:2), pp. 129–157.

Martignon, L. 2001. "Information Theory," In *International Encyclopedia of the Social & Behavioral Sciences*Elsevier, pp. 7476–7480.

Mason, R. M. 1979. *A Study of the Perceived Benefits of Information Analysis Center Services. (Final Report National Science Foundation Contact No. DSI-7718035)*Atlanta.

Mason, R. O., and Mitroff, I. I. 1973. "A Program for Research on Management Information Systems," *Management Science* (19:5), pp. 475–487.

McKay, J., Marshall, P., and Hirschheim, R. 2012. "The Design Construct in Information Systems Design Science," *Journal of Information Technology* (27:2), pp. 125–139.

McKinney Jr, E. H., and Yoos, C. J. 2010. "Information About Information: A Taxonomy of Views," *MIS Quarterly* (34:2), pp. 329–344.

McKinnon, S. M., and Bruns, W. J. 1992. *The Information Mosaic*, Boston: Harvard Business School Press.

McLeod, R., and Schell, G. 2007. *Management Information Systems*, Upper Saddle River: Prentice Hall.

McNurlin, B., Sprague, R. H., and Bui, T. 2009. "Information Systems Management in Practice,"Upper Saddle River, NJ: Prentice Hall.

Meadow, C. T., and Yuan, W. 1997. "Measuring the Impact of Information: Defining the Concepts," *Information Processing and Management* (33:6)Faculty of Information Studies, University of Toronto, Toronto, Ont. M5S 3G6, Canada, pp. 697–714.

Miller, G. A. 1956. "The Magical Number Seven Plus Minus Two: Some Limits on Our Capacity for Processing Information," *Psychologcal Review* (63:2), pp. 81–97.

Miller, G. A. 1983. "Information Theory in Psychology," In *The Study of Information*-New York: Wiley, pp. 493–496.

Miller, G. L. 1987. *Resonance, Information, and the Primacy of Process: Ancient Light on Modern Information and Communication Theory and Technology*Rutgers University, New Brunswick.

Milton, S. K. 2007. "Ontological Foundations of Representational Information Systems: An Australian Perspective," *Scandinavian Journal of Information Systems* (19:1), pp. 109–134.

Mingers, J. 1995. "Information and Meaning: Foundations for an Intersubjective Account," *Information Systems Journal* (5:4), pp. 285–306.

Mingers, J. 1996. "An Evaluation of Theories of Information With Regard to the Semantic and Pragmatic Aspects of Information Systems," *Systems Practice* (9:3), pp. 187–209.

Mingers, J. 1997. "The Nature of Information and its Relationship to Meaning," In *Philosophical Aspects of Information Systems*, R. Winder, S. K. Probers, and I. A. Beeson (eds.), London: Taylor and Francis, pp. 73–84.

Mingers, J. 2004. "Real-izing Information Systems: Critical Realism as an Underpinning Philosophy for Information Systems," *Information and Organization* (14:2), pp. 87–103.

Mingers, J. 2010. "Prefiguring Floridi's Theory of Semantic Information," *Kent Business School Working Paper Series* (7595:235), pp. 1–18.

Mingers, J., and Walsham, G. 2010. "Towards ethical information systems: The contribution of discourse ethics," *MIS Quarterly* (34:4), pp. 833–854.

Mittleman, D. D. 2009. "Planning and Design Considerations for Computer Supported Collaboration Spaces," *Journal of the Association for Information Systems* (10:3), pp. 278–305.

Moisiadis, F., Genrich, R., Stair, R. M., and Reynolds, G. W. 2008. *Principles of Information Systems*, (1st Aust,)Melbourne: Cenega Learing EMEA.

Mooer, C. N. 1996. "Mooers' Law or Why Some Retrieval Systems Are Used and Others Are Not," *Bulletin of the American Society for Information Science and Technology* (23:1), pp. 22–23.

Moore, G. E. 1998. "Cramming More Components onto Integrated Circuits," *Proceedings of the IEEE* (86:1), pp. 82–85.

Morris, C. W. 1946. *Signs, Language and Behavior*, New York: Prentice-Hall.

Mukhopadhyay, A. K. 2008. "A Radical View of Information: On its Nature and Science," *Frontier Perspectives* (16:2), pp. 19–29.

Mumford, E. 2006. "The Story of Socio-Technical Design: Reflections on its Successes, Failures and Potential," *Information Systems Journal* (16:4), pp. 317–342.

Murdock, G., and Golding, P. 1989. "Information Poverty and Political Inequality: Citizenship in the Age of Privatized Communications," *Journal of Communication* (39:3), pp. 180–195.

Musgrave, A. 1985. "Realism Versus Constructive Empiricism. Taken from: Churchland, Paul M.; & Hooker, Clifford A. (Eds). Images of science. Chicago: University of Chicago Press," In *Philosophy of Science: The central issues (1989)*, M. Curd and J. A. Cover (eds.), New York: W. W. Northon & Company, pp. 1088–1113.

Myers, M. D. 2003. "The IS Core - VIII: Defining the Core Properties of the IS Disciplines: Not Yet, Not Now," *Communications of the Association for Information Systems* (12:1), Article 38.

Nauta, D. 1972. *The Meaning of Information*, The Hague: Mouton.

Neely, M. P., and Cook, J. S. 2011. "Fifteen Years of Data and Information Quality Literature: Developing a Research Agenda for Accounting," *Journal of Information Systems* (25:1), pp. 79–108.

von Neumann, J. 1951. "The General and Logical Theory of Automata," In *Cerebral Mechanisms in Behavior; The Hixon Symposium*, A. Lloyd (ed.), Oxford: WileyJeffress, pp. 1–41.

Nevo, S., Nevo, D., and Ein-Dor, P. 2009. "Thirty Years of IS Research: Core Artifacts and Academic Identity," *Communications of the Association for Information Systems* (25:1), pp. 221–242.

Ngwenyama, O. K., and Lee, A. S. 1997. "Communication Richness in Electronic Mail: Critical Social Theory and the Contextuality of Meaning," *MIS Quarterly* (12:2), pp. 145–167.

Nonaka, I., and Takeuchi, H. 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, New York: Oxford University Press.

Norman, D. A. 2002. *The Design of Everyday Things*, *The design of everyday things*New York: Basic Books.

Novak, J. D. 2004. "A Science Education Research Program That Led to the Development of the Concept Mapping Tool and a New Model for Education," In *Concept Maps: Theory, Methodology, Technology: Proceedings of the First International Conference on Concept Mapping*, A. J. Cañas, J. D. Novak, and F. M. González (eds.), Pamplona, Spain: Universidad Pública de Navarra, pp. 457–467.

Nunberg, G. 1996. "Farewell to the Information Age," In *The future of the book*Berkeley: University of California Press, pp. 103–138.

Nyquist, H. 1924. "Certain Factors Affecting Telegraph Speed," *Bell System Technical Journal* (3:2), pp. 324–346.

OBrien, J. A., and Marakas, G. M. 2009. *Management Information Systems*, (9th Ed.,) Boston: McGraw-Hill.

Okoli, C., and Schabram, K. 2010. "A Guide to Conducting a Systematic Literature Review of Information Systems Research," *Sprouts: Working Papers on Information Systems* (10:26).

Onwuegbuzie, Anthony J Collins, K. M. T., Leech, N. L., Dellinger, A. B., and Jiao, Q. G. 2007. "Mixed Methods + Literature Reviews = Mixed Research Syntheses: A Framework for Conducting and Writing Rigorous, Comprehensive, and Insightful Literature Reviews," In *The World of Educational Quality. Annual Meeting of the American Educational Research Association*Chicago.

Orlikowski, W. J. 1992. "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science* (3:3), pp. 398–427.

Orlikowski, W. J. 1996. "Improvising Organizational Transformation Over Time: A Situated Change Perspective," *Information Systems Research* (7:1), pp. 63–92.

Orlikowski, W. J. 2000. "Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations," *Organization Science* (11:4), pp. 404–428.

Orlikowski, W. J. 2002. "Knowing in Practice: Enacting a Collective Capability in Distributed Organizing," *Organization Science* (13:3), pp. 249–273.

Orlikowski, W. J. 2007. "Sociomateriality: A Practice Lens on Technology at Work," In *ICTs in the Contemporary World Seminar*.

Orlikowski, W. J. 2010. "The Sociomateriality of Organisational Life: Considering Technology in Management Research," *Cambridge Journal of Economics* (34:1), pp. 125–141.

Orlikowski, W. J., and Gash, D. C. 1994. "Technological Frames: Making Sense of Information Technology in Organizations," *ACM Transactions on Information Systems* (12:2), pp. 174–207.

Orlikowski, W. J., and Iacono, C. S. 2001. "Research commentary: Desperately seeking the 'IT' in IT research - A call to theorizing the IT artifact," *Information Systems Research* (12:2), pp. 121–134.

Orlikowski, W. J., and Scott, S. V. 2008. "Sociomateriality: Challenging the Separation of Technology, Work and Organization," *The Academy of Management Annals* (2:1), pp. 433–474.

Osborne, M. J. 2004. *An Introduction to Game Theory*, New York: Oxford University Press.

Ostalé, J. 2009. "Analysis of Semantic Information via Information Reports," *Triple C cognition communication co-operation* (7:2), pp. 202–207.

Österle, H., Becker, J., Frank, U., Hess, T., Karagiannis, D., Krcmar, H., Loos, P., Mertens, P., Oberweis, A., and Sinz, E. J. 2011. "Memorandum on Design-Oriented Information Systems Research," *European Journal of Information Systems* (20:1), pp. 7–10.

Osterloh, M., and von Wartburg, I. 1998. "Organisationales Lernen und Technologie-Management," In *Technologiemanagement: Idee und Praxis*, Zürich: Verlag Industrielle Organisation, pp. 138–156.

Paisley, W. 1980. "Information and Work," In *Progress in communication sciences (Vol. 2)*, Norwood: Ablex, pp. 113–165.

Pant, S., Sim, H. T., and Hsu, C. 2001. "A Framework for Developing Web Information Systems Plans: Illustration with Samsung Heavy Industries Co., Ltd.," *Information and Management* (38), pp. 385–408.

Parker, E. B. 1973. "Information and Society," *Annual review of information science and technology* (8), pp. 345–373.

Paul, R. J. 2007. "Challenges to Information Systems: Time to Change," *European Journal of Information Systems* (16:3), pp. 193–195.

Paul, R. J. 2010. "Loose Change," *European Journal of Information Systems* (19:4), pp. 379–381.

Pearlson, K. E., and Saunders, C. S. 2010. *Managing and Using Information Systems: A Strategic Approach*, (4th Ed.,)Hoboken: Wiley.

Peirce, C. S. 1873. "On the Nature of Signs," In *Peirce on Signs: Writings on Semiotic* (Vol. Winter-Spr)Chapel Hill: University of North Carolina Press, pp. 141–143.

Peirce, C. S. 1955. *Philosophical Writings of Peirce*, (J. Bachler, ed.)New York: Dover Publications.

Perry, C. 1998. "A Structured Approach for Presenting Theses," *Australasian Marketing Journal* (6:1)Elsevier, pp. 63–85.

Peters, J. D. 1988. "Information: Notes Toward a Critical History," *Journal of Communication Inquiry* (12:2), pp. 9–23.

Pettigrew, A. 1999. "Organizing to Improve Company Performance," *HotTopics, Warwick Business School* (1:5).

Phang, C. W., Kankanhalli, A., and Sabherwal, R. 2009. "Usability and Sociability in Online Communities: A Comparative Study of Knowledge Seeking and Contribution," *Journal of the Association for Information Systems* (10:10), pp. 721–747.

Phlips, L. 1988. *The Economics of Imperfect Information*, Cambridge: Cambridge University Press.

Pickering, A. 1995. *The Mangle of Practice: Time, Agency and Science*, Chicago: University of Chicago Press.

Popper, K. R. 1972. *Objective Knowledge: An Evolutionary Approach*, Oxford: Clarendon Press.

Popper, K. R. 1978. "Three Worlds,".

Popper, K. R. 1994. *Knowledge and the Body-Mind Problem: In Defence of Interaction*, *Defence of Interaction*, (M. A. Notturno, ed.)London: Routledge.

Pratt, A. D. 1977. "The Information of the Image: A Model of the Communication Process," *Libri* (27:3), pp. 204–220.

Pratt, A. D. 1978. "Letters to the Editor: Information Concepts," *Journal of Documentation* (34:3), pp. 242–244.

Pratt, A. D. 1982. *The Information of the Image*, Norwood: Ablex.

Price, R., and Shanks, G. 2005. "A Semiotic Information Quality Framework: Development and Comparative Analysis," *Journal of Information Technology* (20:2), pp. 88–102.

