Enriching Enterprise Resource Planning Systems for Strategic Advantage:
A Semiotic Motivated Approach

Adrian Benfell[1], Roy Williams[2] and Kecheng Liu[3]

[1]*University of Portsmouth, Portsmouth Business School, Operations and Systems Management Subject Group, Richmond Building, Portland Street, Portsmouth. PO1 3DE. United Kingdom. adrian.benfell@port.ac.uk*
[2]*University of Portsmouth, Department of Mathematics, Lion Gate Building, Lion Terrace, Portsmouth. PO1 3HF. United Kingdom. roy.willams@port.ac.uk*
[3]*Director, Informatics Research Centre Henley Business School, University of Reading, Building 42, Whiteknights, Reading. RG6 6WB. United Kingdom. k.liu@henley.reading.ac.uk; k.liu@reading.ac.uk; www.reading.ac.uk/irc*

Keywords: Enterprise Resource Planning, Affordance, Semiotic

Abstract: Enterprise Resource Planning is often endorsed as a means to facilitate strategic advantage for businesses. The scarcity of resources is the method by which some businesses maintain their position. However, the ubiquitous trend towards the adoption of Enterprise Resourcing Planning systems coupled with market saturation makes the promise of advantage less compelling. Reported in this paper is a proposed solution based upon semiotic theory that takes a typical Enterprise Resource Planning deployment scenario and shapes it according to the needs of people in post-implementation contexts to leverage strategic advantage in different ways.

1. INTRODUCTION

Doing business on the web demonstrates clearly the cogency and ubiquity of Information Technology (IT) and its utilisation to leverage strategic advantage for businesses. Advocates of IT solutions propagate the notion that strategic advantages can be gained by all. By implication, IT expenditure should produce tangible benefits over a competitor. However, Carr (2003) criticises such a notion. Carr (2003) proposes that contemporary IT does not provide such advantage to businesses suggesting that IT has become more of a commodity. Additionally, business strategy should strive to demarcate a business from its competitors, thus IT is no longer an enabler on its own. According to Carr (2003),

> *"What makes a resource truly strategic—what gives it the capacity to be the basis for a sustained strategic advantage—is not ubiquity but scarcity. You only gain an edge over rivals by having or doing something that they can't have or do."*

Modern IT solutions such as Enterprise Resource Planning (ERP) systems can be made available to everyone over the web as Software as a Service (SaaS) solutions. The accessibility of such tools has transformed them from strategic motivators to mere components of production; they have become nothing more than accepted costs of doing business. In this paper, Carr's (2003) view is taken whilst additionally aligning with the opinion that strategic advantage can only be achieved when people are deeply involved. As a motivating case we consider the saturation of ERP solutions for all types and sizes of business where 'vanilla' (original source) implementation modes dominate. Furthermore, according to Law, Chen and Wu (2010); Jones, Kalmi and Kauhanen (2011); and Velcu (2010), businesses that do adopt ERP systems tend to focus principally upon implementation orientated factors whilst overlooking others. As a result, the usefulness and operation of ERP systems may diminish over time, thus further compromising any strategic advantages that may be gained.

Suggested in this paper is an approach to overcome post-implementation issues associated with ERP systems. The development of a special kind of dictionary allows people to create and modify its contents, as memes (Blackmore, 1998), to communicate particular uses of an ERP system. Such uses are described as affordance, the concept first proposed by Gibson (1977). The dictionary presents a categorisation of various signs particular

to ERP systems, that are codified semiotically, in thought processes described as semiosis (Peirce, 1931-58).

