Preface: Co-Design of Business and IT Systems

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Introduction

Information technology (or IT) has an important role to play in a business organisation. The assumption that the use of IT is necessary in any business is almost taken for granted. It can be witnessed that continual investments in IT have been made to sustain the productivity in industry. However, it has been widely observed that there is often a gap between an operational IT system and current business requirements in an organisation. An IT system, that at one time is highly supportive, after an initial period of time, could impose constraints to business operations, and could be regarded as a legacy system. Such a problem may be caused by a number of factors. One is that IT systems and business processes are not treated as one integral unit and they are designed separately. Calibration and adjustment of IT and business systems can overcome some of the problem, but sometimes more costly exercises such as process re-engineering or re-development of the IT system have to be involved. Many research communities such as computing and management sciences have made great effort in searching for a solution, through investigation of flexible architecture of IT systems, evolutionary information systems and co-evolution of IT systems and business processes.

The co-design of business and IT systems is an approach towards this direction. When an IT system is viewed as a part of the business organisation, and both the IT and business systems are designed in the same time, the gap between them will be minimised. This is a position taken by most of the authors in this special issue. In this Preface, we shall first of all discuss the motivation of why the co-design is important, given the context of constant changes of IT functionality and business requirements. We shall then present **a perspective (or 2, depending on the later sections to be produced)** for the co-design by introducing the theory of semiotics and presenting our arguments derived from those viewpoints. Highlights of the papers in this special issue will be then be presented, followed by conclusions and future work.

Context and Motivation

Amongst many, we shall only discuss three research communities where work has been conducted towards designing IT systems to meet business changes. In the organisational semiotics community, organisations are viewed as information systems, as they regard that the function of signs and information is crucial and people's behaviour is governed by social and organisational norms (see, for example, Liu *et al.* 2001 and 2002). The key concerns for them are how to make organisations effective in perform business functions and achieve business objectives, through the proper use of information. Any technologies such as computer systems or any other instruments could only extend human's capability if they are incorporated properly into the business system. This kind of extension is called a new "affordance", which could not be acquired without it (see Stamper, 2001, p145). A piece of technology must be designed to fit into the organisation and to support the business process in order to enhance its capability.

The community of the Language Action Perspective (LAP) takes the similar position but viewing the problems from a slightly different angle. They emphasise the role of language and human communication in organisations. IT in the first instance is to support communicative actions, which bring the change of states of the business (for example from an offer made to a contract received). An important part of a business process under study is the

process of using language in human organisations, which is essentially the way to get business done. Much valuable work can be found in their workshop proceedings (see for example Schoop and Taylor, 2001).

In the UK, having recognised conflicts between IT systems and business needs, the Engineering and Physical Science Research Council (EPSRC) funded a research programme entitled Systems Engineering for Business process Change (SEBPC). Thirty research projects were set up with a total fund of £4.5 million to investigate how the problems of legacy IT systems in relation to changing business processes. The programme aimed "to release the full potential of IT as an enabler of business process change, and to overcome the disabling effects which the build-up of legacy systems has on such changes." (Henderson, 2000, Preface). The flexible business systems and IT systems are very much the motives of this community. The projects within the programme cover a wide range of topics, but the key issue is how to make IT systems to support the business processes and organisational objectives. Work has also been conducted by researchers in the areas of information systems, systems engineering, business systems modelling, and others. Much effort and resource has been put in by industry (both IT supply and user companies) in finding out solutions to alleviate the legacy problems by maximising the benefits of the current IT systems and extend the effective time of the new systems.