Qvortrup, L. 1993. "The Controversy Over the Concept of Information. An Overview and a Selected and Annotated Bibliography," *Cybernetics & human knowing* (1:4), pp. 3–24.

Ramberg, B., and Gjesdal, K. 2009. "Hermeneutics," In *Stanford Encyclopedia of Philosophy*Stanford: The Metaphysics Research Lab.

Randall, D., Harper, R., and Rouncefield, M. 2007. *Fieldwork for Design: Theory and Practice*, London: Springer.

Rapoport, A. 1955. "What is Information?," *Synthese* (9:1), pp. 157–173.

Rasmusen, E. 2007. *Games and Information. An Introduction to Game Theory*, (fourth,)Malden: Blackwell.

Ratzek, W. 2004. "Informationsutopien - Proaktive Zukunftsgestalltung. Ein Essay," In *Grundlagen der praktischen Information und Dokumentation (5.Aufl.)*Müchen: Saur, pp. 115–124.

Rayward, B. W. 2011. "Information for the Public: Information Infrastructure in the Republic of Letters as Reflected in the Work of Théophraste Renaudot, (1586-1653), Gabriel Naudé (1600-1653), Samuel Hartlib (1600-1662) and John Dury (1596-1680)," In *Information History in the Modern World*Basingstoke: Palgrave Macmillan, pp. 31–56.

Recker, J., Indulska, M., Rosemann, M., and Green, P. 2009. "Business Process Modeling: A Comparative Analysis," *Journal of the Association for Information Systems* (10:4), pp. 333–363.

Rice, R. E., McCreadie, M., and Chang, S.-J. L. 2001. *Accessing and Browsing Information and Communication*, Cambridge: MIT Press.

Ricoeur, P. (1981). *Hermeneutics and the Human Sciences: Essays on Language, Action and Interpretation*, Cambridge: Cambridge University Press.

Ridley, D. 2008. *The Literature Review. A Step-by-Step Guide for Students*, Thousand Oaks: SAGE.

Riemer, K., and Johnston, R. B. 2011. "Artifact or Equipment? Rethinking the Core of IS useing Heidegger's Ways of Being," In *International Conference on Information Systems*Shanghai, pp. 1–18.

Ritchie, D. 1986. "Shannon and Weaver - Unreveling the Paradox of Information," *Communication Research* (13:2), pp. 278–298.

Robey, D. 2003. "Identity, Legitimacy and the Dominant Research Paradigm: An Alternative Prescription for the IS Discipline A Response to Benbasat and Zmud ' s Call for Returning to the IT Artifact," *Journal of the Association for Information Systems* (4:7), pp. 352–359.

Rocco, T. S., and Plakhotnik, M. S. 2009. "Literature Reviews, Conceptual Frameworks, and Theoretical Frameworks: Terms, Functions, and Distinctions," *Human Resource Development Review* (8:1), pp. 120–130.

Romm, N. 1997. "Implications of Regarding Information as Meaningful Rather than Factual," In *Philosophical aspects of information systems*London: Taylor & Francis, pp. 23–34.

Rouse, J. 1996. *Engaging Science: How to Understand its Practices Philosophically*, Ithaca: Cornell University Press.

Rowe, F. 2012. "Toward a Richer Diversity of Genres in Information Systems Research: New Categorization and Guidelines," *European Journal of Information Systems* (21:5), pp. 469–478.

Rowley, J. 1998. "What is Information?," *Information Services and Use* (18:4), pp. 243–254.

Rowley, J. 2007. "The Wisdom Hierarchy: Representations of the DIKW Hierarchy," *Journal of Information Science* (33:2), pp. 163–180.

Rudd, D. 1983. "Do We Really Need World III? Information Science With or Without Popper," *Journal of Information Science* (7:3), pp. 99–105.

Ryan, S. 2009. "Wisdom," In *Stanford Encyclopedia of Philosophy*, E. N. Zalta (ed.), (Spring 200,)Stanford: The Metaphysics Research Lab.

Sambamurthy, V., Bharadwaj, A., and Grover, V. 2003. "Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," *MIS Quarterly* (27:2), pp. 237–263.

Sandelowski, M. 2008. "Reading, Writing and Systematic Review," *Journal of advanced nursing* (64:1), pp. 104–10.

Saracevic, T. 1999. "Information Science," *Journal of the American Society for Information Science* (50:12)School of Communication, Information and Library Studies, Rutgers University, 4 Huntington Street, New Brunswick, NJ 08903, United States, pp. 1051–1063.

de Saussure, F. 1959. *Course in General Linguistics*, New York: Philosophical Library.

Scarrott, G. G. 1989. "The Nature of Information," *The Computer Journal* (32:3), pp. 262–266.

Schatzki, T. R. 1997. "Practices and Actions A Wittgensteinian Critique of Bourdieu and Giddens," *Philosophy of the Social Sciences* (27:3), pp. 283–308.

Schatzki, T. R. 2006. "On Organizations as they Happen," *Organization Studies* (27:12), pp. 1863–1873.

Schleiermacher, F. 1998. *Hermeneutics and Criticism and other Writings*, New York: Cambridge University Press.

Schucan, C. P. 1999. *Effektivitätssteigerung Mittels Konzeptionellem Informationsmanagement Arbeit*Zürich: PhD dissertation, ETH Zürich.

Schultze, U. 2000. "A Confessional Account of an Ethnography About Knowledge Work," *MIS Quarterly* (24:1), pp. 3–41.

Schultze, U. 2012. "Will Making the World Better Through ICT Make the IS field Better Off?," *Journal of Information Technology* (27:2), pp. 108–109.

Schultze, U., and Leidner, D. E. 2002. "Studying Knowledge Management in Information Systems Research: Discourses and Theoretical Assumptions," *MIS Quarterly* (26:3), pp. 213–242.

Schwarz, A., and Chin, W. 2007. "Looking Forward: Toward an Understanding of the Nature and Definition of IT Acceptance," *Journal of the Association for Information Systems* (8:3), pp. 230–243.

Schwarz, A., Mehta, M., Johnson, N., and Chin, W. W. 2007. "Understanding Frameworks and Reviews: A Commentary to Assist us in Moving Our Field Forward by Analyzing Our Past," *DATA BASE for Advances in Information Systems* (38:3), pp. 29–50.

Schönian, K. 2011. "From 'Virtuality' to Practice: Researching the Intranet as a 'Sociomaterial Assemblage'," *Graduate Journal of Social Science* (8:3), pp. 142–160.

Scopus. 2012. "What does it Cover?,".

Sebeok, T. A. 1972. *Perspectives in Zoosemiotics*, The Hague: Mouton.

Seife, C. 2006. *Decoding the Universe: How the New Science of Information is Explaining Everything in the Cosmos, From our Brains to Black Holes*, New York: Viking.

Sengupta, J. 1993. *Econometrics of Information and Efficiency*, Dordrecht: Kluwer Academic Publishers.

Shannon, C. E. 1948. "A Mathematical Theory of Communication," *Bell System Technical Journal* (27:3,4), pp. 379–423; 623–656.

Shannon, C. E., and Weaver, W. 1949. *The Mathematical Theory of Communication*, Urbana: University of Illinois Press.

Siau, K., Tan, X., and Sheng, H. 2010. "Important Characteristics of Software Development Team Members: An Empirical Investigation Using Repertory Grid," *Information Systems Journal* (20), pp. 563–580.

Soffer, P., and Wand, Y. 2007. "Goal-Driven Multi-Process Analysis," *Journal of the Association for Information Systems* (8:3), pp. 175–203.

Spang-Hanssen, H. 2001. "How to Teach About Information as Related to Documentation?," *Human IT* (5:1).

Stamper, R. 1973. *Information in Business and Administrative Systems*, London: Batsford.

Stamper, R. 1985. "Towards a Theory of Information. Information: Mystical Fluid or a Subject for Scientific Enquiry?," *Computer Journal* (28:3), pp. 195–199.

Stamper, R. 1987. "Semantics," In *Critical Issues in Information Systems Research*London: Wiley, pp. 43–78.

Stamper, R. 1991. "The Semiotic Framework for Information Systems Research," In *Information Systems research: Contemporary Approaches & Emergent Traditions*, H.-E. Nissen, H. K. Klein, and R. Hirschheim (eds.), Amsterdam: North Holland, pp. 515–528.

Stamper, R. 1992. "Signs, Organizations, Norms and Information Systems," In *ISOP 92 Proceedings Third Australian Conference on Information Systems, Wollongong, Australia, 5-8 October*, pp. 21–65.

Steinmüller, W. 1993. *Informationstechnologie und Gesellschaft: Einführung in die Angewandte Informatik*, Darmstadt: Wissenschaftliche Buchgesellschaft, pp. 998.

Stenmark, D. 2001. "The Relationship Between Information and Knowledge," In *Proceedings of the 24th Information Systems Research Seminar in Scandinavia (IRIS 24)*Ulvik, Norway.

Stonier, T. 1989. "Towards a General-Theory of Information II. Information and Entropy," *Aslib Proceedings* (41:2), pp. 41–55.

Straub, D. 2006. "The Value of Scientometric Studies: An Introduction to a Debate on IS as a Reference Discipline," *Journal of the Association for Information Systems* (7:5), pp. 241–246.

Straub, D. W. (forthcoming). "Editorial: Use," *MIS Quarterly*.

Strauss, A. L., and Corbin, J. 1990. *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*, London: Thousand Oaks.

Suchman, L. A. 1987. *Plans and Situated Actions: The Problem of Human-Machine Communication*, Cambridge: Cambridge University Press.

Sun, H. 2010. "Sellers' Trust and Continued Use of Online Marketplaces," *Journal of the Association for Information Systems* (11:4), pp. 182–211.

Swift, D. F., Winn, V. A., and Bramer, D. A. 1979. "Sociological Approach to the Design of Information Systems," *Journal of the American Society for Information Science* (30:4), pp. 215–223.

Symons, V. J. 1991. "Impacts of Information Systems: Four Perspectives," *Information and Software Technology* (33:3), pp. 181–190.

TREC. 2006. "Data - English Relevance Judgements,". Accessed September 30, 2012 from: http://trec.nist.gov/data/reljudge_eng.html

TREC. 2012. "TREC Tracks,". Accessed September 30, 2012 from: http://trec.nist.gov/tracks.html

Tague-Sutcliffe, J. 1995. *Measuring Information: An Information Services Perspective*, San Diego: Academic Press.

Taylor, C. 2006. "Engaged Agency and Background in Heidegger," In *The Cambridge Companion to Heidegger* (2nd ed,)Cambridge: Cambridge University Press, pp. 202–221.

Taylor, R. S. 1986. *Value-Added Processes in Information Systems*, Norwood: Ablex.

Taylor, R. S. 1991. "Information Use Environments," In *Progress in communication science*, B. Dervin and M. J. Voigt (eds.), Norwood: Ablex, pp. 173–216.

Thompson, F. B. 1968. "The Organization is the Information," *American Documentation* (19:3), pp. 305–308.

Thompson, S. G. 1995. "Why Sources of Heterogenity in Meta-Analysis Should be Investigated," In *Systematic reviews*, I. Chalmers and D. G. Altman (eds.), London: BMJ, pp. 48–63.

Thorngate, W. 1995. "Measuring the Effects of Information on Development," In *Making a Difference, Measuring the Impact of Information on Development. Proceedings of a Workshop Held in Ottawa, Canada 10-12 July 1995*Ottawa: IDRC, pp. 195–200.

Toffler, A. 1983. *Previews & Premises*, New York: Morrow.

Torvinen, V., and Jalonen, K. 2000. "Stimulating Power Games as a Part of Systems Development," *European Journal of Information Systems* (9:1), pp. 16–24.

Truex, D. P., Baskerville, R. L., and Klein, H. 1999. "Growing Systems in Emergent Organizations," *Communications of the ACM* (42:8), pp. 117–123.

Tuomi, I. 1999. "Data Is More Than Knowledge: Implications of the Reversed Knowledge Hierarchy for Knowledge Management and Organizational Memory," *Journal of Management Information Systems* (16:3), pp. 103–117.

Turban, V. 2010. "Information Technology for Management: Improving Performance in the Digital Economy,"Hoboken: Wiley.

Turing, A. M. 1950. “Computing Machinery and Intelligence,” *Mind* (LIX:236), pp. 433–460.

UKAIS. 2012. “Definition of IS,” *About*.

Valacich, J. S., and Schneider, C. 2012. *Information Systems Today: Managing the Digital World*, (5th ed,)Upper Saddle River, NJ: Prentice Hall.

de Vaujany, F.-X., Walsh, I., and Mitev, N. 2011. “An historically grounded critical analysis of research articles in IS,” *European Journal of Information Systems* (20:4), pp. 395–417.