2. ERP SYSTEMS

ERP systems are designed to integrate software that facilitates the synchronisation of work across an organisation, both internally and externally. The intention behind ERP is to combine core business processes, such as 'front-office' customer orientated operations including sales, marketing and customer services (Finnegan and Currie, 2010), with 'back-office' ERP functions, for instance, accounting, finance, human resources management, purchasing, inventory and manufacturing (Velcu, 2010). The assumption behind ERP is that a universally pre-configured set of business operations can be reused in a multiplicity of organisations. The work in this paper considers the activity of enriching people's experience of using ERP systems in post-implementation contexts to help mitigate the commodification of ERP systems. The transformation proposed is underpinned by the motive that enrichment ought to be rooted in the notion of affordance (Gibson, 1977; Stamper, 1985), where the properties of affordance helps in the dissemination of competencies allied to the use of ERP systems. Affordance may also be coupled with the idea of 'memes', (Dawkins, 1976; Blackmore, 1998), to take a significant part in the codification, as permissives, the process of enhancing the use of an ERP system and spreading competencies. Dawkins (1976, p192) first describes memes as:

> *"memes propagate themselves in the meme pool by ... a process which, in the broad sense, can be called imitation".*

Blackmore (1998) develops the term 'imitation' to include reading, writing, watching television, being taught by people in authority, and by listening to the conversations of others. Memes are intentionally used here as the ground for which communicating affordance from one person to another to support the enhancement process. If memes are to include imitation as described previously, they overlap with the phenomenological categories suggested by Peirce (1931-58). Such phenomena formulate a process of 'semiosis' (understanding what a sign means through thought processes) that correlate with the meaning of imitation. Additionally, the concept of memes duplicates the behaviour of genes in that they self-replicate (can optionally be used across disparate business cultures), mutate (allow people to continuously adapt them to specific needs), and finally respond to selective pressures (to allow memes to become redundant) in a business environment.

3. ENRICHING THE USE OF ERP SYSTEMS THROUGH AFFORDANCE

The theory of affordances originates from Gibson (1977) and is often extended to study real world patterns of human behaviour (Liu, 2000). A business as an environment makes many patterns of behaviour possible; should a person be separated from its environment, the repertoire of behaviour the person owns would cease to exist (Stamper, 1985). Gibson (1977) further describes affordance as the consequence of interactions between a person and its environment. Each interaction contributes to the way a person makes sense of the environment, and potentially changes both the person and environment. The interactions with an ERP system will depend upon the particular properties of the person and the system, but the properties of either the person or the ERP system are not sufficient for the affordance to be realised; they can only realised within an interaction. Regarding ERP systems, an affordance is something that may only be realised when a person carries out an action that an ERP system compels them to take. In doing so, a person creates, reacts and modifies a vast array of 'signs'. Such signs aligned to affordance are understood through semiotics (the study of signs) in a process of semiosis (meaning making of signs through thought processes). This idea of affordance is relevant to understand the post-implementation of ERP systems and their improvement. By beginning with a definition of affordance as the product of interactions between a person and its environment; the identification of key elements aligned to affordance, development, and why they are relevant to the successful evolution of ERP, the relationship of affordance with semiotics provides the starting point of a framework necessary to augment ERP systems.

Several researchers, such as Stamper (1985), have built on Gibson's work, and have developed and consolidated the concept of 'affordance' that

emphasises Gibson's active perception. Gaver (1991, p.2-3) refers to this notion as:

"Perceptible affordances are inter-referential: the attributes of the object relevant for action are available for perception"...........“The actual perception of affordances will of course be determined in part by the observer's culture, social setting, experience and intentions. Like Gibson I do not consider these factors integral to the notion, but instead consider culture, experience, and so forth as highlighting certain affordances. Distinguishing affordances and the available information about them from their actual perception allows us to consider affordances as properties that can be designed and analyzed in their own terms."

In connection with Gaver (1991), affordances using an ERP system exist independently of perception, hence suggesting that a business context can lead to the emergence of affordances, and thus include memes as properties of affordance that are realised over a period of time through perception. The term perception is used in collaboration with Peirce's phenomenological categories, expressed as thought processes – semiosis. Affordances thus provide a rigorous reformulation of the nature of perception, and may be considered fundamental to the way people use an ERP system. The idea of active perception allows the utilisation of ERP systems proposed in this paper to cut across the dichotomy of subjective user experience and objective ERP installations.