A Semiotic Perspective to Co-design
Semiotics is the study of signs that examines the nature and properties of all kinds of signs (Peirce 1931/35, Morris 1946). A sign is anything that stands for something else. Three major categories of signs can be found, judging by the relationship between the sign and what is represented by the sign. Iconic signs are associated to what they represent by similarities and metaphors, e.g. image, map, and photo. Indexical signs are by inherent connections, e.g. smoke and fire, footprints on a sandy beach and the presence of a tiger. Symbolic signs are by conventions and cultural norms and are dependent very much on the context where a sign is used, e.g. the meaning of colours of traffic lights and the meaning of a cross sign in a church and in a hospital. Understanding these signs are extremely important when designing a system that processing signs – such as a business organisation and an IT system.

A sub-discipline of semiotics, Organisational Semiotics, is emerging (see Liu *et al*., 2001, 2002). Stamper has developed a semiotic framework (figure 1) which guides us in examining all the aspects of the signs and studying how signs are used for communication and coordination in an organisational context. Organisations have both a technical and a social dimension and their performance relies heavily on their ability to integrate both of these dimensions. From this semiotic perspective the IT platform serves the technical business operations whilst the human information functions capture the social dimension of business activities.

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┌─────────────────────────────────────────────────────────────────────┐
│                              │ SOCIAL WORLD  beliefs, expectations,   │
│   Human Information          │ functions , commitments, contracts, law, culture, ... ...│
│       Functions              │ PRAGMATICS  intentions, communications,│
│                              │ conversations, negotiations,.....      │
│                              │ SEMANTICS meanings, propositions,      │
│                              │ validity, truth, signification, denotations, ... ...│
├──────────────────────────────────────────────────────────────────────┤
│   The IT        │ SYNTACTICS formal structure, language, logic,       │
│   Platform      │ data, records, deduction, software, files, ... ...  │
│                 │ EMPIRICS pattern, variety, noise, entropy,          │
│                 │ channel capacity, redundancy, efficiency, codes,..... │
│   PHYSICAL WORLD signals, traces, physical distinctions,              │
│   hardware, component density, speed, economics,.....                 │
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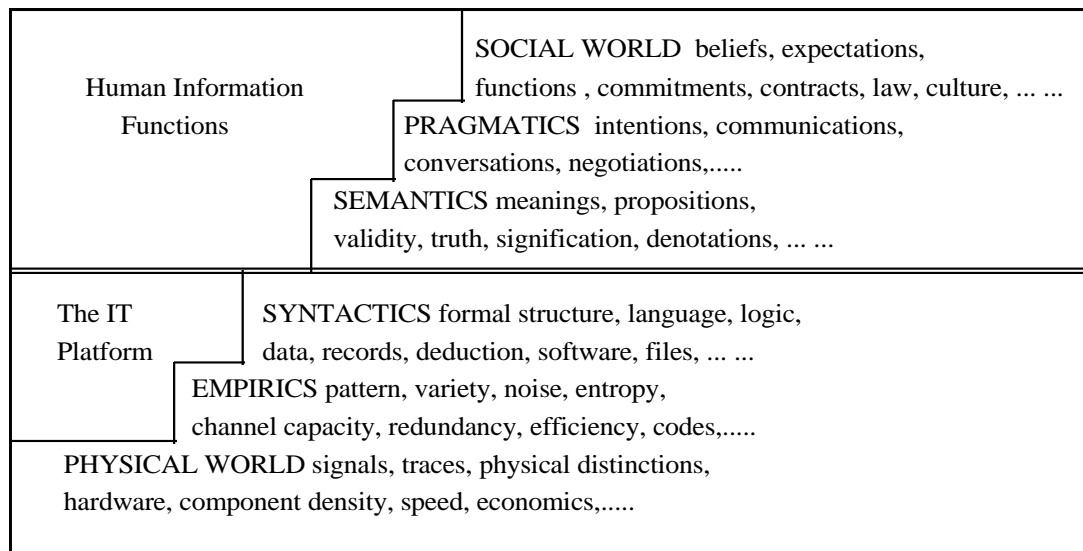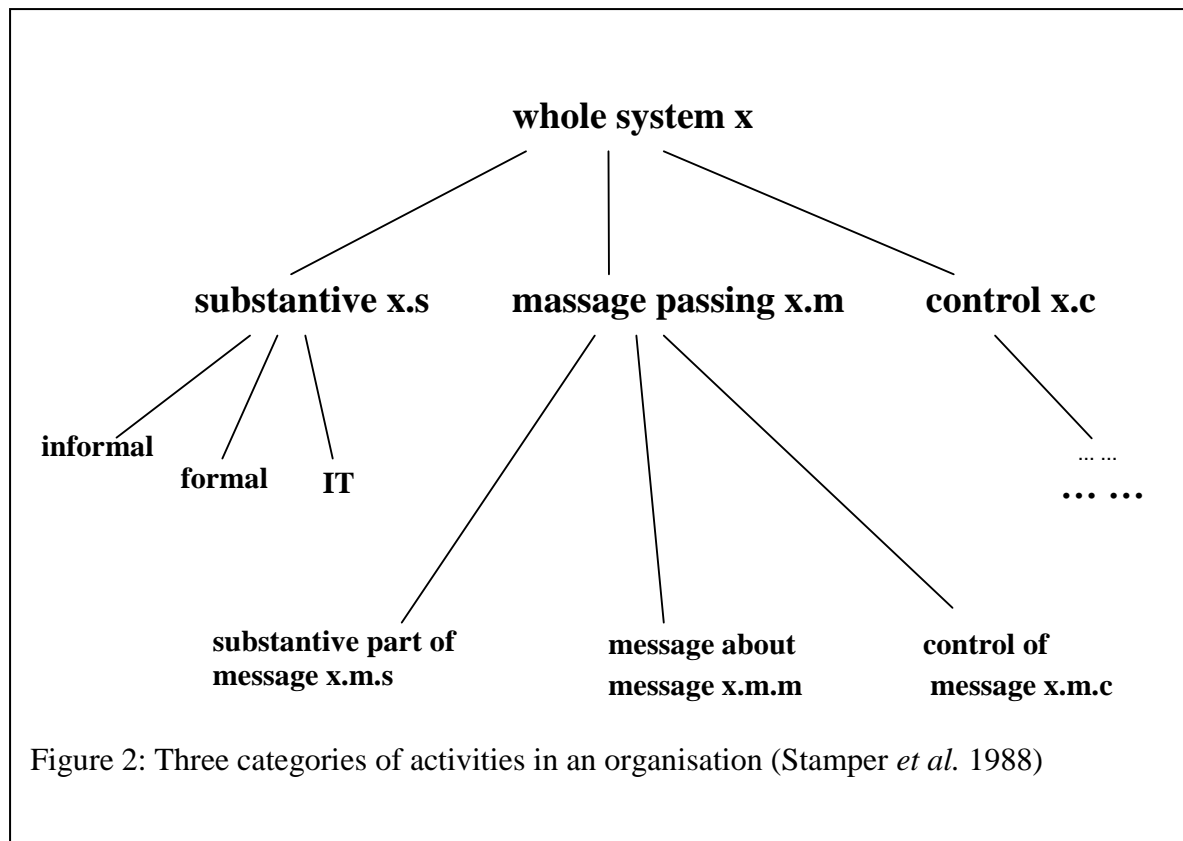
Figure 1. The semiotic framework (Stamper 1996)

