A Socio-technical Perspective on Back-end Technologies

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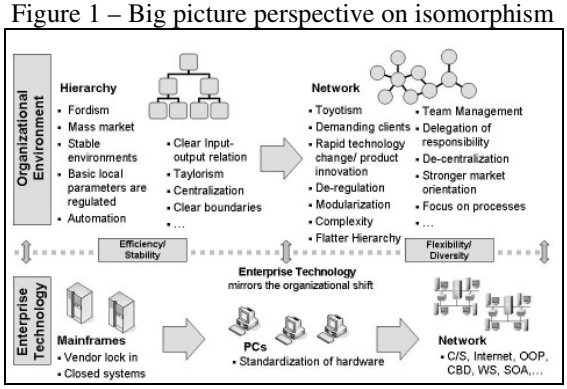
1. Abstract/Introduction

This concept paper mainly deals with the question whether back-end technology such as Web Services or concepts such as the Service Oriented Architecture (SOA) have any social meaning (and if so, how social science can conceptualize it). Both technologies are discussed broadly in academia and business. However, most of the research points on pure technical questions and barely analyzes social and organizational issues [Papazoglou et al. 2006 provide an overview of the state of the art and grand challenges in academic Services research].
Since not much work has been done before in this field by social scientists, this paper tries to answer the research question coming from a very broad perspective. It follows a three step approach. First, in putting together insights from very diverse fields of research I want to show, different ways how to conceptualize isomorphism between Information Technology (IT) at the one side and the organizational and social dimension respectively on the other side. Second, I apply basic statements of this discussion to understand the organizational and social issues of SOA. Third, these assumptions are evaluated and compared shortly with early results from empirical field work. Theoretical reflections and impressions from expert interviews lead us to an affirmative answer of the research question.
This results finally in a pleading for more interdisciplinary research. For this purpose intellectual approaches which cross traditional lines of research like Social Informatics (SI) might provide further support.

2. Isomorphs in Organizational Structure and Information Technology

Some sociological theory conceptualizes the technology dimension completely independent from the social dimension [e.g. Luhmann]. While the following discussion does by far not develop a coherent competitive approach it shows evidence from different fields of research for assuming isomorphism between (Information) Technology at the one side and organizational and social structure on the other side.
As yet a big picture perspective indicates, there are similarities in the historical development of societies with its macro- and micro-economical structure on the one side and the historical development of IT on the other side. Different steps of economic development can be roughly associated with different steps in the development of IT. Both dimensions seem to be very similar to each other. Figure 1 shows this high level perspective.

Figure 1 – Big picture perspective on isomorphism



Source: own design

On the organizational side highly integrated factories were followed by the (post-fordistic, post-tayloristic,…) network as the dominant emblem for modern business. On the system side the mainframe era with highly integrated closed systems was followed by the PC era (with an open hardware architecture) and then very roughly said with the end of the 1980s/ beginning of the 1990s the network has become the most important vision here as well [see for this periodization of IT´s history Boes und Baukrowitz 2002:32-49]. Basic similarities can be seen in the frequency of key terms usage. The *network metaphor* is one example since it has been discussed very intense throughout the last decade in computer sciences, as well as in social sciences. A second example is *Flexibility* which does not only describe modern ways of how to design a system's architecture but determines also the sociological discourse of the last years [Lemke 2004; Sennett 2006,…]. Finally, on might think on *loosely coupled* – a key term which has been broadly used in combination with Web Services in computer science during the last years [e.g. Kaye 2003] but which had become also more important in organizational theory [e.g. Weick 1984, Perrow 1987].
This idea of associating certain types of technology to different types of society has been discussed within sociology since the early days of Karl Marx. Contemporary capitalistic theories have modified this to certain degrees. When analysing the meaning of IT for modern society one of the most prominent sociological analysis was written by Manuell Castells [ibid. 1996, 1997, 1998 – especially the first part of the trilogy is important at this point]. His analysis of the information age is very rich on empirical data regarding economical, political, social, and cultural developments from all over the world. However, most important in our context is his idea to equate different steps in the development of

