Context Engineering: An IS Development Approach

Licínio Roque, Ana Almeida, António Dias de Figueiredo

Centro de Informática e Sistemas da Universidade de Coimbra
Universidade de Coimbra - Polo II
3030 Coimbra
Portugal
{lir, asa, adf}@dei.uc.pt

Abstract

The authors present the Context Engineering (CE) approach to Information Systems Development (ISD) as a framework to organise ideas about previous development experience and to guide future research on specific ISD methods and techniques. The goals of the CE approach are: to achieve an understanding of the ISD as sociotechnical phenomena within a cultural and historical envelope; to provide a framework of problems supported on the relation between context and mediators; and to use contextuality as a key to performing emancipatory movements. Fundamental concepts are the notions of context as figure-ground and as autopoietic flux, of human activity as unit of contextual analysis, of the pervasiveness of mediation in human activity, of sociotechnical networks as media and the hypothesis of a heterogeneous social engineering. A framework of development problems is presented along with a discussion of general and process related principles for the CE approach.

Keywords: Context Engineering, Information Systems Development, Sociotechnical Approach, Activity Theory, Actor-Network Theory.

1.   Introduction

1.1   The Challenge of Context in IS Development

The process of IS Development has long been understood by practitioners as an opportunity for the transformation of work, if not its main motive. In this transformation we can identify a dialectics between an idea of organisation or context of intervention and the goals, roles, instruments, rules and practices, and their relations within the context of the intervention. Intentional formulation of the intervention presupposes some form of understanding about the target context and the role the IS may play on that context.

Context as long been a key issue in the engineering and design disciplines as a complex of conditions that must be understood in order to develop an artefact that must fit that context, achieving some set of goals while possibly changing some of the initial conditions. The requirements analysis phase in Software Engineering aims to elicit a set of conditions formulating the problem to be solved in a tractable and objective way and thus enabling some distance or isolation from the complexities of everyday changes. Yet, in IS Development there is more to requirements than elicitation. Depending on how radical we are about our philosophical background, we may understand requirements as being constructed on a daily basis by a social network of human and non-human actors. Requirements construction brings with it the question of stakeholders, i.e., requirements to whom and by whom. And we need not look much further to uncover the question of IT and organisational alignment. All this we can argue to be dependent on our particular understanding of what constitutes the organisational context.

At least since [Suchman 1987] we have learned not to trust plans and formal definitions of procedures for the real everyday activities. As she points out, plans are good enough as descriptions or rationalisations of human activities, but their role may be minimal during actual activity. Based on accounts of human action, she argues them to be situated in a running context. It would be difficult, if not impossible, to consider all the contingencies in an *a priori* prescription of the action, and some *a posteriori* rationalisation tends to overlook details that may have been crucial in the development of a course of action. Contextual information, being tacit, tends to be overlooked or unspoken as it is frequently understood as trivial or already shared as common ground. What does this mean for someone doing IS Development? Can we trust procedural or functional descriptions of organisations and individual roles as complete accounts for the real thing, thus ignoring variability and free will? Should we take them as fallible or auxiliary communicational constructs and try some form of development *in situ*?

Several recent reports [Kyng 1997] explicitly acknowledge the importance of context in design. Participatory approaches, as a development strategy, try to overcome, among others, the difficulties in understanding the usage situation. Ethnographic methods like *Contextual Design* [Beyer et al 1998] propose on site observation of the situation and its extensive documentation for later analysis and integration into a design phase, in a cascade-like approach. For dealing with contextual issues, there are also scenario-based techniques, used in diverse fields, from strategic analysis to system design. Those usually take the form of verbal accounts for typical or extreme situations. Scenarios may be combined with a participatory approach to modelling. Of course, all these assume a common understanding among the players of what constitutes reality, i.e. an ontological view shared by all participants that enables them to focus on designing the solution. But that understanding may itself be the focus of initial debate as, for instance, in the Soft Systems Methodology [Checkland, Scholes 1999].

Each other's understanding of what constitutes the nature of the object and of the context of our development work is central to what the actors involved can formulate as development goals. For instance, when people begin to recognise the social dimensions in development, quite different methods begin to emerge. The sociotechnical tradition, present in ETHICS [Mumford 1983, 1999] and in the scandinavian infological and trade-unionist approaches [Iivary, Lyytinen 1999] , is a case in point, although lacking the volume of experience we have with more technicaly oriented approaches. Recently, Kling and Lamb considered change in digital economy organisations, sociotechnically [Kling and Lamb 2000]. Reviewing previous work, Sawer and Rosenbaum, distil a research basis for what they call social informatics [Sawyer, Rosenbaum 2000] and put to good evidence the role of context in development. Still, the social dimension in development may be recognised in many ways, promoting different conceptions of the object or motive for development and respective formative context, of the idealised methodological processes and of the phenomenon of development itself.