From the semiotic perspective, an organisation is essentially an information system. This is because in the organisations, information is created, stored, and processed for communication and coordination and for achieving the organisational objectives. As illustrated in figure 2, the organisation is the whole system. Within the organisation, there are three categories of activities. The *substantive activities* are governed by the assignments and tasks that are derived from the organizational objectives within a given institutional structure. Results of the actions in this category are supposed to contribute directly to the attainment of the business goals of the organization. The actions will normally result in changes physically or socially. The substantive activities are carried out in three sub-systems; each depends on another and interacts with one another (figure 3). The initial context for any business operations is informal, represented as a sub-culture in the organisation in which trust, beliefs and understanding are established. Commitments and responsibilities are defined there and the members of the organisation try to fulfil them to achieve the organisational objectives. Within this context, there are formally defined rules, or bureaucracy. The bureaucratic rules define the procedures and formats, and further dictate behaviour of the members of the organisation. Following rules is sometimes seen as more important than getting the right contents. Furthermore, within this formal context where all the procedures and formats are defined, it is possible to introduce IT to perform some of the well defined functions. The scope of each sub-system is not always clear, and the divide between these sub-systems can become blurred (hence the dotted lines in the figure). Changing in one sub-system will definitely have impact on others. For example, re-engineering business processes will cause the need for re-design of the IT system, and vice versa.

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                    whole system x
                   /        |        \
                  /         |         \
         substantive x.s   massage passing x.m   control x.c
          /  |  \            /    |    \                    \
         /   |   \          /     |     \                    \
   informal  |    \        /      |      \                 ... ...
         formal   IT      /       |       \              ... ...
                        /         |         \
              substantive part of   message about    control of
              message x.m.s         message x.m.m     message x.m.c
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Figure 2: Three categories of activities in an organisation (Stamper *et al.* 1988)

Communication activities, i.e. message passing as seen in figure 2, is the second type of activities whose feature, among others, is that signs are mostly used as "input" and "output" of the communication process. Communication passes messages from one agent to another for the purpose of supporting successful performance of the first category: substantive actions. Signs are employed and sent between agents with agreed meanings by the both parties involved in communication to express intentions. Communication is important in management of the firm and conduct of business. Within a firm, substantive actions have to be coordinated in terms of the use of resources with regard to temporal and spatial relations. Between organizations, messages such as inquiries, orders, invoices, reminders, etc. are sent to each other in order to make sure that the objectives are achieved and interests are fulfilled from each business partner's perspective. Communication can sometimes become vital in relation to achievement of the primary goals which however rest upon the substantive actions. Imagine a military combat as an example, try to understand what are substantive actions and communications, and what are their roles in successfully attaining the military goals.

The third type of activities, *control*, is governed by some enforcement norms. Within an organization, the power of enforcement may be from the stipulated rules and regulations. Between organizations, it may be generated from inter-firm agreements, treaties, or contracts. But both the power of enforcement within and between organizations ultimately rests upon socially established norms which may be related to the legal laws, business norms and sometimes cultural conventions. This control part of behaviour within a firm assures every relevant agent acts properly in performing the substantive tasks. If an agent has understood what his duty is and is aware of how and where to act after necessary messages are received by him and he fails to complete his duty, the organizational control will be imposed to the agent. Sanctions (punishment and reward) are necessary as a means to maintain social and organizational orders as well as incentives for achieving the goals.