societies with different steps of technical production. Based on this equation, Castells understands modern social living order as *network* societies based upon *network* organizations and the increasing meaning of *network* technologies.
Another example is German KAIROS [1] Group which provided an early approach in German sociology that dealt intensively with the meaning of IT for society. KAIROS´ *Informatization theory* is based upon the core assumption of a very deep relation between economic and technical development[2]. Informatization is understood as a historical process consisting of the increasing meaning of information since modern economies evolve more than 100 years ago. It came up with industrial ways of production, with modern ways of work-division and with an increasing need of unambiguousness, calculability and exact control. KAIROS combines the process of informatization with a specific understanding of information. Information here is understood as an entity formed under clear defined conditions; it is an artefact of formal rationality. Unlike parts of Computer Science [Goguen 1997:7f.], American information science [Cornelius 2002; Saracevic 1999:1054], and Information behaviour research [Pettigrew et al. 2001] sociological informatization theory understands the notion of information in clear contrast to the common (cultural and personal bounded, contextual and semantically rich, social, unclear,…) understanding of knowledge. This differentiation is used to understand the transformation of ambiguous social reality and materiality into clear defined technological supported form. However, what is interesting here is that KAIROS points on several equivalences between information technique's dimension and the social dimension, too [Schmiede 1996].
The basic assumptions of structural isomorphism between IT and organisations have been also adapted in other fields of research located at the organizational level of perspective. Eric Brynjolfsson for instance examines the relation between IT and Organizational Design using also broad empirical data [Brynjolfsson/Hitt 1998]. He maps distributed technologies to modern ways of management including delegation of decision rights: „The new technologies will allow managers to handle and widen their span of control. Fewer levels of management hierarchy will be required, enabling companies to flatten the pyramid of today's management structure. The new IT allow decentralization of decision-making without loss of management awareness" [Brynjolfsson/ Mendelson 1993].
Within sociology of technology one can roughly map this whole discussion to specific theoretic approaches, basically saying that technology could be seen as a rigidification of social structure, (also following the work of Emile Durkheim). Based on this, Bettina Heintz claims that under certain circumstances machinery might tell social scientists more about society than any statistics or survey [ibid. 1994:14][3].

The sociological discussions on IT´s social meaning often remain on an abstract level. At least they are seldom linked to contemporary research in computer science. Not many attempts exist to bridge the gap between the two research communities. A missed chance since one can find very similar ideas within software development literature for instance.
A first Idea gives Peter Denning, a computer scientist who sees "many similarities between approaches to software design and approaches to managing organizations". He associates user-centered software design and participative software design with participative management approaches. And contrasts them to traditional ways of building software and tayloristic management respectively [ibid. 1991]. A second interesting intellectual approach is Conway´s Law. In 1968, Melvin Conway examined the relation between the design organization and the designed system itself. After comparing different graphical analysis of system's structure with the sociogram of the organization responsible, he gives the following order: "1. Replace "system" by "committee." 2. Replace "subsys-

[1] **K**ritical **A**nalysis of the **I**nfo**R**matization **O**f **S**ociety.

[2] The notion Informatization came up at the end of the 1970s together with a report written for the French government by Simon Nora and Alain Minc. They used Informatization to describe merely the quantitative diffusion of IT [ibid 1979]. Today the concept is used in different ways within sociology [Pfeiffer 2004].

[3] However, within sociology there have been always critics on this perspective. Ingo Schulz-Schaeffer develops a classification of different theories on technology and shows the theoretical limits of this rather deterministic approach [ibid. 2000].
Also studies on an organizational level have relativized some of the assumptions made above. Windeler for instance shows, that orientation, genesis and implementation of IT Projects is often coined through micro-politics – not through a rational top down approach [ibid. 1992, see also Aichholzer et al. 1992; Ortmann et al. 1990]. Finally, there were critics on the societal level. One might think on Daniel Bell with his postindustrial society as one prominent example [ibid. 1996]. Recurring directly on Castells, Perkmann gives another example: "The leap from `flexible´ PC networks to `flexible´ production networks cuts through several levels of emergence, and threatens to see necessities where there are nothing more than contingencies; consider, for instance, that technological `networks´ can easily be imagined as being employed for organizing hierarchical relationships rather than network forms of interaction. In this sense, the analytical surplus of the concept of the `network society´ appears to be relatively modest" [ibd. 1999:624].

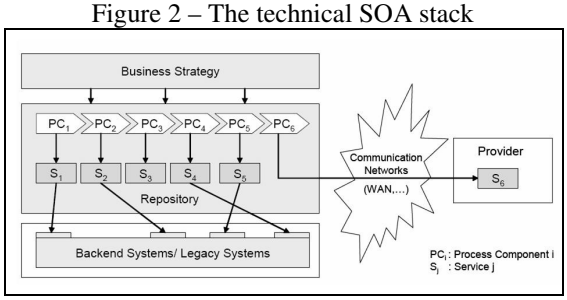
tem“ by “subcommittee.“ 3. Replace “interface“ by “coordinator.” [ibd. 1968:29]. Based on this he states: “We are now in a position to address the fundamental question of this article. Is there any predictable relationship between the graph structure of a design organization and the graph structure of the system it designs? The answer is: Yes, the relationship is so simple that in some cases it is an identity” [ibd. 1968:29]. The isomorphism perspective pops up again, later in the article, even clearer: „The basic thesis of this article is that organizations which design systems (in the broad sense used here) are constrained to produce designs which are copies of the communication structures of these organizations“ [ibd. 1968:31].