Vedral, V. 2010. *Decoding Reality: The Universe as Quantum Information*, Oxford: Oxford University Press, pp. 229.

Venkatesh, V. 2011. *Road to Success: A Guide for Doctoral Students and Junior Faculty Members in the Behavioral and Social Sciences*, Indianapolis: Dog Ear.

Walsham, G. 2012. “Are We Making a Better World with ICTs? Reflections on a Future Agenda for the IS Field,” *Journal of Information Technology* (27:2), pp. 87–93.

Wand, Y., and Weber, R. 1990. “Toward a Theory of the Deep Structure of Information Systems,” In *ICIS 1990 Proceedings*, J. I. De Gross, M. Alavi, and H. Oppelland (eds.), Copenhagen: ACM Press, pp. 61–71.

Wand, Y., and Weber, R. 1995. “On the Deep Structure of Information Systems,” *Information Systems Journal* (5:3), pp. 203–223.

Watson, R. T. 2001. “Introducing MISQ Review - A New Department in MIS Quarterly,” *MIS Quarterly* (25:1), pp. 103–106.

Weaver, W. 1949. “The Mathematics of Communication,” *Scientific American* (181:1), pp. 11–15.

Weber, R. 2012. “Evaluating and Developing Theories in the Information Systems Discipline,” *Journal of the Association for Information Systems* (13:1), pp. 1–30.

Webster, J., and Watson, R. T. 2002. “Analyzing the Past to Prepare for the Future: Writing a Literature Review,” *MIS Quarterly* (26:2), pp. xiii–xxiii.

Weick, K. E. 1985. “Cosmos vs. Chaos: Sense and Nonsense In Electronic Contexts,” *Organizational Dynamics* (14:2), pp. 51–64.

Weick, K. E. 1989. “Construction Theory Disciplined Imagination,” *Academy of Management Review* (14:4), pp. 516–531.

Weick, K. E. 1995. “What Theory is Not, Theorizing Is,” *Administrative Science Quarterly* (40:3), pp. 385–390.

Weizsäcker, C. F. von. 1985. *The Structure of Physics*, Dordrecht: Springer.

Wenger, E. 1998. *Communities of Practice: Learning, Meaning, and Identity*, New York: Cambridge University Press.

Wersig, G. 1993. "Information Science: The Study of Postmodern Knowledge Usage," *Information Processing and Management* (29:2)Free University Berlin, Department of Communication Sciences, Work Unit Information Science, Malteserstr. 74-100, 1000, Berlin 46, Germany, pp. 229–239.

Wersig, G. 1997. "Information Theory," In *Encyclopaedic Dictionary of Library and Information Science*London: Routledge, pp. 220–227.

Westrup, C. 2012. "In Need of Narratives of IS," *Journal of Information Technology* (27:2), pp. 106–107.

Wheeler, J. A. 1990. "Information, Physics, Quantum: The Search for Links," In *Complexity, Entropy, and the Physics of Information*Redwood City: Addison-Wesley.

Wicken, J. S. 1987. *Evolution, Thermodynamics, and Information: Extending the Darwinian Program*, New York: Oxford University Press.

Wiener, N. 1961. *Cybernetics: Or Control and Communication in the Animal and the Machine*, Cambridge: MIT Press.

Wikström, S., and Normann, R. 1994. *Knowledge and Value: A New Perspective on Corporate Transformation*, New York: Routledge.

Winner, L. 1984. "Mythinformation in the High Tech Era," *IEEE Spectrum* (21:6), pp. 90–96.

Wittgenstein, L. 1953. *Philosophical Investigations*, New York: Macmillan.

Wittgenstein, L. 1958. *Blue and Brown Books*, New York: Harper.

Wolfswinkel, J. F., Furtmueller, E., and Wilderom, C. P. M. 2011. "Using Grounded Theory as a Method for Rigorously Reviewing Literature," *European Journal of Information Systems* (in press), pp. 1–11.

Worrall, J. 1989. "'Structural realism: The best of both worlds?'," *Dialectica* (43:1-2), pp. 99–124.

Wright, A. 2007. *Glut: Mastering Information Through the Ages*, Washington: Joseph Henry Press.

Wurman, R. S. 1989. *Information Anxiety*, New York: Doubleday.

Wurman, R. S. 2001. *Information Anxiety 2*, Indianapolis: Que.

Wyssusek, B. 2006. "On Ontological Foundations of Conceptual Modelling," *Scandinavian Journal of Information Systems* (18:1), pp. 63–80.

Yadav, M. S. 2010. “The Decline of Conceptual Articles and Implications for Knowledge Development,” *Journal of Marketing* (74:1), pp. 1–19.

Young, P. 1987. *The Nature of Information*, New York: Praeger Publishers.

Zabusky, S. E. 1996. “Computers, Clients, and Expertise: Negotiating Technical Identities in a Nontechnical World,” In *Between Craft and Science: Technical Work in U.S. Settings*, S. R. Barley and J. E. Orr (eds.), Ithaca: ILR Press, pp. 129–153.

Zaliwski, A. S. 2011. “Information – is it Subjective or Objective?,” *Triple C cognition communication co-operation* (9:1), pp. 77–92.

Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J., and Faraj, S. 2007. “Information Technology and the Changing Fabric of Organization,” *Organization Science* (18:5), pp. 749–762.

Zehnder, C. A. 2005. *Informationssysteme und Datenbanken*, (8th ed,)Zürich: vdf Hochschulverlag, pp. 340.

Zhang, P., and Li, N. (Lina). 2005. “The Intellectual Development of Human-Computer Interaction Research: A Critical Assessment of the MIS Literature (1990-2002),” *Journal of the Association for Information Systems* (6:11), pp. 227–292.

Zhang, Y. 1988. “Definitions and Sciences of Information,” *Information Processing & Management* (24:4), pp. 479–491.

Zhang, Y. 2011. *The Secret Life of ERP: From Technical Tool, Instrument of Control, to Transformative Agent*University of New South Wales.

Zimmermann, H. H. 2004. “Information in Semiotik und Sprachwissenschaft,” In *Grundlagen der praktischen Information und Dokumentation (5.Aufl.)*, R. Kuhlen, T. Seeger, and D. Strauch (eds.), Müchen: Saur, pp. 705–710.

Zuboff, S. 1988. *In the Age of the Smart Machine: The Future of Work and Power*, New York: Basic Books.

Appendix A - Methodology for a Hermeneutic Approach to Literature Reviews

This appendix outlines an hermeneutic approach for conducting literature reviews. This approach was developed as research method for conducting literature reviews as part of this thesis. Parts of this approach are published: Boell and Cecez-Kecmanovic (2010b; 2011c). All references mentioned throughout the appendix are included in the main reference section of this thesis.

Introduction

The main purpose of academic activity is to engage in the creation of knowledge. This is achieved by developing new ways for understanding the world. While disciplines vary in the knowledge they seek to create and the main means for creating valuable insights, the creation of novel insights provides a common ground for all branches of scholarly activity. One important aspect for creating important novel insights is the awareness of research undertaken by others. There are different means for becoming aware of earlier research, for instance, one can learn about relevant research at conferences and meetings or in conversations with colleagues. However, arguably the most important means for becoming familiar with earlier research is through published writings by other scholars. As the amount of published material steadily increases finding literature efficiently through searches in large literature reference database such as *Scopus*, *Web of Science*, or *Google Scholar* is increasingly important. Identification of relevant literature, however, is only one aspect of conducting literature reviews. The body of relevant literature needs to be understood and interpreted, and also subjected to examination, questioning and critical assessment that unleashes imagination and advances scholarship. These two aspects of conducting literature reviews are therefore quintessential pursuits in the work of every scholar.

This appendix is concerned with the literature review process and aims to contribute to a better conceptual understanding of how the search for literature and development of a literature review can be creatively intertwined and mutually enriching so as to advance scholarship.

Generally, the term 'literature review' can refer to a published product such as literature reviews as part of a research report (e.g. in a paper or a thesis), a stand-alone literature review publication or the process of conducting a review. As such a product, literature reviews examine and critically assess existing knowledge in a particular problem domain, forming a foundation for identifying weaknesses and poorly understood phenomena, or enables problematizing assumptions and theoretical claims in the existing body of knowledge (Green et al. 2006; Hart, 1998; Khoo et al. 2011). Literature reviews typically provide: an overview, synthesis and a critical assessment of previous research; challenge or problematize existing approaches, theories and findings; and identify or construct novel research problems and promising research questions (Alvesson and Sandberg, 2011; LePine and Wilcox-King, 2010).

In addition to a final outcome, a 'literature review' can also refer to the process by which the literature review is developed. Used in this sense a literature review is the process during which scholars identify, analyze, assess, and synthesize earlier research. To conduct high quality literature reviews in IS Webster and Watson (2002) propose a topic-centric approach for presenting earlier research, rather than a publication centric listing of results in earlier studies. The strengths of this approach are that it tends to be more critical, and that it foregrounds a researchers voice onto a domain (Khoo et al., 2011). Qualitative research software can be used to facilitate the creation of literature reviews that go beyond the listing of earlier findings (Bandara et al., 2011; Wolfswinkel et al., 2011). In addition, Levy and Ellis (2006) describe different aspects of conducting literature reviews including for instance, the coverage of IS journals and conferences by different databases. Yet none of these papers discuss the role of literature searches in databases in more detail. This has left an open space for the proponents of 'Systematic Literature Reviews' to draw attention to and emphasize the role of literature searches (Okoli and Scharam 2010). However, Systematic Literature Reviews are critiqued for reducing literature reviews to formalistic literature searches thus stifling academic curiosity and threatening "quality and critique in scholarship and research" (MacLure, 2005:393). Moreover, highly structured approaches downplay the importance of reading and dialogical interaction between the literature and the researcher; continuing interpretation and questioning; critical assessment and imagination; argument development and writing – all highly intellectual and creative activities, seeking originality rather than

replicability (MacLure, 2005, Hart, 1998). As Schwarz et al. (2007) note, "there is not a single, uniform approach to developing a framework or review article," (p.44).

Literature searches – to make it clear – are highly important for identifying relevant literature and developing a review. While they are seen as an important component of a literature review process, literature searches are not well understood within this process. Particularly to date none of the literature on literature reviews in IS (Bandara et al., 2011; Levy and Ellis, 2006; Schwarz et al. 2007; Webster and Watson, 2002; Wolfswinkel et al., 2011) provides a clear account of the role of searches within the wider context of the literature review process. Moreover, there is a need to improve understanding of the literature review process and the role of literature searches within it.

While the literature review process is of crucial importance for any research endeavor the nature of this process and how it should be conducted are still subject to debate. In the current literature specific aspects are typically either over or under-emphasized. As a result, often the literature review process is not well understood and novice researchers especially find it difficult and overwhelming (Boote and Beile, 2005; Combs et al., 2010; Kwan, 2008). The key challenge in understanding the literature review process is to unpack the researcher's engagement with the literature – finding, reading and interpreting publications and making sense of a large body of literature relevant for a targeted problem.

Interpretation and understanding are inherent to and permeate the literature review process. It is thus no surprise that the centrality of understanding in literature reviews was highlighted by several authors (Boote and Beile, 2005; Hart, 1998; Schwarz et al., 2007). This appendix therefore propose hermeneutic philosophy as a theoretical foundation and a methodological approach for studying literature reviews as inherently interpretive processes in which a reader engages in ever expending and deepening understanding of a relevant body of literature. Hermeneutics does not assume that correct or ultimate understanding can be achieved, but instead is interested in the process of developing better understanding. Moreover, this reflects the general development of understanding in scholarly activity where earlier theories are continuously replaced by better theories or advanced paradigms (Kuhn, 1962) rather than ultimate or final theories.

This appendix articulates a hermeneutic approach to literature reviews that provides orientation for the general literature review process and that integrates in a meaningful way the development of understanding and critical assessment of literature with the process of searching for literature. Here it is argued that high quality literature reviews require the critical assessment of literature in order to develop a solid argument when discussing earlier research. The ultimate aim of literature reviews is on the one hand to reach a saturation point in understanding earlier research in regard to a particular phenomenon, and on the other, to be able to formulate this understanding in a clear and convincing way for a particular audience (Kwan et al. 2012). It is therefore suggested that review of earlier publications is fundamentally an understanding process that can be described using hermeneutics.

More specifically the objectives of this Appendix are:

1. To contribute to a better understanding of the literature review as a hermeneutic process. By articulating the hermeneutic approach the appendix makes a contribution to a conceptual foundation of literature reviews that aims to advance understanding and assist in conducting literature reviews in practice
2. To demonstrate the role and importance of literature searches within this process and propose different search techniques and strategies that can be employed for conducting literature searches more efficiently. This objective, therefore, addresses a void in earlier literature on literature reviews in IS that did not discuss different search techniques and search strategies in detail.