Figure 3: Three components in an organisation (Stamper 1996).
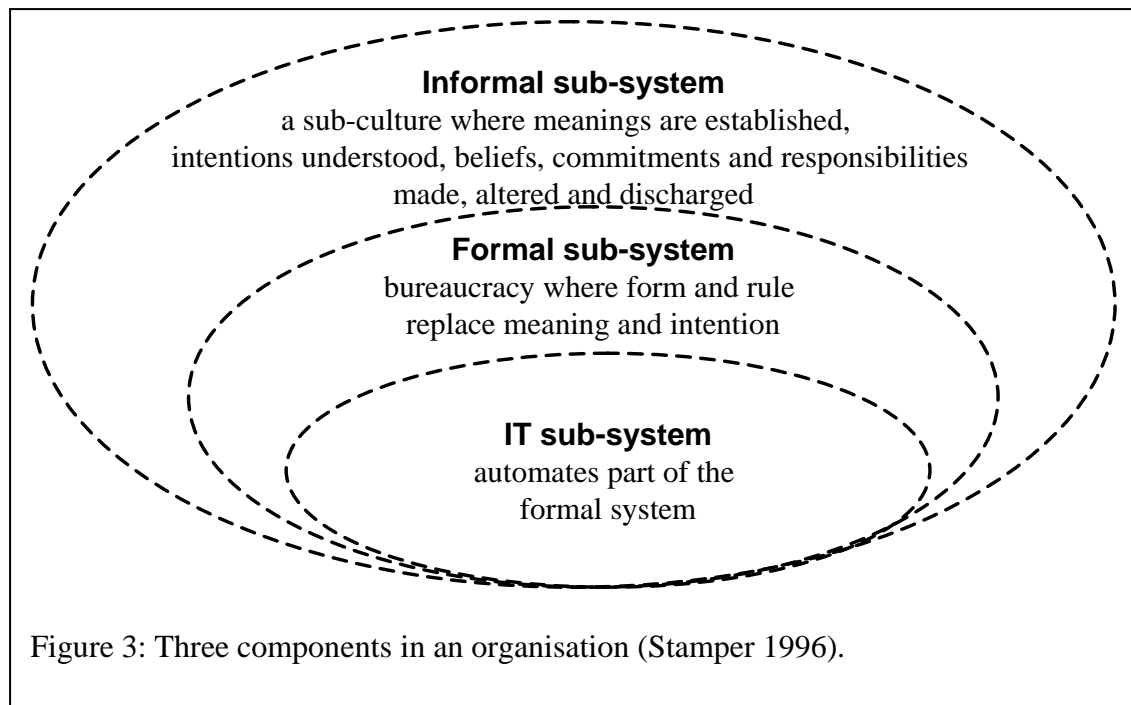
One of our important assumptions based on this organizational morphology is that a "healthy" organization consumes a very small amount of resource in message-passing ($\mathbf{x}$.m) and control ($\mathbf{x}$.c) activities and will direct its most resource in building up the organizational platform for substantive ($\mathbf{x}$.s) activities. However, an "unhealthy" or badly designed organization will have to consume a great deal of its energy in building elaborate communication subsystems and have to rely largely on the control subsystems. These two types of subsystems consist of the total bureaucratic infrastructures. The more elaborate these two subsystems are, the heavier the bureaucratic burden on the organization is. This may have already suggested what reengineering should be about, if effectiveness is the concern. This assumption will be supported by the illustrations of our case study in a later section.

Within an organisation, the deployment of information technology does not change its nature, but only the way the business is conducted. This lends to a holist view of two parts (business and IT systems) being interrelated. From this point of view, the IT system has to be design as part of the organisation, hence the co-design of business and IT systems. IT systems must meet the business requirements, support the business processes, and adapt to changes of business practices. There are many factors that determine the success or failure of an information system. An important issue of research is how to design business and IT systems to fit one another, and to enable the information systems evolving with the changes of business requirements. The hypothesis is that the organic integration of IT into the business processes will allow both systems to evolve naturally. This requires the co-design of the two systems.

Co-evolution …
[Keith: if you would like to add a section of your work in co-evolution or other things?]

Papers in this special issue
The paper by de Moor first examines, what he calls, the two neo-humanist paradigms: language/action perspective (LAP) and organisational semiotics (OS). Both paradigms place a lot of emphases on human aspects as opposed to technological aspects when an IT system is developed. It argues that an information system should be formed on the basis of a socio-

technical system dependent on the professional community interrelated to an IT system. This will make the information system easy to adopt the continuous change of professional practices and new requirements. A user driven specification is necessary to support the system evolution. The RENISTS method introduced in the paper enables the users to gain an understanding of the work flow and the support by IT, therefore to be able to specify the socio-technical system. Drawing input from both LAP and OS, the method is able to involve users in modelling the business processes in terms of transactions and responsibility in terms of norm-governed actions. This user-driven specification makes it more possible to view the information system as a socio-technical system that evolves.