At this point, we can find a clear relationship between organizational and technical structure. Hence, even back end technology is deeply interwoven with the social dimension. Taking this perspective we can roughly anticipate the social and organizational meaning of modern approaches in systems architecture like SOA (and learn from machinery about society).

3. Basic Principles of SOA

Due to lack of space I can only give a very rough idea of basic SOA-principles. As a work definition I take the following into consideration: “A Service-oriented Architecture (SoA) is a specific software architecture based on Services as fundamental elements for integrating and developing applications” [Berbner et al. 2005:4]. Services in this context, whether they are Web Services or not do not affect the user directly. It’s all about system interoperability. While this rather general characterization is commonly accepted there are different opinions circulating about what a Service actually is. Some experts understand a Service as a software component: “Services are specific software components. They are well-defined, self-contained and encapsulate high-level business functionality” [Berbner et al. 2005] – some don’t: „Services are *interfaces* to software, not the underlying software itself. A Service interface simply defines the contractual obligations between consumers and providers. Sometimes people think of a Service as a piece of software that exposes a particular kind of interface, but those are the underlying bits of technology that we call components. It’s possible, therefore, to expose *components* as Services“ [Bloomberg/Schmelzer 2006:102]. As a working perspective I take the second approach into consideration since it points more clearly on one important aspect: The separation of Service’s physical implementation from its functionality defined by the contract and interface respectively. This aspect is especially important for big organizations having a need for flexible business processes but also having a heterogeneous IT landscape (different software, infrastructure, applications and data)[4]. Management literature promises them many benefits through implementing SOA (reducing integration expense, reducing software development cost by increasing reuse of software components, increasing business agility, reducing business risk through increase in visibility and control [Bloomberg/Schmelzer 2006:191]). However, in focusing at the differentiation we made above, one aspect gets in the front: When organizations use their traditional standard software packages to support or execute business processes it happens to be very often that processes are aligned to those pre-configured by the selected standard software. Hence, even simple changes of business processes demand an enormous customizing effort on system side [Berbner et al. 2005; see for this discussion also Schwarz 2000, Brödner et al. 2002,]. Now, SOA decouples the business logic from the system side through adding an additional abstraction layer consisting of coarse grained business Services. Figure 2 provides one possible view on the technical SOA stack. Services (s_1,…) could be either mapped to single activities, single process components (PC_1 …) or complete business processes. Whenever business processes will change, this will primarily only affect the scope and the order of Service invocations and does not automatically result in changes of the underlying architecture. On the other side changes on the back-end systems can be made without affecting business activities.

Figure 2 – The technical SOA stack



Source: Berbner et al. 2005

Furthermore, in storing Services definitions and location information in accessible repositories different clients can locate and invoke the Services irrespective of their location [Berbner et al. 2005]. Therewith the use of a Service is not confined to the

[4] SOA might resolve issues of flexibility even for small organizations with homogeneous IT environments when they would like to expose external services (Bloomberg/Schmelzer 2006:139).

project for which it was originally developed but can also be re-used in other applications. Re-use has been discussed very long within IT-Industry. However, reuse in SOA has far reaching impact than reusing code through code templates or class libraries. Being able to reuse a component at runtime by linking it into a number of different subsystems does not only mean that common code is shared but more importantly that different subsystems are also sharing same application data [Krafzig 2005:244].

While academic research on SOA mostly points on pure technical questions, non academic SOA management literature usually has a broader approach. Nevertheless, this broad approach very often takes the typical business-management perspective. Organizational and social issues are underestimated. An interesting evaluation is given by Marks and Bell: „While we spend only a few pages on the cultural and behavioural challenges of SOA, in reality the effort will be the opposite. The organizational dynamics and behavioural aspects of SOA will require far more effort than the technology" [ibid. 2006, S. 283].