4. PEIRCE'S INTERIM ACCOUNT

Peirce (1931-58) devised a phenomenological theory coupled with his 'interim account' and based it upon three categories: 'firstness' as the conception of being independent of something else, that is a representamen (representamen sign) distinguished by its own phenomenological category; 'secondness' as the concept of a representamen being linked to or having a reaction with its object (object sign); and 'thirdness' as a concept of mediation, where a first and second converge into a relation in which an interpretant (interpretant sign) is assigned to the way a representamen denotes its object. Linked to ERP systems, interpretant signs are memes generated from affordance. Following Peirce's principle of hierarchy amongst categories, a representamen as a type of sign (firstness) cannot belong to a higher

category than its object (secondness), also a type of sign, and in thirdness, an interpretant (a more advanced type of sign) cannot be in a higher category than its object. Thus Peirce (1931-58) yields ten classifications of signs that can be used to understand the phenomenon when people interact with ERP systems.

The Representamen
For the successful signification by a representamen of its object, qualisigns, sinsigns and legisigns are used by Peirce (1931-58) to divide the representamen based upon the three phenomenological categories. Qualisign – firstness (material quality) is a representamen that does not appear in ERP systems. However, sinsign – secondness (material index) is a representamen that relies upon an existential connective with its object. These types of signs are present when using an ERP system, for example they would constitute the actual existence of different kinds of business processes. Additionally, legisign – thirdness, (material convention), is a representamen based upon a law or habit, and in terms of ERP, these signs are the expected conventions when someone follows a business process.

The Object
The object is the notion of the representamen interacting with its object. Related to using an ERP system, the object provides the meaning associated with the syntax contained in a business process. Iconic signs – firstness (relational quality), are interpreted by some shared quality – a likeness to something as an interpretation by a person, for example the particular icons used for nodes and arcs in a graphical representation of a business process. Indexical signs – secondness (relational index), are signs interpreted by causal connections. Example indexical signs include the actual existence of business processes identified by their names, the start and endpoints that can be connected to and be departed from. Indexical signs also are found within the definitions of business processes made possible in an ERP system. Symbolic signs – thirdness (relational mediation), are linked to their representamen by knowing the conventional or habitual rules applicable to the representamen. For example, by practice a person would accept that when working with an ERP system a possible term such BOM for a bill of materials will enable that person to complete a particular business process, or a collection of them.

The Interpretant

The interpretant represents the concept of mediation, where the representamen and object are brought into a relation in which the representamen's interpretant is linked to the way a representamen denotes its object. In essence, the interpretant is the reaction of a person's mind when a connection is made between a representamen and an object. The connection made between a representation and an object (not in the physical sense) is the means by which affordances are revealed as perceived actions during an interaction with an ERP system. The resultant sign meanings can be expressed in a natural or artificial language, (Sowa, 2000), hence it is the way memes are composed and therefore imitated. Interpretant signs include rhemes, dicents and arguments.

Rheme – firstness (formal quality), the interpretant focuses a person's understanding of a sign based upon its (quality) in that a representamen determines its object by its quality only – for example specific naming for a business process. Dicent – secondness, (formal index) the interpretant focuses a person's understanding on the existential features of an object through proposition, for example a business process name to index an actual ERP process whilst the name used suggests its purpose and its application within a business context. Argument – thirdness, (formal mediation) the interpretant focuses a person's mind on a rule of inference to derive an argument by applying some kind of convention or law, such as the implication a business process has within a business context. A person through interaction perceives an array of affordances and communicates these as memes. Memes are interpretant signs of a special kind.

The interpretant (table 1 – shown as *I*) provides a semiotic frame that can be used to circumvent the negatives of ERP vanilla deployment. For example, rhematic-index-legisigns provide the classification of things belonging to a business process that would normally be listed in an ERP user interface environment. Dicent-index-sinsigns are also present as the semantic meaning of a business process is understood by a person when imitating the relationship between various signifiers contained within a business process. Imitation may simply be achieved by forcing a person to use an in-built business process. For example, a business process exists (legisign as a firstness), an actual business process by a name that can be called upon to carry out a specific task (secondness as an index), thus provoking the emergence of affordances that may exist in a business context (thirdness as an argument). The purpose of a meme is added to the

framework in table 1 as the sign classification argument-symbol-legisign. This particular sign classification enables the propagation of memes through imitation to other people. To specify how to deepen people's experience when using an ERP system as argument-symbol-legisigns, Peirce's (1931-58) final account is referred to.