Ciborra [Ciborra 1999] builds a strong case as to the neglected concept and role of improvisation in organisational life and, consequently, on IS development. This author makes extensive references to many studies that reveal that improvisation, ubiquitous as it may be, is frequently overlooked in favour of planed action, and development efforts tend to focus, accordingly, on instruments for that kind of action. Lately, Ciborra, Monteiro [2000], Hanseth [1998], among others, produced several interpretative studies that recognised and even emphasised a less controlled view of development efforts and put forward a concurrent "drift" perspective, recognising development as a complex process of heterogeneous interactions, with less predictable outcomes. With this, comes a notion of installed base cultivation that

views technological development within the context of an infrastructure that keeps evolving, and that is more akin to the idea of cultivation.

Bergman, King and Lyytinen [Bergman et al 2002] also talk of heterogeneous engineering, in the context of studying requirements engineering from a sociotechnical standpoint. They arrive at an evolutionary, two-way influence between problem space and solution space, fostered by heterogeneous influences and conditions. We think that all these studies stem from differing contextual views and, as such, reveal the importance of context and call for a better understanding of its role in development and how it influences the construction of our approaches. On the other hand, we think that there is an identified need for a new conception of IS development that recognises the issues raised by those studies.

1.2   Goals for a new ISD Approach

With the goal of organising the action oriented or process knowledge within the theme of the professionalization of Information Systems Development, Iivari, Hirscheim and Klein propose to distinguish between four classes or knowledge levels: ISD Paradigms, ISD Approaches, ISD Methods (or Methodologies) and ISD Techniques [Iivari et al 1998, 2001].

ISD Paradigms would encompass the philosophical understandings behind each specific ISD Approach, such as the ontological, epistemological, methodological and ethical underpinnings of that approach. For this purpose, Hirscheim, Klein and Lyytinen adapt a previous paradigmatic matrix by Burrel and Morgan (1979), developed to frame research in the organisational and social sciences, that they assume to have some grounds for argumentative dissonance, but still propose as a first attempt. In this philosophical matrix [Hirscheim et al 1995] they organise the ISD paradigmatic space along a two axis mapping the conception of reality, objective vs. subjective, and the relation between the subject and object of ISD, i.e. the nature of the ISD process, order vs. conflict. On the side of order, either we understand the object of ISD to be the creation or maintenance of objective order (Functionalism) or the progressive ordering or resolution of subjectivities (Social Relativism). On the side of conflict, we have the objectivity of a materialistic search for a solution to the social conflict (Radical Structuralism) and the emancipatory movements from social conflict, e.g. through rational discourse (Neohumanism).

On the Neohumanist paradigm the developer is viewed as the emancipator that, through development efforts, seeks to better the life by freeing stakeholders from oppressive situations. Depending on our idea of emancipation, this may present a contradiction: if we think emancipation can only be achieved by our own means and not given by a third party. But, essentially, the idea remains for the purpose of understanding the role of development. We can argue that no actual ISD process can be confined to one of the quadrants, among other reasons, because the actors involved may have different conceptions, but still we can use this to partially understand the roots of specific methodological proposes.

As for ISD Approaches [Iivari et al, 1998, 2001], they are put up as an intermediary understanding between paradigmatic underpinnings and specific method proposals. ISD Approaches are classes of methods that map areas of similar methodological thinking, i.e. methods sharing **goals, guiding principles, fundamental concepts and principles for the ISD process**, but deviate, for instance, in trying to solve specific situations or in selecting main concerns. Goals are what this class of methods tries to achieve. Guiding principles refers to the nature and role of the process, of the object, of the subject and the relation to the instruments of practice. Fundamental concepts refer to the basic ontology behind the understanding of the operative reality. Principles of the ISD process refer to the principles organising the method activities.

While there are hundreds of documented methods and techniques, it became a common perception that they tend to be mostly ignored or adapted for each case. In effect, it would seem that practitioners tend to keep the high level recommendations while, at best, adapting the specific details of each method or technique to what would be doable in each situation. In other words, they seem to keep the ideas of the ISD approach that underlies the method. Methods are prescriptive, require the statement of relationships between techniques and a detailed ISD process. ISD techniques require detailed concepts, notations and procedures. Approaches would then seem to be a more "sociable" result in the sense that they seem to be more effectively communicated while influencing practical action. Approaches are thus a "lighter" form of ISD process knowledge, less prescriptive than methods and more prone to adaptation to or reinterpretation in specific situations.