This appendix is structured as follows. First, the appendix provides a brief introduction into literature reviews followed by an overview into a hermeneutic approach to interpretation and understanding of literature as part of a double hermeneutic loop. It then discusses in more detail the outer hermeneutic loop associated with the analysis and critical assessment of literature. This is followed by a section in which the importance of literature searches and different aspects of the search process forming the inner hermeneutic loop are discussed.

Literature Reviews

This review first provides a brief description of the approach used to engage with the literature on literature reviews. It then introduces different types of literature reviews, followed by a discussion of earlier work on the literature review process.

In order to gain a deeper understanding of the process of conducting literature reviews this appendix drew from different resources. Firstly, general introductory works into literature reviews drawing mostly on introductory textbooks (Davies and Beaumont, 2007; Feak and Swales, 2009; Finn, 2005; Hart, 1998; Machi and McEvoy, 2009; Ridley, 2008). These works enabled to establish a general understanding of how different authors seek to guide novices in undertaking literature reviews, and to derive aspects that are deemed important to high quality literature reviews by different authors. Secondly, publications engaging with literature reviews in the context of IS (Bandara, et al., 2011; Levy and Ellis, 2006; Okoli and Schabram, 2010; Schwarz et al., 2007; Webster and Watson, 2002; Wolfswinkel et al., 2011). And thirdly, searches for additional research publications in the multidisciplinary research databases *Scopus*, *Web of Science*, and *Google Scholar*. These searches aimed at identifying research on literature reviews with a particular focus on the Social Sciences. Searches were further backed by using snowballing, citation tracking, and consulting colleagues for additional literature.

Reviewing earlier work is an important part of any research. Generally, literature reviews aim to summarize and synthesize earlier research in order to provide an overview on what has been done regarding a particular research problem (Green et al. 2006; Khoo et al. 2011). "A review of the literature in any given field shows us both where we have been and where we need to go," (Neely and Cook, 2011:82).

Generally three broad categories of literature reviews can be distinguished. Firstly, literature reviews are an integrative part of any research thesis (Perry, 1998). Several authors have thus emphasized that learning to conduct literature reviews is an important part of research training (Boote and Beile, 2005; Combs et al., 2010; Dong 1996; Finn, 2005; Kwan, 2008; Wolfswinkel et al., 2011). For instance, Combs et al. (2010) highlight the importance of literature reviews in research student training emphasizing the role of advisors as facilitators in this training process.

Secondly, literature reviews can be an important publication type in its own right (Bensman, 2007; Garfield, 1987; Green et al. 2006; Fernander-Rios and Buela-Casal, 2009; Watson, 2001). Stand alone literature reviews make an important contribution to research by 'being more than the sum of its parts' (Schwarz et al., 2007). Articles reviewing earlier research are important in the process of knowledge development (Boote and Beile, 2005; Watson, 2001; Yadav, 2010) as they are not mere summaries of earlier research publications but instead 'serve particular objectives' (Khoo et al., 2011). While the aim is generally to provide a comprehensive summary of earlier research in a particular area, this type of article comes in different shapes and forms depending on how they build their contribution to research. Most common are *review articles*. Such articles provide a comprehensive overview of earlier research often seeking to identify gaps or problematize a particular aspect in a body of literature (Alvesson and Sandberg, 2011). In addition to review articles *framework articles* aim at a more specific contribution (Schwarz et al., 2007). They may either seek to develop and propose new theories, theoretical frameworks, or specific hypotheses as part of a conceptual framework (Rocco and Plakhotnik, 2009). And finally *meta-analysis* are pooling empirical findings from earlier publications in order to compile an overall picture on a phenomenon (King and He, 2005). As they require comparable empirical data they often focus on quantitative data.

However, the most common form of literature reviews appear as a part of research publications. Virtually every research article includes a section between the introduction and the methods section that reviews earlier related research. As part of research articles literature reviews synthesize earlier relevant publications in order to establish the foundation of the contribution made by an article. Ideally literature reviews provide rational for the choice of methodology, the research design, and the interpretation of results presented in the study (Khoo et al., 2011). Thus literature reviews are central to the research process in general (e.g. Boote and Beile, 2005; Hart, 1998; Kwan, 2008). And Green et al. (2006) even highlight that undertaking a literature review is actually an important research method in itself. Moreover, the importance of literature reviews for research publications is further underlined by the observation that inadequate reviews increase the likelihood of manuscripts being rejected (Combs et al., 2010).

Irrespective of the type of literature review to be developed, what is of interest to literature reviews is the actual process of undertaking literature reviews. When presented as part of research thesis or research articles literature reviews usually come before the methods section, the presentation of results, and their discussion. However, this form of presentation implies a particular linear understanding of the literature review process. That is, literature reviews come early in the research process leading to the formulation of research questions and the research design. However, only in rare cases does this picture reflect the actual nature of the way literature is engaged. For instance, grounded theory explicitly suggests not engaging with literature until later during the research process (Glaser and Strauss, 1967). While this view is less strict in Strauss and Corbin (1990), there is an ongoing debate at what point literature should be engaged and to what extend in grounded theory (Dunne, 2011).

While not all research methodologies are as vigilant as grounded theory on the effect of ideas arising from the literature and potentially "contaminating" results grounded in data, there is plenty of evidence that reading earlier research informs research at all of its stages. A literature review is not something that comes 'before' the 'real' study (Dellinger, 2005). Reading, conducting empirical research, and writing are not a linear but rather an iterative process. There is no clear answer to the question of when to stop reading and when to start writing (Goodfellow, 1998; Kwan, 2008). For instance, additional reading can help in strengthening the discussion of results (Dong, 1996) or may help in interpreting unforeseen results (Onwuegbuzie et al., 2007).

All these aspects highlight that engagement with the literature is not a uniform task, but an intellectual development process. Thus, the need to engage with literature and to identify relevant publications may arise at various points during the research process. It is therefore no surprise that several authors have pointed out that conducting a literature review in itself is not a linear process (Boell and Cecez-Kecmanovic, 2010b; Combs, 2010; Kwan, 2008; Wolfswinkel, 2011). For instance, Combs (2010) stresses that conducting literature reviews is an interactive and iterative process that aims for saturation in understanding. The description of literature reviews as an understanding process is also made by several others (Boote and Beil, 2005; Hart, 1998; Schwarz et al., 2007); and further underlined by the observation that an important aspect of creating good literature reviews is re-writing: they need to be re-written several times in order to form bet-

ter understanding and to better convey this understanding to readers (Heyman and Cronin, 2005; Machi and McEvoy, 2009). Other authors also emphasize the importance of (ongoing) reading (Kwan, 2008; Ridley, 2008) and writing (Feak and Swales, 2009; Levy and Ellis, 2006; Venkatesh, 2011) as part of the literature review process. In addition, Kwan et al. (2012) note that there are differences in building arguments in literature reviews in different types of IS research. Learning how to write literature reviews according to these implicit rules is the result of a learning process involving reading and repeated attempts at writing by researchers. Moreover, further important aspects for developing high quality reviews are critical engagement (Finn, 2005; MISQ, 2006; Ridley, 2008) and argument development (Feak and Swales 2009; Kwan et al., 2012; Machi and McEvoy, 2009; Ridley, 2008).

The notion of literature reviews as fundamentally an understanding process is further underlined by the advice given in textbooks on literature reviews. These textbooks generally do not emphasize a particular method for conducting a review but instead emphasize that literature reviews are an intellectual process. Hart captured this aspect in what he describes as a 'research imagination':

> It is something not easily acquired. A research imagination takes time to develop: something that is part of the research apprenticeship. (...) the research imagination is about: having a broad view on a topic; being open to ideas regardless of how or where they originated; scrutinizing ideas, methods and arguments regardless of who proposed them; playing with different ideas in order to see if links can be made; following ideas to see where they might lead; and it is about being scholarly in your work (Hart, 1998, pp. 29-30).

In contrast to these observations highlighting the intellectual nature and originality of literature reviews are approaches to literature reviews that suggest the use of formal methodology (Okoli and Schabram, 2010) and step by step approaches (Bandara et al. 2011; Wolfswinkel et al. 2011). Here the emphasis shifts from intellectual engagement with earlier research towards rigor, replicability, and objectivity of the review process (Boell and Cecez-Kecmanovic, 2011c; Green et al. 2006; Okoli and Schabram, 2010). Of particular importance in this regard are so called Systematic Literature Reviews, which originated in Medicine in the context of meta-analysis (Eysenck, 1995; Thomp-

son, 1995) but which were later adopted outside Medicine, first in software engineering (Kitchenham, 2004) and later in IS (Okoli and Schabram, 2010).

Systematic Literature Reviews are of particular interest due to the emphasis they place on the literature search process. While some general guidelines for conducting literature reviews mention the importance of locating literature (Boote and Beil, 2005; Levy and Ellis, 2006; Wolfswinkel et al. 2011) none of them address the literature search process in detail. The reason for this may be that they consider aspects such as reading, criticality, and argument development, as more important. However, these aspects can only come into play after the relevant literature is identified. In addition, over the last decade the need of locating literature through database searches has become more and more important. In this regard formal approaches to literature reviews do address an important need that arises from the complex nature of database searches and the frustration researchers are facing while, on the one hand, being inundated with the sheer number of documents available and, on the other hand, fearing to miss important literature. However, claims made by systematic reviews do not hold up in practice and their adoption is seen as a risk to scholarship (Hjorland, 2011; MacLure, 2005; Murray et al., 2007; Sandelowski, 2008).

Based on this review of the literature we can thus conclude:

1) That conducting literature reviews is not only an important aspect in nearly every research publication but also that they play an important part in knowledge development in the form of review articles, and that they are a central aspect in research training and the development of research thesis;
2) That there are different and often conflicting understandings of the nature of the literature review process and confusing instructions on how it should be conducted; and
3) That locating literature is an important aspect of the literature review process that is currently only insufficiently addressed in the literature.

To advance understanding of the literature review process developed in this appendix a conceptual foundation based on hermeneutic philosophy. Drawing from hermeneutics the appendix champions an approach for conducting literature reviews that acknowledges that developing literature reviews is fundamentally an intellectual pursuit, an un-

derstanding process that involves reading, critical engagement, argument development, and writing. Within such a conceptualization of the literature review process this appendix provides a clear account of different methods and approaches that can be adopted in order to locate literature that feeds this understanding process. A hermeneutic approach thus contributes to better understanding of the nature of the literature review process and also assists researchers in conducting literature reviews in practice.

A hermeneutic model of the literature review process

Research typically starts with a puzzle or a problem found in research or professional literature, through media or experience in practice. A researcher then begins her/his exploration by first seeking more general introductory texts and review papers which are especially valuable. S/he reads, makes sense of and interprets these texts and finds out further relevant texts in order to identify and understand major ideas, findings, concepts and theories and establish connections among them. During this process the development of understanding progresses gradually while researcher engages with and makes her/his own way through the literature. Initial ideas and preunderstanding are questioned, refined and extended in the light of what is being learned. Given that interpretation and understanding are of central concern this appendix adopts hermeneutics as an underlying philosophy and methodology for conducting literature reviews. As a theory of interpretation that deals with questions of meaning of texts, hermeneutics philosophy (Gadamer, 1976; Ricoeur, 1981) provides a rich theoretical foundation for understanding and describing the literature review process. Furthermore, by providing principles for interpreting meaning and developing understanding of texts hermeneutics affords a methodology to conduct literature reviews. Drawing from hermeneutic philosophy as both a theory of interpretation and a methodology this appendix propose a hermeneutic model of the literature review process.

While hermeneutics was initially concerned with the interpretation of biblical texts it has been extended first to the interpretation of any text or linguistic material and later to understanding in general (Ramberg and Gjesdal, 2009). The initial aim of hermeneutics in the nineteenth century was to reconstruct the original meaning of a text, that is, the meaning intended by an author (Schleirmacher, 1998). Similarly Dilthey (1957) argued for a theory of interpretation that aims to imaginatively re-enact the original meanings

and experiences of others. These views were challenged by the twentieth century philosophers, in particular Heidegger (1927|2002) and Gadamer (1976). Heidegger made an important ontological turn and proposed that "interpretation is not just a meaning; it is grounded in a whole set of background practices, a kind of *preunderstanding* that makes knowing possible" (Barrett et al., 2011:187; emphasis in the original). Unlike Schleirmacher and Dilthey who assumed that interpretation and understanding are cognitive processes, inside the mind, aimed at reconstructing an original meaning, Heidegger radically changed the view of hermeneutics beyond a methodology for understanding such original meaning. For Heidegger understanding is not only a cognitive process but the practical mode of human existence, embedded in the tradition of being and universal to all human activity (1927|2002).