	Firstness	*Secondness*	*Thirdness*
R	**Qualisign** (A quality)	**Sinsign** (An existent thing) A business process that can be perceived.	**Legisign** (A convention or law) Expected conventions for business process syntax.
O	**Icon** (A similarity)	**Index** (Causal connection) A business process that when executed creates an effect in the real-world, it has semantic meaning.	**Symbol** (refers to its object by convention or law) Business process naming convention to describe the semantic meaning of a business process.
I	**Rheme** (Quality only – a common noun) A classifier for a set of related business processes.	**Dicent** (An sign of actual existence – a sentence). A business process used for a general task.	**Argument** (An inference from dicent signs in context). **Intended** – meme to represent affordance with regulated action agreed to by consensus.

Table 1: Signs available when using an ERP system

5. PEIRCE'S FINAL ACCOUNT

In this version Peirce divides the object and interpretant to take into account a chronological process of inquiry. This approach is applicable to ERP systems when the dynamic conditions of business contexts affect maximising the availability of an ERP system post-implementation. Peirce (1931-58) introduces two important considerations with regard to dividing an object and dividing an interpretant. The terms Peirce uses are the 'immediate' and 'dynamic' object. The immediate object is the object as a person would know it to be an object at any instance in time. The dynamic object is the object as it is known to be at the end of 'exhaustive' inquiry. The execution of a business process leads to perceived affordances – achievable as dynamic objects. However, to explain fully what an ERP system realises, the mechanism Peirce (1931-58) uses to divide the interpretant into three, 'immediate', 'dynamic' and 'final' is equally

applicable. The dynamic interpretant is an understanding of the relation between a representamen and a dynamic object at any stage, and the immediate interpretant is a generalised understanding of the relationship between a representamen and a dynamic object. The final interpretant is a complete understanding of a dynamic object that all people would agree to when using an ERP system. The final interpretant is a collection of memes reached by a group of people (as users) that are spread, virally for example, using suitable communication tools. For instance, the reaction of the dynamic object with the final interpretant determines how an argument-symbol-legisign is arrived at and requires a person to enact the appropriateness of a business process when using an ERP system, as a process of imitation. The argument-symbol-legisign is a meme that can be derived from imitation to understand the usefulness of a business process in various dynamic conditions. Peirce's 'pragmatic maxim' - three grades of clarity, is also further applied to arrive at argument-symbol-legisigns to codify different views. The first grade of clarity is to have an unreflective grasp aligned to ERP system availability – the immediate interpretant. The second grade of clarity is being able to define the generalised concepts of what the ERP system provides to a person – dynamic interpretant. The final grade of clarity determines what effects that are held in relation to the concepts of study that are considered to be useful, for example memes that represent affordances – the final interpretant. The pragmatic maxim ensures that the effects of using an ERP system can be communicated successfully. Pragmatic conditionals (as dynamic conditions) are linked to Peirce's account of modality. Possibility and necessity are based upon the epistemological facts in relation to the meaning of signs as memes, they have implicational properties. To say something is necessary is to confirm that something must be the case by a person using an ERP system that a set of sufficient conditions that exist need to be fulfilled. Also, to say it is possible is to say that under varied dynamic conditions a person knows something to be the case when using an ERP system, and conversely impossible when the case cannot be met.