With this in mind, and considering the role of context in development, we began considering the synthesis of an approach to ISD within the Neo-Humanist paradigm, that we could find useful for the interpretation of our own practice. This synthesis was guided by a set of goals that we will now present, while leaving for later the discussion of general principles, main concepts and process principles. Within the previous discussion of challenges and paradigms we have considered that a new approach proposal should have the following **goals**:

- Enable us to frame the ISD activities, supported on the relation between context and mediators of the activities that mould that context.

- Achieve an understanding of the ISD activities on the proposed framework, viewing IS development as a social-technical phenomenon within a cultural and historical envelope.

- To deal explicitly with contextuality in ISD as the key to performing emancipatory movements.

Our goal of achieving a framework supported on the relation between context and mediators in that context stems from an understanding of mediated human activity, which is common to some theories of human behaviour and social organisation, and central to Activity Theory, which we have taken as a fundamental source in our work [Almeida and Roque, 2000??]. Especially if we begin to understand the activity as a fundamental contextual unit and pay close attention to the mediating relations, pervasive in organisational life. The mediations in those relations can be viewed as the technical target of development efforts. Yet, in those mediators there are several disciplinary traditions represented, e.g. informatics, law, management. So, both a social and technical understanding of their interplay is needed to begin thinking about ISD as an interdisciplinary effort. A framework for an approach aiming at emancipatory movements should deal with this interdisciplinarity within a cultural and historical envelope. More than that it should foster an explicitation of the differing contextual views in order to enable open discourse about ISD. For a better understanding of these goals we need to go further in our understanding of the diverse conceptions of context and contextualization in action and language use, which in turn are the centre of our concerns while analysing organisational discourse and action about IS.

2.   The Essence of Context

2.1   The Problem of Context

In a seminal essay on "The Problem of Meaning in Primitive Languages", Bronislaw Malinowski (1923) elaborated two important themes that were to figure prominently in the

study of context: 1. That language is embedded within a context of situation; 2. That Language must be conceptualised as a mode of practical action. Such a perspective on language as "an indispensable element of concerted human action" led him at a later date to articulate a view of meaning as something embedded within trajectories of action, and the word as a means of bringing things about, a handle to acts and objects. He also told us that "Meaning [...] does not come [...] from contemplation of things, or analysis of occurrences, but in practical and active acquaintance with relevant situations. The real knowledge of a word comes through the practice of appropriately using it within a certain situation." What we think this anthropological text means for the study of the engineering activity and the education of ISD professionals is a need for a firm grasp of the role played by context, or the lack of it, in communication and learning.

The concept of context resists a single technical definition and poses significant challenges as one proceeds from one research area to another. Sharfstein tells us about his working definition as that which envelops the object of interest and that by its relevance helps explaining it [Sharfstein 1989]. And adds that by definition context is what is relevant for what we aim to explain and excludes all other however near it may be found but that does not offer the required explaining power. The author proceeds explaining, making a difference between contextualism, relativism and scepticism in terms of the degree of argument and elaborates on what he calls the problem of context. A purely philosophical approach would be caught between an illusion that full knowledge of circumstances would enable perfect explanations, but, on the other, such omniscience would be logically inconceivable, since knowledge itself depends on limiting conditions that make it worth, and as such omniscience seems humanly improbable.

From the Latin *contexere* [Dilley 1999], which means weaving or joining together, alluding to a process of weaving words to produce elaborated speech, the search for context would be the establishing of connections between elements enabling the construction of explanations for a situation. Dilley tells us that context has long been a key concept in studies of language and anthropology. And adds that for a time its use remained mostly tacit and, in the attempt to produce contextualized versions of their knowledge, several authors from cultural anthropology forgot about the nature of context itself and considered it static, clear and self-sufficient, even self-evident, requiring no extra duelling. Fabian, in [Dilley 1999] says those studies reveal the underlying positive view of context. Yet, context is itself an apprehension subject to interpretation prior or after that of the contextualized object. The context is itself a choice and, when explicit, a human construction. Context is thus part of the problem in the way that we chose to interpret our own rules. There are thus, at least, two approaches to context in anthropology: thinking about it as connections to be established by the interpretative act; and thinking about it as object of study, itself subject to analysis. Dilley cites Wittgenstein's word of advice, not to seek for the meaning of context but for the uses of the concept.