Hans Gadamer (1976), Heidegger's student, developed these ideas further and approached understanding as a practical achievement through a dialogue between the reader and the text, between readers and between texts. For Gadamer understanding of a text is always a translation in a concrete socio-historical and cultural context. There is no correct or universal interpretation of a text outside of history, culture, or irrespective of a standpoint. In Gadamer's words "the standpoint beyond any standpoint ... is pure illusion" (1976:376). Gadamer adds new conceptual apparatus to hermeneutics as explained by Barrett et al. (2011):

> Understanding ... is a projection of the horizon of the reader that meets the horizon of the text. Gadamer introduces an important phrase that many cite as one of his core contributions to the field of hermeneutics: *understanding is the fusion of horizons*. The dialogical encounter between reader and text extends or contracts the reader's world (p. 189; our emphasis).

Horizon here denotes "the range of vision that includes everything that can be seen from a particular vantage point" (Gadamer, 1975|2004:301). Reader's horizon initially may be narrow, thus allowing very limited understanding. However, reader's engagement with a text may challenge the initial horizon and potentially extend it as well as open up new horizons. In such an engagement the reader extends and projects his/her horizon towards the text, which itself participates with its own historical context and horizon. The fusion of horizons of the reader and the text is a particular dialogical encounter through

which reader's view may be enriched and expanded but also contracted together with a text's horizon.

This leads us to the notion of the hermeneutic circle first proposed by Schleirmacher (1998) and later advanced by Heidegger and Gadamer. The hermeneutic route to understanding is always iterative: an understanding of a text or text equivalent (a part) draws from reader's preunderstanding of a context (a whole); and vice versa, the understanding of a context (a whole) develops from understanding individual texts or text equivalents (parts). These involve as Clifford Geertz explains:

> (a) continuous dialectical tacking between the most local of local detail and the most global of global structure in such a way as to bring both into view simultaneously . . . Hopping back and forth between the whole conceived through the parts which actualize it and the parts conceived through the whole which motivates them, we seek to turn them, by a sort of intellectual perpetual motion into explications of one another (Geertz, 1974 p. 43).

Through such a circle the understanding of both the text (part) and the context (whole) are continually revised and mutually co-produced. As more texts are engaged with, the dialogical encounter is extended and the fusion of horizons broadened to texts reaching to each other's as well as to the reader's horizon. The questions of preunderstanding, preconceptions, tradition and biases involved in all dialogical encounters among readers and texts have been widely debated (Gadamer, 1976; Heidegger, 1927|2002; Kearney, 1999). While they cannot be avoided – being inherent to all understanding – they can be reflected upon and thereby rendered more open for the unknown, unexpected and strange. The key issue for a reader, Gadamer (1975|2004) warns us, "is to be aware of one's own bias, so that the text can present itself in all its otherness and thus assert its own truth against one's own fore-meanings" (p. 272). The more the reader remains open to the meaning of the other person or text the more likely it is that the hermeneutic circle will lead to the enriching and broadening of horizons.

The literature review process involves numerous activities of identifying and interpreting relevant texts for a particular research problem or a puzzle. To develop a literature review a researcher needs to find out relevant texts, interpret them and develop a broad understanding of the literature before endeavoring to critically assess the state of knowledge. The literature review process can be seen as a complex hermeneutic enterprise in

which researcher engages in a dialogue with individual texts and gradually extends this dialogue to include different texts talking to each other. In such a way the fusion of horizons may assist unfolding of a broader whole or a body of relevant literature which can open new horizons for understanding the research problem or puzzle. The new understanding of a body of literature in turn enables identification of new texts and a renewed dialogue with individual texts. We can thus see how the literature review develops iteratively through numerous hermeneutic circles.

To better understand the nature of literature review processes this appendix propose the hermeneutic model of the literature review (Figure A.1) which describes two major hermeneutic circles: the searching for literature circle and the wider literature development circle that are mutually intertwined. Starting with initial ideas, questions or a description of a potential research problem from previous readings and experience, the researcher enters the hermeneutic circle for literature searching, sorting, selecting sources, and acquiring papers of interest. This is followed by reading, the key activity that develops understanding. Through reading individual texts new literature sources of potential interest are identified, search strategies are refined and the hermeneutic searching circle continues. The searching circle is part of a wider literature review development circle. Reading in particular is a key activity that links the searching circle with the literature review development circle which evolves through reading, mapping and classification, critical assessment, argument development, research problem/questions (re)formulation and back to searching. The two circles are intimately intertwined not only through major hermeneutic links (full lines) but also through many other linkages among activities, some of which are presented as dashed lines in Figure A.1.

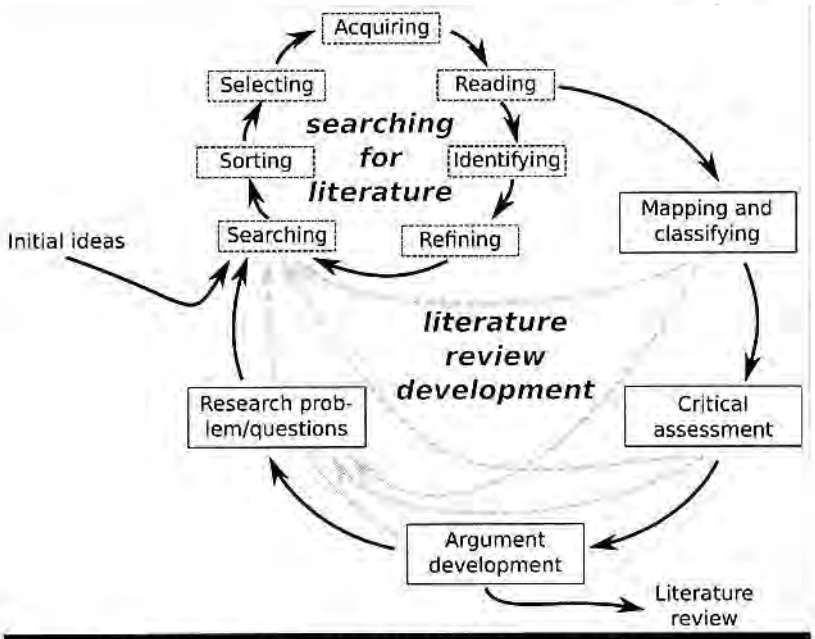

Figure A.1 A Hermeneutic Model of the Literature Review Process Consisting of two Major Hermeneutic Circles

The two hermeneutic circles reflect Wittgenstein's (1953) distinction between puzzles or problems which require information and those that require clarification and insight (Hart, 1998). By searching for literature one is seeking more information about a problem at hand and learn to identify more relevant sources of information. The hermeneutic process within the inner circle 'searching for literature' helps us identify new relevant publications and also assess the relevance of acquired publications. By doing this one creates an ever bigger set of publications that is initially overwhelming, foreign, and confusing. The more literature one acquires the more pressing it becomes to interpret, clarify and understand the diverse ideas, approaches, findings and knowledge claims in individual texts. Through reading one develops better understanding of each text and embark on a route of clarification and insight into different texts and how they relate, that is, the wider 'literature review development' circle. It is analytical reading, mapping and classification as well as critical assessment of the selected publications that address the problem of confusion and a lack of understanding of the whole – the body of literature. Furthermore, developing clarification in this circle goes beyond sorting, comparing, and contrasting. It involves the creation of a distinct (ideally original) perspective on the literature that arises from the dialogical engagement and the fusion of horizons among researcher and numerous texts. A particular perspective on literature thus enables

researcher to critically asses the state of knowledge in the targeted domain and reveal important shortcomings or failures in dealing with the research problem. This also allows the development of new linkages among concepts and theories and new synthesis.

The Wittgensteinian view of the two hermeneutic circles – seeking information and clarification/insight – reminds us that they need to be harmoniously intertwined. Overemphasizing the searching for literature will lead to increasing confusion, while overemphasizing the literature review development at the expense of searching will lead to ignorance.

The process of developing understanding of the relevant literature through the hermeneutic circles seems never-ending. New sources and ways of interpreting and developing meanings that hang together somewhat differently can always emerge. This raises the question: how does literature review as a hermeneutic enterprise converges and eventually produces a well grounded, novel and interesting outcome? We answer this question by going deeper into the hermeneutic circles of the literature review process and by discussing the challenges and potential strategies to cope with them within individual activities of both circles.

Literature review development – the wider circle

The literature review development circle starts with more or less clear ideas about a research problem or a topic, and continues with 'searching for literature' circle, from which at some point the reading progresses to mapping and classifying, critical assessment, and argument development, often leading to the revised research problem and a new circle of literature searching, reading, mapping and classifying, and so on. Through typically several circles a literature review document is produced. We describe here this development circle first and then proceed with a description of the searching for literature circle in the next section of the appendix.

Reading

Reading as part of the literature review is *analytical reading*, which differs from leisurely reading (Hart, 1998). Its purpose is to interpret and understand identified publications, first individually and then gradually in relation to one another. To engage in analytical reading researcher has to be immersed in a publication with the aim to

achieve understanding. The researcher starts with some preunderstanding based on previous readings and experiences. While it can be limited and biased, preunderstanding enables the researcher to make sense of the publication, which in turn may challenge his/her preunderstanding. It is a dialogical encounter with the publication which enables the merging of horizons of reader and text that can lead to expansion of views and greater understanding. Gradually reading analytically produces an outcome – an understanding of the publication, its focus and aims, research questions addressed, approach and methodology adopted, concepts and theories used, type of evidence offered, and major knowledge claims and contributions made. It also reveals how an argument is developed and how claims to knowledge and contributions are justified (Kwan et al., 2012). Such understanding however needs to be developed further for the researcher to be able to assess the publication, to compare and contrast its major findings in relation to others, and to classify its contribution within a broader context of relevant knowledge.

After reading a number of publications researcher start building an understanding of how individual publications come together to form a body of relevant literature. Broader understanding of the literature in turn allows the researcher to re-interpret individual publications and their importance within a bigger 'whole'. The unfolding nature of the body of literature relevant for a particular research problem shows that the body of literature is by no means given. The more the reader delves into the publications the more s/he discovers additional publications and envisages the relevant body of literature. The body of literature is thus an enfolding whole that changes with every encounter with new relevant publications. The body of the relevant literature can expend in breadth and depth. When new publications are discovered through the searching for literature circle the researcher expands the breadth. In contrast the depths of the body of literature refers to the degree of inclusion of genealogy of ideas presented in key publications. For this it is necessary to understand not only the ideas in publications of interest but also their relationships and intellectual history.

For any literature review the question is what is the sufficient breadth and depth. The body of literature, one can observe, is never complete and can always be expanded in both breadth and depth. However, at some point after reading a large number of publications the body of relevant literature tends to stabilize. An indication that this is happen-

ing is fewer and fewer new sources and novel ideas found in the literature. A more experienced researcher is capable of good judgment about what is a sufficient breadth and depth of the body of literature for a given research purpose and objective. There is also a tacit agreement in a research community about an expected breadth and depth for a particular type of publication, e.g. a research article or a PhD thesis. Importantly learning about and understanding the sufficient breath and depth is something that itself evolves out of reading literature reviews presented in the research of others (Kwan et al. 2012).

To achieve a desired breadth and depth of the body of literature a novice researcher needs to develop reading skills and adopt appropriate reading strategies. Through analytic reading researcher develops an ability to identify key concepts, findings and theories and their interpretations and a capacity to infer assumptions and a methodological approach even when they are not explicitly stated. Researcher also develops a confidence in assessing knowledge claims and the strength of the argument and evidence provided. Moreover, given that potentially relevant literature on any topic is typically huge the reading needs to be carefully structured and organized. A useful reading strategy in case of a very large number of publications is first to glance through the identified texts in order to gain an overall impression of their content. This applies to research papers but is even more critical to reading larger texts such as books or thesis. If the text is considered promising and relevant, one goes on to read abstract/preface, introduction and conclusion. This may be sufficient for a researcher to gain an initial understanding of the publication and its importance for the problem/topic addressed. And finally publications that are considered of central importance are read in-depth while taking extensive notes and comments (further discussed below). These notes form a basis for the development of the broader view of the relevant literature and for mapping and classifying the ideas and findings, and assessing the contributions of individual publications to the literature.

Mapping and Classifying

Analytical reading enables researcher to acquire a deep understanding of the relevant publications and the body of relevant literature that not only expand her/his horizon but also provides a foundation to develop a novel perspective on the literature. To achieve

this the researcher may adopt different ways of *mapping* and *classifying* different ideas and findings from the literature. Mapping and classifying is a distinct activity in the hermeneutic circle of the literature review development which aims to provide a systematic analysis of relevant ideas, findings and contributions to knowledge within the body of literature and present them in a way that enables the subsequent activity – a critical assessment of the state of knowledge related to the research problem.