The paper by Champion and Stowell introduces a practical, coherent approach to a client-led information systems development. It begins with the examination of the underpinning foundations, arguing for relevance of the interpretive proposition, and 'an information system is a system to serve purposeful action'. It points that conceptual models and systems design will not be a full representation of what will occur. Learning about situation to determine possible actions will be on a continuous undertaking, which leads to the need for the client-led approach. The illustration through a case study is helpful in showing how the requirements can be captured and the design of an information system can be derived.

Schoop looks at the architecture of electronic markets and argues for co-design of the business and the IT systems. The paper presents the language-action paradigm and its theoretical underpinnings before it investigates the relations between business operations and IT support in electronic markets. Based on the language-action perspective, a generic marketplace model is proposed which consists of three major phases: search, negotiation and fulfilment. The empirical study reported in the paper shows how the two systems can be designed together for the business to benefit from the IT system.

Eatock *et al.* offer a theory to explain the interrelationship between technical information systems and business processes, based on a project in the SEBPC programme funded by EPSRC. The evidence from their study shows that despite the fact business processes and IT systems are interrelated, most existing methods only address one system or another. The framework presented in the paper deal with the business processes and IT systems design. The IT simulation models presented in the paper demonstrate the effect of change of the IT systems on the business domains, which enhances one's understanding of the interrelationship between business and IT systems and assists the co-design.

The paper of Beeson *et al.* also examines the relationship between business process and IT systems. The authors discuss the decision and communication processes which link strategic activity in a business with information development activities. The technique of role activity diagrams has been used in modelling the information systems development in a chosen company, with possibility of generalisation for others to adopt in similar situations.

Snoeck and Michiels in their paper start with the discussion of enterprise domain modelling to argue the enterprise models can provide a basis for better understanding the business domain and rules, which allows the design of the IT systems to support the business.

Finally, Sayer and his colleagues in their paper tackle a major difficulty in legacy systems re-engineering – requirements recovery from scattered, piecemeal documents such as standards, interview transcripts and legacy specifications when no systematic documentation is available. The authors have adopted a natural language approach and developed techniques for requirements recovery. The case study, using a software tool developed in their work, demonstrates convincing benefits of their work. This project is also part of the SEBPC initiative.

Conclusions and future directions

Designing effective IT systems to meet the ever-changing business requirements is a challenging task. The co-design of business and IT systems brings a great deal of benefits to business companies. The papers in this special issue present a wide range of approaches to the co-design and the experience reported demonstrates how the co-design can be achieved. A predominant position adopted by most authors is to view an organisation as a unity of both business and IT functions. The research reported relates to various theoretical underpinnings, including organisational semiotics, language-action perspective, business process modelling, human-computer communication, organisational studies and information systems analysis and design.

From the papers included in this special issue, we can see that the co-design is not a completely new effort as many researchers have advocated this for decades, for example, through participatory and user-centric design, socio-technical approach, systems design based on business processes, and many others. Each has a lot to offer. The major contribution of this special issue is that each paper has taken an appropriate position and developed the theory into concrete methods for designing the IT system in the business context with a view of change.

More work can be identified for future research. One direction is the research in flexible architecture of information systems. This architecture should allow extension of the system scope (e.g. in terms of data and functionality), change of business processes and refit of IT and business functions, customisation and penalisation of human-computer interaction.

Many researchers are looking into the co-evolution of business and IT systems. This requires
…. [Keith: could you add a few lines here?]

More thorough empirical work is also required. Due to the nature of information systems work, validation of a method is not possible by conducting classical laboratory testing. However, isolated case studies may not be adequate to demonstrate the validity of a method. Therefore the selection of an appropriate research approach is extremely important. One of them the action research, which requires people to design their research in such a way that a series of experiments can be conducted while intermediate outcomes can be fed into the development of the methods and techniques, till a level of confidence is reached about the research outcome. This approach should be helpful for those who are involved in the research of co-design.

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