6. THE FRAMEWORK FOR ERP SYSTEM ENRICHMENT

Using Stamper's (1985) overview of ontologies, reaching interpretant signs such as argument-symbol-legisigns, requires that all people as stakeholders understand the dynamic conditions in a business context that an ERP system belongs to, thus additionally aligning memes to the meaning of ontology provided by Stamper (1985). The purpose of memes (see figure 1) is to provide the components for all interpretant signs. Semiosis for someone using an ERP system therefore starts when examining preliminary description files to assess the functional properties and capabilities of one or more business processes. Chandler (2002) refers to this as intertextuality. These two activities comply with Peirce's first grade of clarity, as they initiate semiosis to form the representamen that is required for memes to be effective:

1. The representamen – the elements (composition of business process description) designating dynamic objects in a dictionary (shared) that can be imitated (first grade of clarity);
2. The dynamic objects as they relate to the semantics describing the business processes contained in a shared dictionary. Dynamic objects also correspond to the steps and stages within a business process and the capabilities of using them (second grade of clarity);
3. The final interpretant signs that describe all features and capabilities of a particular business process in dynamic conditions using high-level descriptions based upon various modalities (third grade of clarity).
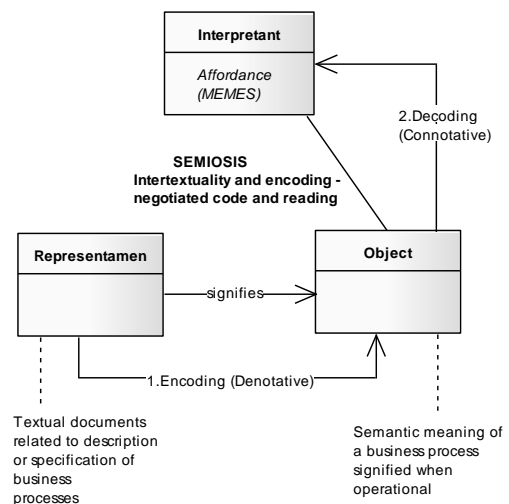

Figure 1: Shared Semiosis

With reference to figure 1, semiosis profiles the representamen between a person and an ERP system to compile dictionary entries related to business process execution, whilst working as the starting point in a chronological, akin to Peirce's final account, series of action-perception. The dictionary holds the syntactic and semantic meanings that describe the intrinsic nature of each business process. Arrow 1 in figure 1 illustrates that syntactic documentation such as business process diagrams for example, can be used to describe a useable business process. Intertextuality and encoding work together to create a dictionary that can be shared. Hence the first generation of a dictionary as a first grade of clarity encompasses the primary elements of a business process (or a collection).

Intertextuality and encoding combine to produce an initial dictionary as part of semiosis (formalised in table 2). Semiosis then moves onto 'negotiated code and reading' (Chandler, 2002) to commence the formulation of affordances as memes between all people interacting with an ERP system. The dictionary includes internal dependencies of different kinds, first, with the elements of a business process, and second with memes, thus final interpretant signs (table 1) are contingent upon the business processes that highlight affordances that in turn are spread as memes. The dependencies between these elements helps to facilitate the usefulness of an ERP system. For example, someone may submit a description based upon some dynamic conditions, specified using Peirce (1931-58) modalities, to suggest a 'possible' mode of interaction. Another person, who has a set dynamic conditionals linked to that meme may have some related actions, thus mutation of that meme ensues.

The implication of this approach is that memes need not relate to purely using a business process or a collection of them; they illustrate a complete affordance context. Memes are also captured and represented in a chronological format, thus allowing the representation of memes to evolve in a decoding process (figure 1) through communication. To summarise, the phenomenological categories devised by Peirce (1931-58) are used in table 2 to show that memes are based upon the process of semiosis shown in figure 1. However, encoding and decoding cycles are required to further the spread of memes, and thus a suitable communication mechanism is required.

Semiotic branch	Memes (affordance)	Semiosis
Firstness	Capture through existing texts the elements to form a rudimentary dictionary as a starting point for a specialised dictionary.	**Representamen – Textual code (intertextuality and encoding)** business process specifications – narrative and diagrammatic models.
Secondness	Imitation (dynamic objects) the business process and its relationship to affordance.	**Dynamic object – Connotative sign (negotiated code and reading)** Ontological dependencies linked to the contextualised interpretation by an Interpreter (Person).
Thirdness	Linking the interpretations of the memes with potential contexts and effects on all people interacting with an ERP system and specifying a meaning of all memes congruent with everyone.	**Final interpretant –** Connotative signs (argument-symbol-legisigns) linked to the social parameters of a business defined as the imitation of memes that undergo continuous decoding.