Mapping and classifying is a significant intellectual endeavor as the body of literature is typically very large and not easily captured by maps or classification schemes and expressed in a comprehensive and succinct form suitable for subsequent assessment. As Hart (1998) explains the purpose of mapping is to systematize the ideas and other important elements identified through analytical reading and present them in a succinct form:

> Mapping out the ideas is about setting out, on a paper, the geography of research and thinking that has been done on a topic. At one level, it is about identifying what has been done, when it was done, what methods were used and who did what. At another level, it is about identifying links between what has been done, to show the thinking that has influenced what has been produced. You can use these methods to elicit knowledge about the topic and then prepare diagrams and tables to represent that knowledge in terms of the relationships between ideas and arguments that you have found (Hart, 1998, p. 144).

Mapping of ideas and knowledge claims from the literature often starts during the analytical reading when it can be done in any way that makes sense to researcher. However when the mapping aims to present the geography of research as part of the literature review document it needs to be presented in a way that is intelligible to readers. Tabular, graphical, or pictorial presentations of maps are useful to describe for instance different streams of research, historical development of ideas, schools of thought or other major research classifications (Daley et al., 2010). The aim is to synthesize the relevant literature into a compact classification that describes major views/approaches, contributions, authors and sources, etc. For instance, Webster and Watson (2002) or Perry (1998) argue for concept-centric rather than author-centric classification of the literature, a structure that supports criticality and a reviewer's voice (Khoo et al., 2011). To achieve this articles can be classified according to concepts developed and the unit of analysis (organi-

zation, group, individual) using comparison tables or hierarchical ordering. A concept map is a schematic device that represents concepts and their relations (in a form of a propositional statement) (Novak, 2004). Hart (1998:156-7) provides illustrative examples of literature mapping using semantic maps of research approaches and concept or mind maps (Perry, 1998). Software tools can be helpful for this, for instance, mind maps can be developed using software like *Compendium*[11], enabling easy update and restructuring.

An alternative way for mapping and classification is to propose or adopt a conceptual framework to present the literature. An excellent example is provided in Schultze and Leidner (2002) where knowledge management literature is classified according to Deetz's (1996) framework that defines four discourses of orgnizational inquiry – normative, interpretive, dialogic, and critical. By adopting a particular framework Schultze and Leidner expose certain aspects of knowledge management literature that pertain to the origins of concepts and problems studied ("elite/a priori" vs "local/emergent") and the "consensus/disensus" orientation of research. Research papers with elite/a priori orientation use the language and concepts from the literature while those adopting local/emergent orientation draw from culture, language and interpretations in a specific organizational context; the consensus orientation is in line with the social order while a disensus orientation seeks to disrupt it. The literature review based on this conceptual framework reveals that knowledge management research is biased in favour of a consensus and especially normative discusourse, while largely ignoring disensus discourses.

It is important to note that the mapping and classification of literature is a creative process that builds on the deep understanding of the body of literature achieved through analytical reading. This process may lead to new questions and identify new relevant publications (an iterative path to literature searching presented in Figure A.1 as a dotted line) to be included in the body of knowledge. Researchers are invited to use their imagination to develop a distinct, innovative and interesting way of mapping and classifying the literature (using e.g. concept mapping, classification scheme, frameworks, etc.). Eventually this will help in developing a review of the literature that is centered around the discussion of important concepts or ideas rather than the discussion of individual

11 http://compendium.open.ac.uk/

publications. A particular mapping and classification serves to provide an overview of the literature and at the same time enable a novel insight into the state of knowledge in the targeted domain. Ultimately such a mapping and classification allows the researcher to critically assess the body of literature and to problematize dominant knowledge claims.

Critical assessment

Systematic and comprehensive presentation of complex and varied literatures as maps and classifications provides a basis for critical assessment (see Figure A.1). A critical assessment of the body of literature aims to analyze and evaluate the state of knowledge related to the problem/topic studied and identify major weaknesses (Finn, 2005; Ridley, 2008). Maps and classifications help in analyzing connections and disconnections, explicit or hidden contradictions, and missing explanations, and thereby identify or construct white spots or gaps. While analytic reading implies critical reading of every publication, the activity of critical assessment addresses the body of literature and requires a broader analysis of what is known, how knowledge is acquired, what types of knowledge are produced, how useful different types of knowledge are in understanding and explaining a problem of interest, and where the boundaries of existing knowledge are. A critical assessment of the body of literature thus demonstrates that literature is incomplete, that certain aspects/phenomena are overlooked, that research results are inconclusive or contradictory, and that knowledge related to the targeted problem is in some ways inadequate (Alvesson and Snadberg, 2011; author forthcoming). Critical assessment, in other words, not only reveals but also, and more importantly, challenges the horizon of possible meanings and understanding of the problem and the established body of knowledge.

For instance in their review of knowledge management literature based on the Deetz's (1996) framework Schultze and Leidner (2002) show that the literature presents a one-sided view of knowledge in organizations: it only addresses knowledge management that has positive implications and fails to recognize its negative and unintended consequences. A particular way of seeing and mapping the body of literature (using a framework) enabled them to both hightligh weaknesses in the dominant approaches (consen-

sus focused and normative) and also convincigly demostrate blind spots – the lack of research that addresses the contradictory and double-edged nature of knowledge.

Critical assessment of a body of literature can be more radical than identifying or constructing gaps or white spots. Alvesson and Sandberg (2011) propose "problematization of a literature domain" that challenges the "assumptions that underlie not only others' but also one's own theoretical position ... (not) to totally undo one's own position; rather, it is to unpack it sufficiently so that some of one's ordinary held assumptions can be scrutinized and reconsidered in the process of constructing novel research questions" (p. 252). To attempt a more radical critique and problematize a literature domain researcher has to engage in dialectic interrogation of assumptions and results in the literature and also of his/her own familiar position. This challenges researchers to adopt a reflective attitude toward the horizon of possible meanings established by the body of literature and question the hermeneutic achievements thus far. The researcher, especially the junior researcher, needs to feel encouraged to think differently and question authority.

While critical assessment or critical scrutiny of a body of literature as an essential step in developing literature review, can be approached and conducted in many different ways there is no single, best way to do it. One however may provide a more or less strong argument and be more or less convincing and effective in demonstrating weaknesses and gaps or problematizing assumptions. This is why critical assessment is rarely completed is a single hermeneutic circle. Rather, the researcher goes through a few circles seeking additional publications (see the dotted line in Figure A.1 from critical assessment activity to literature searches) that either strengthen the argument for the particular gap or change the meaning of the gap (Kwan, 2008).

Whatever type of critique is proposed existing research and knowledge should be treated with due respect (Webster and Watson, 2002). Whether adopting gap-spotting or problematization one is always drawing from and building upon the knowledge of others one way or another.

Argument development

Analytical reading, mapping and classification and critical assessment of the body of literature form a foundation for *argument development* in the literature review document.

Based on a critical assessment of different approaches, strands of research and knowledge produced thus far researcher develops an argument for a research gap or problematization of established knowledge. The arguments for the claim that existing knowledge is insufficient or problematic have to be compelling in order to warrant further research. The arguments are compelling if sufficient evidence is shown to demonstrate not only the gap or problematic assumptions but also why it is important to address the gap or conduct research based on different assumptions. The logic of the argument from the mapping and classification, to critical assessment and the construction of a gap, to the motivation for further research has to be consistent, well articulated and convincingly documented.

Importantly, the way arguments are developed and laid out will to some extend depend on the research community addressed by a piece of research. Research is not only always written on basis of a background provided by other research it draws *from*, but also in regards to a community it seeks to contribute *to*. Different communities have different standards for building their arguments and thus different structures will be convincing to different readers and reviewers. One aspect of a hermeneutic engagement with the literature is thus to become familiar with these standards. For instance Kwan et al. (2012) show that there are differences in the way how IS researchers build their arguments: they noted differences between the way literature reviews are constructed in design science research versus behavioral science research.

Argument development is crucial for the writing process when conducting literature reviews and is also the reason for the importance of continuous writing while conducting a literature review (Levy and Ellis, 2006). Writing forces the development of a linear argumentation based on the literature analysis and assessment. Moreover, through argumentation future directions of research and the rationale for specific research questions, are developed.

Research Problem / Questions

The argument development ultimately constructs a gap or problematizes dominant knowledge in the literature that often requires the revision or reformulation of the initial research problem. Due to increasing understanding of the literature that emerges through several hermeneutic circles a researcher is likely to refine or sometimes even

change the targeted research problem. The refined research question may then trigger new circle of searching and reading followed by updating the maps and classification of the literature and its critical assessment. A particular framing of a research problem reflects a researcher's critical assessment of the state of knowledge in the domain of literature and his/her assumptions about, and arguments for its relevance. Apart from constructing a gap or problematizing the existing literature a researcher also needs to argue why it is important to fill the gap or to develop new knowledge about the problem. This is highly important for establishing the necessity for further research.

A research problem is often transformed into one or more specific research questions that are worthy of examination and that a study (PhD or honors thesis, a research article) intends to answer. Research questions can be formulated at a more general, abstract level and at a more specific, empirical level. A more general, abstract research question will logically follow from the gap in the literature or problematization of existing knowledge. Such a question is often theoretical and not suitable for empirical investigations. Such a question however is important as it indicates what theoretical contribution the research intends to make. A general or theoretical question needs to be developed further into one or more specific research questions that will be empirically tested.

A researcher goes through the hermeneutic circles of literature review development until a satisfactory outcome – a well argued literature review (including research problem/questions) – is produced. As the above discussion demonstrates, the literature review is a hermeneutic achievement that has a dual purpose. It establishes, synthesizes and critically assesses a body of literature and also creates newness and proposes novel understanding that broadens the horizon of existing knowledge. The quality of literature review thus depends on the quality of all activities in the wider hermeneutic circle of the literature review development

Searching for literature – the inner circle

Searching for literature – itself a hermeneutic circle – is part of a wider literature review development circle. Searching does not guarantee high quality reviews, but without proper understanding of searches the production of high quality reviews is impossible. It is, therefore, of general importance to understand how to effectively conduct literature

searches. Literature searching is an integrative part of hermeneutic understanding of literature reviews in which searching and reading inform each other (Figure A.2).

Searching allows a researcher to move from the general to the particular by identifying publications relevant for a topic. In turn reading publications will allow to improve searches as one better understands what one is looking for, and also what one is not looking for. This process can be further broken down into different steps that usually follow each other in a circle as presented in Figure A.2. We examine this circle briefly and introduce different tools and techniques that can be employed when searching for literature. The literature searching does not always take a full circle as different shortcuts are possible and often happen during this process. For instance, when reading one may directly identify additional literature that is then acquired; or searches may directly lead to the formulation of refined search strategies (indicated by dashed arrows in Figure A.2). Starting from the top right in Figure A.2 introduces different tools and methods while going once through this hermeneutic circle.

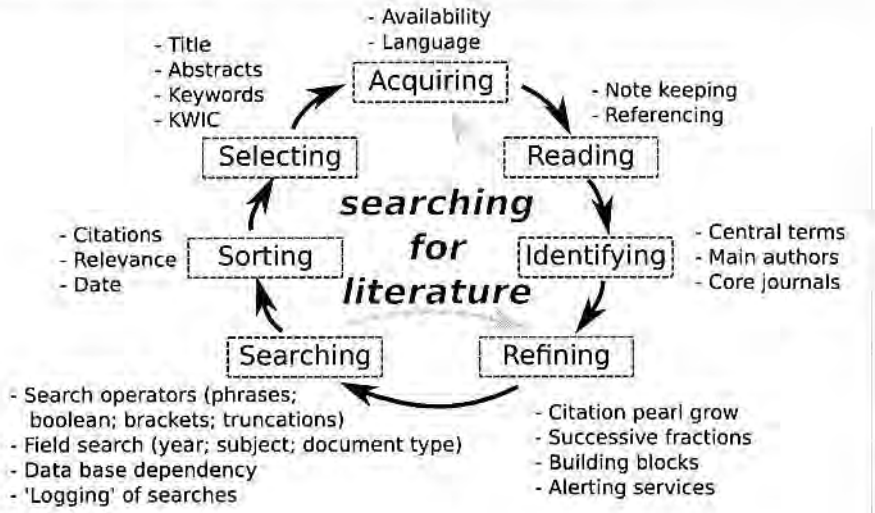

Figure A.2 An Overview of Different Tools and Techniques Associated with Individual Steps of the Hermeneutic Literature Searching Circle

Searching

Heidegger (1927|2002) noted that how one enters the hermeneutic circle affects understanding. In the context of literature reviews it is therefore important to consider how initial readings can facilitate understanding of a research area. Not all types of text are

equally suitable for someone who is engaging with a new field of inquiry. Generally primary and secondary research literature can be differentiated. While the former consists of original research publications, the later are publications that summarize and review original research publications.