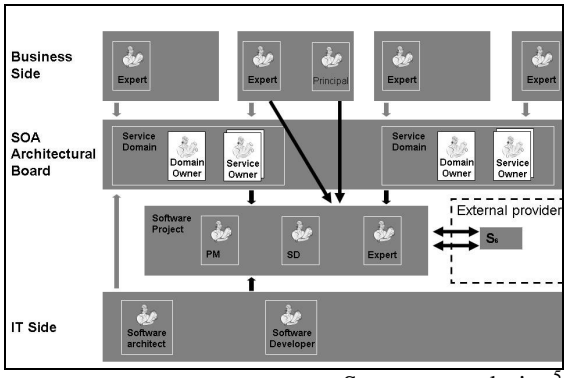
4. Organizational Issues of SOA

The following aspects do not necessarily come along with SOA transformation. On the other hand, discussing them does not cover all relevant organizational dynamics [e.g. developer's so called `not invented here syndrome´ are not part of it, see Baukrowitz et al. 1994:122-128 for a discussion of different IT staff's identities]. As mentioned before, the focus lies on finding similar developments in technical and social structure through using the socio-technical perspective.

Two aspects can be derived: First, the further layer in the technical stack consequently pops up also on the organizational stack. This points on implementing institutional arrangements like architecture boards and so on [a more detailed discussion is given by Rieger/Bruhns 2007]. The idea is shown in Figure 3, with a "further layer" in the organizational stack. The architecture board consists of members from both sides business and IT side to support these initiatives in a proper way.

Moreover, SOA means massive change in collaboration between business side and IT in general. Both must interact more closely and a much deeper collaboration is needed. Pointing on this relationship we get into an interesting field, coined by many conflicts and misunderstandings [evidence is coming from different fields of research Information Systems: e.g. Mertens/Knolmayer 1995, Governance Literature: Rüter et al. 2006, Research on Requirements Engineering: Kaminski 2007].

Figure 3 – The organizational SOA stack



Source: own design[5]

However, analyzing systems architecture points also on another critical field. Figure 2 and Figure 3 are both simplifications. What here is tagged as IT side in reality is much more diverse. Interestingly, not only the technical stack consists of monolithic blocks (ERP, CRM, Homegrown systems,…) but also its isomorphic counterpart the organisational side. Brita Hohlmann had a broad study on ERP implementations accompanying twelve case studies. What remains after most implementations – each IT organization ended up creating a new ERP department with control, budget, and personnel resources of their own [ibid. 2007]. Obviously, this is not an uncommon procedure: Especially big companies´ IT organisations consist of different organizational silos. Bloomberg and Schmelzer discuss the way IT departments have developed over time: "In the days where it was necessary to separate technology into isolated, monolithic blocks of functionality that required constant attention and baby-sitting to achieve the results that business required of IT, it made complete sense for such silos of IT control to exist. After all, IT itself was a bunch of silos, so why shouldn't executives manage IT in silos? […] Now, because we're talking about new technologies and IT approaches that can increase business agility, it's simple human nature that the people who hold the power, or the gold, in those silos will resist such change. Therefore, the only way for a company with a siloed IT organization to even hope to achieve business agility in the face of unpredictable change is to get rid of those IT silos" [ibid. 2006:71]. Hence, SOA initiators always must be aware, that fragmenting monolithic blocks on the system side, inversely implies fragmenting monolithic blocks on the organizational side, as well. Unexpectedly, the feigned apolitical back end tech-

[5] The picture was originally taken out of a presentation from Bernd Oestereich [ibid. 2006] but modified to some degree.

nology implies important questions of power: Service Re-use crosses departmental boundaries. But who is responsible for this? Who owns the Service, who owns the Service domain? How to charge Service use within organizations? Organizations have always to reflect isomorphism and must establish a proper environment to support this transformation.

However, our work does not primarily point on development management guidelines to solve questions like this, but more on revealing the social meaning of information technology. This is supported through a research project conducted at Technische Universität Darmstadt (Germany). Till this day we had several workshops, guided interviews with 22 SOA experts (members of vendor organizations, user organizations, and third party external consultants) and visited several conferences and vendors road shows (More information on www.soa-change.com – English translation of websites will hopefully follow soon). Our socio-technical perspective was mostly confirmed by the experts.
However, while organizations deal in different ways with modern approaches like SOA, as a general tendency there seems to be a strong focus on technical problems. An integrated perspective seldom has been established; organizational change often lags behind technical solutions and the business side is very often much less involved in SOA initiatives.

5. Towards interdisciplinary research

Interestingly, this imbalance could be found on academic research, too. This article should not downplay the importance of `pure technical´ research on SOA. It definitely contains tremendous work regarding typical engineering questions and challenges. However, we think with SOA´s maturation organizational and therewith political and social problems are getting more important. Our socio-technical perspective gives first hints on organizational issues. More research by social scientists is needed to understand these aspects fully. Therewith, our research shows that real world problems often do not care about traditional academic work-division. We think SOA is also a problem for interdisciplinary approaches like SI. Since SI combines computer sciences with sociology [Kling et al. 2005], it provides a solid basis to understand SOAs meaning for work and organization from a broad perspective.

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