Table 2: Formalising Semiosis for Enriching ERP

7. COMMUNICATION

For proper communication of memes, the multi-responsive communication framework by Benfell and Liu (2009) based upon communicative act theory by Austin (1962) and Searle (1969), underpins the communication segment of memes that the encoding and decoding mechanism demands. The mechanism generates the principles of trans-situational grounds and multi-responsive actions. Trans-situational grounds are used to further format rheme, dicent and argument signs (as in table 1) that describe business processes under particular conditions. To structure the notion of memes as a part of semiosis, trans-situational grounds form the necessary and sufficient conditions that must be in place to derive regulated action that people would adhere to when using an ERP system. In this case the deontic conditionals permission and forbidden are used. As independent dicent signs are classed as the modality necessary, such signs on their own are only adequate when marked as true (relevant and agreed to by consensus), when they all become necessary to developing a meme. Hence each necessary condition is combined as a conjunction for deontic regulated (DR) actions to be taken in what may be defined as closed world situations (Beller, 2008). For example, if a trans-situational ground is represented as "it is necessary to use business process X only when customer types A purchase this product", determines that

conjunctions must be present between the atomic conditions in the closed world principle. This approach sets a DR action aligned to a meme that is contingent upon trans-situational grounds, as it forms the multi-responsive nature of communication between people. Taking the principles of causation, Carroll and Markosian (2010), where a causes b, if and only if, a and b both take place suggests that for a meme which includes possible or impossible actions b (DR multi-responsive action) to occur, an action a must be taken and is expressed as:

A perceived action a causes b, if and only if, a is necessary and sufficient and both a and b take place.

With reference to necessary and sufficient conditions in order for a DR multi-responsive action to occur, several necessary conditions must be combined to make up sufficiency, and whilst necessary and sufficient conditions are mutually exclusive, the resultant method defines an ontological structure of memes for the dictionary:

1. Multi-responsiveness is a DR action in response to one or more memes represented as trans-situational grounds;
2. Trans-situational grounds for a deontic action are brought into the current situation by a person as justification for an affordance when using an ERP system;
3. Trans-situational grounds (as necessary conditions) are rule making which provides an ontological structure for memes; thus
4. A multi-responsive (deontic) action is a compound of signs that reflect business contexts as rhemes and dicent signs, as business process signifiers, and memes that collectively describe action perceived affordance. The standardised form of argument signs that make up a meme is:

meme = a(rheme $\land$ dicent $\land$ argument)) $\rightarrow$ b(DRMulti-responsive action)

The standardised form of a meme configures the special kind of dictionary needed to make possible the spreading of memes.

8. DISCUSSION AND CONCLUSION

Affordance is the proposed mechanism for developing ERP systems in post-implementation scenarios that may improve strategic advantage for businesses through the use of memes. ERP enrichment strategies need to take into account the mix of organisational culture, process, people and other technology that can be encapsulated through the notion of affordance (Finnegan and Currie, 2010). This highlights a relationship to the interpretivistic paradigm of organisational culture (Burrell and Morgan, 1979). Finnegan and Currie (2010) also propose that affordances in relation to structures and people exhibit collections of possibilities and limitations that are intended as memes within this paper. Such use of affordance implies a link to the dissemination of memes as a method to improve strategic advantage for businesses.

The semiotic view of memes in terms of interpretant signs as rhemes, dicent and argument signs further supported by representamen and object signs (in the Peircean sense) is appropriate when coupled with encoding and decoding cycles to manage the influence of business contexts over ERP use. The collation of rheme, dicent and argument signs in a semiosis where all people have the opportunity to engage is an appropriate means to capture all relevant views from people when using ERP systems. For example, linked to ERP implementation Ke and Wei (2008, p.213) state:

"Culture that enables and motivates employees to generate innovative ideas, openly share their information and knowledge, readily support and collaborate with others within and across functional units, be willing to participate in decision making and share power, and tolerate conflicts and risk."