Often it is advisable to approach research areas through secondary literature as it provides a wider overview on a research area. In contrast approaching the literature through primary literature can be tough as it is not immediately clear how the findings of individual studies relate to a larger research area. While journal articles generally frame their findings they often need to be succinct when introducing earlier research. For instance, to those familiar with a research area one sentence containing the reference to a landmark publication can be sufficient without the need for repeating the whole argument presented in that original paper. For this reason someone entering a field is generally not able to grasp the complete depth of a literature review presented in original research papers.

In contrast secondary publications, such as review articles or entries in subject specific encyclopedias, provide an overview of earlier research. Reviews have several benefits: they introduce a wide range of publications; they provide orientation into an area; they introduce specific terms and concepts; they relate different streams of research; and they usually point out shortcomings in earlier research providing directions for future development.

Using a hermeneutic approach retrieving small sets of highly relevant publications is preferable over huge sets of documents whose relevance cannot be sufficiently judged. The aim is to employ search techniques in a way that allow to quickly drill down to a manageable set of highly relevant publications. Accordingly a good search strategy is one that results in high precision rather than high recall. Searching is an integrative part of conducting a literature review, not something that stands at the beginning of the review process. Through the engagement with the literature a researcher becomes more familiar with specialized terms, expressions, research approaches, names of important authors, journals and conferences. Based on this deeper understanding of an area the way searches are approached can be continuously improved, for instance, as one becomes aware of new search terms.

Searching involves different techniques and methods that can be used when looking for literature in databases. For instance the use of 'field search' can help in identifying recent literature review articles on a specific topic. Moreover, search operators such as 'AND', 'OR', 'NOT' or 'NEAR', the formulation of phrases, and the combination of these can be used to formulate powerful search strategies.

Sorting

After a search is undertaken different methods can be used for sorting results. One way is to use the ranking algorithm provided by a database which is designed to display 'more relevant' documents towards the top of the list while pushing 'less relevant' documents towards the bottom. Generally relevance of documents depends on a combination of factors which may include: the appearance of search terms in titles, abstract, and keywords; the recency of publications; or the number of times a document is cited. An alternative approach is to rank results by date. For instance, users interested in latest developments might prefer recent publications over the older ones.

In addition, sorting can employ citations. This method makes use of the fact that academics cite the work of other academics in their publications. Using citations as ranking criteria allows a researcher identifying central publications that are used extensively by other academics. Three databases mainly associated with this search feature are *Web of Science*, *Scopus*, and *Google Scholar*. Citations are a good means for identifying landmark papers that are often referred to by others. Usually such papers should be included in a review. For instance, if one is interested in researching the acceptance of technology one could start a literature review by searching for the terms 'acceptance' and 'technology' in *Scopus*. Even though this search retrieves more than 10,000 documents sorting them by number of citations will identify Davis (1989) as a landmark publication in this area. However, this example also illustrates the downside of citations. Older publications are generally more cited as they had more time to be cited by others. As a consequence citations are not useful when searching for latest developments and current research.

Selecting

After a search is taken out and results are sorted individual papers are selected for reading. This involves looking at the title of documents and also the context in which the search terms appear. Often abstracts are useful for a brief assessment of the relevance of publications. Abstracts contain a short description of the content of a document usually between 200 and 500 words in length, ideally describing the aim, scope, method, main findings, and relevance of an article. However, not in all cases will abstracts sufficiently convey the content of publications (Hartley and Betts, 2009). In such instances snowballing may help in capturing publications that were initially missed. Based on titles and abstracts papers may then be selected for acquisition. Following the hermeneutic approach it is acceptable to focus on a limited number of publications that appear to be highly relevant. After these papers are read subsequent iterations of the searching circle will allow to pick up additional publications that initially were not selected.

One further note, in some cases the analysis of search results may lead directly to refined searches. This will be especially the case at the beginning of a search process, when good search terms are not already known. For example, if retrieved results are not matching the desired documents. Search strategies to cope with such situations are discussed are building blocks, or successive fractions.

Acquiring

After publications are selected for reading full texts have to be acquired. In some cases this can be difficult, but if authors concentrate only on publications that are easy to obtain for them important findings may be missed. Often institutional libraries subscribe to the electronic form of journals. In this case articles can be conveniently accessed from the desk or from home. However, not all publications are available in electronic form. For example, books, conference proceedings or older journal issues may require a trip to the library in order to obtain a copy. Moreover, some literature might not be available at an institution's library at all. In such cases publications may need to be requested through inter library loan (ILL). In addition, conference contributions are usually more difficult to obtain than journal articles. Libraries typically do not hold copies of proceedings of all major international conferences. In addition, relevant publications might appear in proceedings of first-rate conferences held by national societies overseas and

therefore only available abroad. Similarly important publications might be published in foreign languages. If one cannot read the language in which they are written one may miss relevant findings.

Limited access should not be an excuse for excluding publications believed to be of importance. However, following a hermeneutic approach initially focusing on accessible literature is acceptable. After reading the first set of relevant papers the importance of publications not yet obtained can be better judged. For example, if it turns out that several relevant papers cite a particular publication this publication may be important to the research at hand. Even though initially the publication could not be readily acquired this indicates that additional effort to obtain a copy might be rewarding.

There are some strategies for coping with difficult access to literature. One strategy for obtaining copies is to contact authors directly. Academics are generally happy to be contacted by others interested in their research. If possible they will pass on copies of their publications. In addition, the open access movement made self-archiving of publications on homepages and in repositories more common thus providing better access to publications appearing in subscription journals.

Reading and Identifying

Arguably the most important step for informing searches is reading. Reading will allow researchers to learn more about a topic area that will allow, for instance, the identification of central terms and concepts that then can be used in subsequent searches. The importance of reading and different approaches to reading were already introduced above and will not be repeated here. However, there are some more technical aspects of reading of specific interest here. These techniques include referencing, and note keeping.

Referencing software will help to keep track of identified and read literature. Moreover, it will assist in citing material correctly. This is especially helpful when using different types of literature. For example, articles, books, book chapters, or conference proceedings are all cited differently. Referencing software is also helpful when facing different referencing styles, like Harvard style or Chicago style. Popular referencing software and tools are, for example, *Endnote*, *Refworks*, *Zotero*, or *Mendeley*. Also, the *Association for Information Systems (AIS)* provides on its homepage a list of *Endnote* citation styles for different IS journals and conferences; *Refworks* is an online service with great con-

nectivity to import citations from many different databases; *Zotero* is an add on for the Firefox web browser; and *Mendeley* brings social network features to citations allowing to share references and comments on documents with others.

Note keeping is another important technique associated with the reading process (Levy and Ellis, 2006). Reading several texts in the context of a particular research it is important to keep track of specific ideas appearing in different texts. Keeping notes either in a text document or a notebook helps a systematic recording and analysis of ideas and findings and assists researcher's orientation. This will also allow the shift from particular papers to concepts when writing the literature review (Webster and Watson, 2002). It is, however, not possible to advocate one general approach for note keeping that might suit everyone and every research problem. No matter which approach one chooses, it is generally advisable to write personal summaries of read publications (Levy and Ellis, 2006), and to continually keep writing down ideas that appear while reading papers. This will force one to clearly express ideas and arguments and to better recall them during the mapping and classification as well as the writing process of the literature review.

In addition to identifying further search terms, building on a body of relevant literature can also help to identify important authors, journals, and conferences. Authors are not equally productive and for every area of research some 'core authors' can be identified (Lotka, 1926). Future searches can for instance aim to more closely examine the oeuvre of such authors. Investigating the distribution of publications on a particular topic over journals can be used when searching for literature as it allows a researcher to identify 'core journals' for specific topics. Using field search one can then focus on core journals and important conferences only. Also instigating an alerting service for the most relevant journals or authors may help to stay in touch with latest publications on a topic. Nevertheless, it is important to keep in mind that the entire body of relevant literature will always extend over a vast amount of journals, books and conferences many of which containing only few publications on a topic. A thorough and reasonably complete literature review can therefore not be limited to a specific or prescribed set of journals only.

Refining

Finally search strategies can be used to refine searches in order to improve the precision of literature searches. In particular 'citation pearl grow', 'successive fractions', or 'building blocks' can help in locating additional literature. These strategies were developed to improve database searches.

The circular nature of searching processes highlights that the development of understanding of a relevant literature is not a linear process. While one is traversing through the hermeneutic circle of literature searching one continually improves understanding of what are the relevant publications and how different publications are related. For example, the reading of the same written work may lead to different understanding after further relevant publications are identified, acquired and read. This is reminiscent of Gadamer's (1976) claim that to understand means to understand differently, (Bernstein, 1983).

Leaving the hermeneutic circle – Enough is enough

This leaves us with the question when a quest for literature should end? Following the hermeneutic approach it can be argued that any additional iteration of the literature searching circle will help to retrieve additional literature. Therefore, there is potentially no end to a literature search. Even though this is true, as the production of human knowledge is ongoing and consequently never ending, literature reviews have to end at some point. Usually research faces time constrains that do not exclude the literature review process. For this reason it is important that literature review is as comprehensive as possible in the time that is available. Following the hermeneutic approach can help researchers to identify the majority of central publications addressing a particular research problem or topic within several iterations (cycles).

When time constrains are less prevalent the review process can be extended until a point of saturation is reached (Combs et al., 2010). Criteria for saturation depend on the aim and type of the literature review. For a literature review as part of research articles this means that high confidence in the novelty and importance of a contribution can be established. It is important for the readers that a literature review critically and convincingly assesses existing literature and motivates the research. In contrast a review article

will emphasize comprehensiveness in covering earlier research, especially landmark publications, mapping and classification and an assessment of the body of literature.

The point of saturation in literatures searches will thus correlate with the confidence that the purpose of the review can be achieved. One criterion for saturation is diminishing novelty when reading additional literature, contributing to only marginal improvements of understanding the research problem. "One common rule of thumb is that the search is near completion when one discovers that new articles only introduce familiar arguments, methodologies, findings, authors, and studies," (Levy and Ellis, 2006). A more formal criterion for saturation can also be established by looking at cited publications. If most of the cited references of a new publication are already known and read a point of saturation might have been reached.

Conclusion

This appendix provides an important addition to earlier publications on literature reviews in IS. It proposes a hermeneutic model of the literature review process that advances understanding of the nature of this process and the role of literature searches within it. This is an important contribution for three reasons: firstly, it contributes a hermeneutic model of the literature review process that advances understanding and earlier guidelines for conducting literature reviews in IS; secondly, it situates and demonstrates the importance of literature searches in this process, and thirdly, it assists researchers in conducting literature reviews and creating high quality outcomes.

We argue that the process of conducting literature reviews is fundamentally an understanding process that is best described as a hermeneutic enterprise. Hermeneutics provides an account of how understanding is formed of a subject, such as a body of literature relevant to a particular problem. According to hermeneutics understanding is not a linear process, but one that it is informed by earlier understanding (*Vorverständnis*). In other words, the way one comes to understand a specific piece of literature is based upon earlier understanding of other literature. The hermeneutic approach therefore provides a theoretical foundation for the view of literature review "as an organic system that is constantly growing and changing" (Levy & Ellis 2006:208).

By proposing the hermeneutic approach the appendix makes a contribution to a conceptual foundation of literature reviews that aims to advance understanding and assist in conducting literature reviews in practice. Importantly the hermeneutic model of literature review processes identifies two intertwined circles – the literature review development circle and searching for literature circle building on each other in a recursive manner. This clearly reveals the role and relevance of literature searches within a broader process of the literature review development. In such a way the hermeneutic approach provides an important alternative view on the role of searches which is conceptually different from protocol based, formal approaches (e.g. Okoli & Schabram, 2010). Moreover, it enables the introduction of search techniques and methods in a meaningful way.

More specifically, our contribution is to show how the concept of the hermeneutic circle allows to provide an integrative model of different activities that are associated with the preparation of high quality reviews. Different authors have identified the development of understanding (Boote and Beile, 2005; Combs et al., 2010; Hart 1998; Perry, 1998; Schwarz et al. 2007), critical engagement (Finn 2005; MISQ, 2006; Ridley 2008) and argument development (Feak and Swales 2009; Kwan et al., 2012; Machi and McEvoy 2009; Ridley 2008) as central for developing high quality reviews. While literature reviews have different purposes and diversity in outcomes is a desired aspect of literature reviews (Hart, 1998), literature reviews generally include specific phases that facilitate understanding: searching, reading, mapping and classifying, critical assessment, and argument development. Importantly, using the hermeneutic circle as a framework these phases do not follow each other in a simple linear fashion, but are part of an iterative process (hermeneutic circle) that successively leads to improved understanding.