The core algorithm for denoting memes based upon trans-situational grounds is a useful mechanism to capture deontic regulated action aligned to the enhancement of ERP so that other people when interacting with an ERP system may participate in the modification of memes and the resultant deontic regulated action. This approach may also aid in the customisation of an ERP system as part of a continual development process to avoid negative post-implementation consequences (Morton and Hu, 2008). Negative customisation effects can

be explored alongside which types of customisations have more positive effects.

The process of enriching ERP systems preferably should be supported by a communication tool to support the creation and evolution of memes and the instantaneous sharing of them. One such tool is going through several phases of development and will soon be available to enhance ERP systems post implementation.

9. REFERENCES

Austin, J. (1962) How to Do Things with Words. Cambridge, Massachusetts: Harvard University Press.

Beller, S. (2008) Deontic norms, deontic reasoning, and deontic conditionals. Thinking and Reasoning, 14, 4, pp 305-341.

Benfell, A., and Liu, K. (2009) Defining a Pragmatic Based Web-service Discovery Mechanism, I-SEMANTICS Special Track: 4th AIS SigPrag, International Pragmatic Web Conference. Graz, Austria. ISBN 978-3-85125-060-2 pp 763 – 774 (2009).

Blackmore, S. (1998) Imitation and the definition of a meme. Journal of Memetics - Evolutionary Models of Information Transmission, 2.

Burrell, G., & Morgan, G. (1979) Sociological Paradigms and Organisational Analysis, Heinemann (1979).

Carr, N., G. (2003) available at: http://hbr.org/2003/05/it-doesnt-matter/ar/1

Carroll, J., W. and Markosian, N. (2010) An Introduction to Metaphysics. Cambridge University Press.

Chandler, D. (2002) Semiotics – The Basics, Routledge.

Dawkins, R. (1976) The Selfish Gene. Oxford, Oxford University Press.

Finnegan, J, D., and Currie, L,W. (2010) A multi-layered approach to CRM implementation: An integration perspective, European Management Journal, Vol 28, 2, pp 158 – 173,

Gaver, W.,W. (1991) Technology Affordances, In: Proceedings of CHI'91, (New Orleans, Lousiana, April 28 - May 2, 1991), ACM, New York, 79-84.

Gibson, J., J. (1977) The Theory of Affordances. In Perceiving, Acting, and Knowing, Eds. Robert Shaw and John Bransford. ISBN 0-470-99014-7.

Jones, D.,C., Kalmi, P. and Kauhanen, A. (2011) Firm and Employee Effects of an Enterprise Information System: Micro-econometric evidence, Journal of Production Economics,130, p159–168.

Ke, W., and Wei, K., K. (2008) Organizational culture and leadership in ERP implementation, Decision Support Systems, 45, 208–218.

Law, C., C., H., Chen, C., C. and Wu, B., J., P. (2010) Managing the full ERP life-cycle: Considerations of maintenance and support requirements and IT governance practice as integral elements of the formula for successful ERP adoption Computers in Industry, 61, p297–308.

Liu, K. (2000) Semiotics in Information Systems Engineering, Cambridge University Press (2000).

Morton, A., N. and Hu, Q. (2008) Implications of the fit between organizational structure and ERP: A structural contingency theory perspective, International Journal of Information Management, 28, 391–402.

Peirce, C., S. (1931-58) Collected writings (8 vols), Editors, Charles Hartshorne, Paul Weiss and Arthur W. Burks, Cambridge, MA, Harvard University Press.

Searle, R. (1969) Speech Acts. Cambridge University Press, London, UK.

Sowa, J. (2000) Knowledge Representation: Logical, Philosophical and Computational Foundations, Brookes/Cole: Thomson Learning, ISBN: 0-534-94965-7.

Stamper, R. (1985) Knowledge as action: a logic of social norms and individual affordances. In Gilbert, G,N., and Heath, C., (eds) Social Action and Artificial Intelligence. Gower Press, Aldershot, Hampshire. pp 172-191.

Velcu, O. (2010). Strategic alignment of ERP implementation stages: An empirical investigation, Information & Management, 47, 158–166.