From this follows that other parts of the literature review development process may also be related to additional hermeneutic understanding processes (circles). For these processes different individual phases may be identified that are part of such an understanding processes. For instance, the process of theory development may be tied into the larger literature review development process, particularly to the argument development phase. Theory development may then go through a number of iterations while better understanding of a new theory is built. That theory development may be broken down into different elements is indicated for instance by Weick (1995). Future research could,

therefore, expand on the hermeneutic understanding process introduced here by providing an account of different phases that are part of a theory development cycle.

One practical implication of the hermeneutic account introduced here is that understanding of a body of literature is an ongoing, potentially never ending, process. The concept of saturation is, therefore, important in order for setting criteria when the literature review is sufficiently comprehensive and insightful. Saturation in turn implies that a literature review will not only depend on the literature, but also on the understanding of researcher. The comprehensiveness and insightfulness of the literature review is judged by the arguments and evidence provided. The deeper a researcher's understanding of the relevant literature, the more convincing the argument for comprehensiveness and insightfulness of the literature review.

When a researcher can produce an account that s/he believes provides a reasonable picture of topic s/he will be able to argue this account convincingly in a review. From this follows that deeper understanding of the literature will allow the production of more insightful reviews.

Appendix B - List of Definitions of Information Systems

This appendix provides a full listing of all definitions of 'information systems' used in the third essay. The definitions range from 2012 back to 1973 and are listed in reverse chronological order. Definitions are drawn from reputable academic literature, including peer-reviewed journals, edited volumes, and monographs. For more detail on the identification and selection process see the methodology section of the third essay.

Definition	**View of IS**
"Information systems are combinations of hardware, software, and telecommunications networks that *people* build and use to collect, create, and distribute useful *data*, typically in organizational settings" (Valacich and Schneider, 2012, p. 21, emphasis in original).	technology view
"an information system can be seen as being in a continuous state of emergence from the interactions among its three constituent subsystems: the technology system, the organization system, and the data system. The interactions continuously transform the data into what the syntax, representation, or adaptation views would consider to be information" (Lee, 2010, p. 340).	socio-technical view
"An information system (IS) collects, processes, stores, analyzes, and disseminates information for a specific purpose. Like any other system, an IS includes *inputs* (data, instructions) and *outputs* (reports, calculations). It *processes* the inputs by using technology such as PCs and produces outputs that are sent to users or to other systems via electronic networks" (Turban and Volonino, 2010, p. 11-12).	process view
"Information Systems are viewed as those procedures which function to collect, process, store and communicate to support the work activity of the enterprise" (Gardner and Grant, 2010, p. 104).	process view
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Definition	View of IS
"Information system is defined more broadly as the combination of technology (the "what"), people (the" who"), and process (the "how") that an organization uses to produce and manage information. In contrast information technology (IT) focuses only on the technical devices and tools used to create, store, exchange, and use information" (Pearlson and Saunders, 2010, p. 15-16).	process view
"Information Systems is Information Technology in Use" (Paul, 2010, p. 379).	process view
"An information system can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products" (Laudon and Laudon, 2010, p. 46).	technology view
"An information system is a form of communication system in which records represent and are processed as a form of social memory" (Beynon-Davies, 2010, p. 392).	social view
"Information systems are systems for using signs in the sense that they act as a communication medium between different people, sometimes spatially and temporally distant" (Beynon-Davies, 2009, p. 5).	social view
"IS combines the technologies, people, data, and business processes for fostering the use of IT to improve organizational performance" (McNurlin et al., 2009, p. 2).	technology view
"Information Systems (1) A set of people, procedures, and resources that collects, transforms, and disseminates information in an organization. (2) A system that accepts data resources as input and processes them into information products and outputs" (O'Brian and Marakas, 2009, p. 631).	process view / technology view
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Definition	**View of IS**
"A business information system is a group of interrelated components that work collectively to carry out input, processing, output, storage and control interactions in order to converts data into information products that can be used to support forecasting, planning, control, coordination, decision making and operational activities in an organization" (Bocij et al,. 2008, p. 42).	process view
"An information system (IS) is a set of interrelated components that collect, manipulate, store, and disseminate data and information and provide a feedback mechanism to meet an objective. The feedback mechanism helps organisations achieve their goals, such as increasing profits or improving customer service" (Moisiadis et al., 2008, p. 3).	technology view
"An IS is a work system whose process and activities are devoted to processing information, that is, capturing, transmitting, storing, retrieving, manipulating, and displaying information. Thus, an IS is a system in which human participants and/or machines perform work (process and activities) using information, technology, and other reseources to produce informational products and/or services for internal or external customers" (Alter, 2008, p. 451).	process view
"The IS is what emerges from the usage and adaptation of the IT and the formal and informal processes by all of its users" (Paul, 2007, p. 195).	socio-technical view
"define an information system as an organizational system that consists of technical, organizational and semiotic elements which are *all* re-organized and expanded during ISD to serve an organizational purpose" (Lyytinen and Newman, 2006, p. 4)	social view
"We view information systems as social institutions that exert their own types of agency that interact with human agency in the systems development process" (Chae and Poole, 2005, p. 20).	social view
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Definition	View of IS
"An information system is not the information technology alone, but the system that emerges from the mutually transformational interactions between the information technology and the organization" (Lee, 2004, p. 11).	socio-technical view
"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" (Lee, 2001, p. iii).	socio-technical view
"Web information systems are computer applications that leverage intra- and inter-firm process and system integration" (Pant et al., 2001, p. 385).	technology view
"A simple definition might be that an information system is a system in the organization that delivers information and communication services needed by the organization. This can be expanded to describe the system more fully. The information system or management information system of an organization consists of the information technology infrastructure, application systems, and personnel that employ information technology to deliver information and communication services for transaction processing/operations and administration/management of an organization. The system utilizes computer and communications hardware and software, manual procedures, and internal and external repositories of data. The systems apply a combination of automation, human actions and user-machine interaction" (Davis, 2000, p. 67).	process view
"Any and every information system can always be thought of as entailing a pair of systems, one a system which is served (the people taking the action), the other a system that does the serving [i.e., the processing of selected data (capta)]" (Checkland and Holwell, 1998, pp. 110-111).	socio-technical view
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Definition	**View of IS**
"*information systems* - in a wide sense that includes computer-based systems, as well as systems that are paper-based, conversation-based, graphics-based, and so on, and the combination of these. Any system that interacts meaningful with humans can be seen as information system in this sense; in particular, business corporations and government agencies may be included" (Goguen, 1997, p. 28, emphasis in original).	socio-technical view
"An information system is a subsystem of an organisational system, comprising the conception of how the communication- and information-oriented aspects of an organisation are composed (e.g. of specific communicating, information-providing and/or information-seeking actors, and of specific information-oriented actands) and how these operate, thus describing the (explicit and/or implicit) communication-oriented and information-providing actions and arrangements existing within that organisation. […] Any actual instance of an information system (in the broader sense) comprises all informal and formal informational actions and all knowledge- and data-processing actions within the organisation in question" (Falkenberg et al., 1996, p.72-73).	process view
"An information system is an object that can be studied in its own right, independently of the way it is developed and deployed in its organizational and social context" (Wand and Weber, 1995, p. 205).	modeling view
"IS are technically mediated social interaction systems aimed at creating, sharing and interpreting a wide variety of meanings. […] Meaning is related to human understanding: through meaning we make sense of our feelings, thoughts and the world around us" (Hirschheim et al., 1995, p. 13).	social view
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Definition	**View of IS**
"an information system is a *social system that uses information technology*. There are always social system and information technology elements to be considered in IS design and implementation. […] an information system is more like a compound than a mixture. Its constituent social system and technical system react to one another so that their properties in combination are different from their properties in isolation. A proper understanding requires that the two systems be studied together" (Davis et al., 1992, p. 297-298, emphasis in original).	socio-technical view
"An organisation has many layers of information systems but three main layers deserve special attention. Each of them could be sub-divided like the layers of an onion. [these three systems are an] informal information system [based on language interactions ...] formal information system [the bureaucratic structures established .... and a] technical information system [based on IT that presupposes a formal system]" (Stamper, 1992, p.32-33).	socio-technical view
"information systems are essentially social systems of which information technology is but one aspect" (Land, 1992, p. 6).	social view
"an integrated, user--machine system for providing information to support operations, management, and decision-making functions in an organisation. The system utilises computer hardware and software; manual procedures; models for analysis, planning, control and decision making; and a database.' The emphasis is on information technology (IT) embedded in organizations" (Symons 1991, p. 181).	technology view
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Definition	View of IS
"We conceive of an information system as an object that can be studied in its own right, independently of the way it is deployed in its organizational and social context, and the technology used to implement it. In other words, when modeling an information system we are not concerned with the way it is managed in organizations, the characteristics of its users, the way it is implemented, the way it is used, the impact it has on such factors as quality of working life or the distribution of power in organizations or the type of hardware or software used to make it operational. Instead, we are concerned only with information system as independent artifacts that bear certain relationshipy to the real-world system they are intended to model" (Wand and Weber, 1990, p.61).	modeling view
"information system exist to generate, record, manipulate and communicate data necessary for the operational and planning activities which have to be carried out if the organization is to accomplish its objectives" (Land & Kennedy-McGregor, 1987:63).	process view
"... information systems are future-oriented systems. That is to say, choices of input today are based on anticipation of usefulness tomorrow, next year, or even next century in the case of research libraries and archives. This assumption--messages carry a potential value--is important because it demands that we see system and user in a larger systemic sense" (Taylor, 1986, p. 5).	social view
"an information system is a social system, which has embedded in it information technology. The extent to which information technology plays a part is increasing rapidly. But this does not prevent the overall system from being a social system, and it is not possible to design a robust, effective information system, incorporating significant amounts of the technology without treating it as a social system. It is not enough to design a technical system, and then attempt to make it user friendly, or to tell the designer to remember to take into account of human factors" (Land, 1985, p. 215).	social view
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Definition	**View of IS**
"Information systems are *not* technical systems which have behavioural and social consequences, rather they are *social systems* which rely to an increasing extent on information technology for their function. Nevertheless, the technology is never more than a component of the information system" (Land and Hirschheim, 1983, p. 91, emphasis in original).	social view
"we propose that an information system consists of at least one PERSON of a certain PSYCHOLOGICAL TYPE who faces a PROBLEM within some ORGANIZATIONAL CONTEXT for which he needs EVIDENCE to arrive at a solution (i.e., to select some course of action) and that the evidence is made available to him through some MODE OF PRESENTATION" (Mason and Mitroff, 1973, p. 475).	process view

Appendix C - Coverage of IS Types by Textbooks

This table summarizes the types of systems discussed by IS textbooks published in 2008 or later and appearing in at least in their fourth edition.

	Management Information Systems: Managing the Digital Firm (Laudon and Laudon, 2010)	**Management Information Systems (O'Brian and Marakas, 2009)**	**Information Technology for Managemen (Turban and Volonino, 2010)**	**Principles of Information Systems (Moisiadis et al., 2008)**	**Management Information Systems: For the Information Age (Haag and Cummings, 2008)**	**Business Information Systems: (Bocij et al., 2008)**	**Information Systems Today (Valacich and Scheneider, 2012)**
Edition	11th	9th	7th	7th	7th	4th	5th
Transactions Processing Systems (TPS)	X	X	X	X		X	X
Collaboration Technologies[1]	X	X	X	X	X	X[2]	X
Office Automation Systems			x			X	X
Enterprise Resource Planning (ERP)	X	X	X	X	X	X	X
Supply Chain Management (SCM)	X	X	X		X	X	X
Customer Relationship Management (CRM)	X	X	X		X	X	X
Management Information Systems (MIS)	X	X	x	X		X	X
Decision Support Systems (DSS)	X	X	X	X	X	X	X
Data Visualization Systems[3]	X[3]	X[3]	X[3]		X[3]		X
Executive Information Systems (EIS)	X	X		X		X	
Intelligent Systems / Artificial intelligence[4]	X	X	X	X	X	X	X
Knowledge Management Systems (KMS)	X	X	X		X		X
Virtual Reality	X		x	X			

*The first regional edition is based on the seventh international edition. A small 'x' indicates only minor coverage by a hand book; 1) Includes: group support systems (groupware), conferencing software, workflow systems; 2) Bocij et al. Discuss these as part of Office Automation Systems; 3) Includes geographic information systems (GIS); 4) Includes: expert systems; intelligent agent systems; neural networks; genetic algorithms.