Introducing a set of studies of the role of context [Goodwin, Duranti 1992], Goodwin and Duranti refer to several understandings of context and its use. The most common would be the dichotomy between focal event and context. Focal event being the object or event of interest to be explained and context the environment that is brought into the explanation. The context is thus a frame that surrounds the event being examined and provides resources for its interpretation. The notion of context thus involves a juxtaposition of two entities, a focal event and a field of action within which that event is embedded. A relationship between two orders of phenomena that mutually inform each other to comprise a larger whole is absolutely central to the notion of context. From a comparison with the relationship between organism and environment, from cybernetic theory, a parallel is drawn on the problem of delineating

where the system ends and where the environment begins, that is what is the context that informs a certain behaviour. Making use of a Bateson's metaphor (1972) of a blind man with a stick crossing the street, the authors expose a number of issues central to the analysis of context. First, the importance of taking as a point of departure for the analysis of context the perspective of the participant(s) whose behaviour is being analysed. What analysts seek to describe is not what they consider context, but rather how the subject himself attends to and organises his/her perception of the events and situations that he is navigating through. Second, the metaphor illustrates how what a participant treats as relevant context is shaped by the specific activities being performed at that moment. Continuing, Goodwin and Duranti, explain how "one of the great difficulties posed in the analysis of context is describing the sociohistorical knowledge that a participant employs to act within the environment of the moment". Moreover, "in so far as participant's articulation of their environment is shaped by the activities of the moment, the context that is relevant to what they are doing changes radically when they move from one activity to another". "The dynamic mutability of context is complicated further by the ability of participants to rapidly invoke within the talk of the moment alternative contextual frames". This is one of the key insights from Gumperz notion of contextualization cues.

Concluding, such phenomena demonstrate the importance of, "first, approaching context from the perspective of an actor actively operating on the world within which he or she finds him- or herself embedded; second tying the analysis of context to study of the indigenous activities that participants use to constitute the culturally and historically organised social worlds that they inhabit; and third, recognising that participants are situated within multiple contexts which are capable of rapid and dynamic change as the events they are engaged in unfold". Within social situations a key constituent of the environment are other human beings, who are active agents with their own plans and agendas. People become environments for each other. Of the themes being addressed in [Duranti, Goodwin 1992] is the capacity for human beings to dynamically reshape the context that provides organisation for their actions within the interaction itself. The dynamic and socially constitutive properties of context are inescapable. "Each additional move within the interaction modifies the existing context while creating a new arena for subsequent interaction". Moreover, as strategic actors, individual participants can actively attempt to shape context in ways that further their own interests. In so far as the processes to which context is relevant are social and interactive, one party's proposals as to what should constitute operative context might fail to achieve ratification by others. Miscommunication and active challenges to a proposed redefinition of the situation are possibilities. In brief, context is viewed as a socially constituted, interactively sustained, time-bound phenomenon.

2.2.   Context as Activity

In "Through the Interface", Bodker [1991] first used Activity Theory (AT) as a theoretical framework for dealing with context in Human-Computer Interaction and design. Blackler refers to the AT historical perspective as essential for understanding the transformations on activity systems [Blackler 1995]. Kuutti [1991, 1996] has since argued in favour of taking activity as the basic unit of analysis to understand the coherence of individual actions in the larger social context, useful in IS development. Later, [Kuutti 1999] argued the relevant role Activity Theory can play as a basis for a critical view of information systems.

Engeström's model of the activity [Engeström 1987], an extension of the original subject-object instrumental mediation originated in the study of language and signs [Vygostky 1978], by explicitly considering the community dimension, reveals a richer set of relations and respective mediators. This model can be used as a guide for the analysis of different types of

mediations in individual and social human activity. The artefacts, considered as instrumental mediators enabling their user to relate to the object of interest, and thus to achieve an outcome, are now accompanied by social rules governing the subjects relation to the community and by a division of labour organising the relation of community and object of the activity. These are the three prime relations that can easily be brought into explanations about every human activity and in particular for the multidisciplinarity of ISD [Almeida, Roque 2002].

But Engeström's contribution does not stop there. He goes on to explore the relations and possible contradictions between the elements of activity systems and between activity systems. He exposes another construct that can be useful to interpret what goes on in organisations as change takes place through development efforts. With the Cycle of Expansive Transition we can build understandings about organisational learning as transitions in activity systems as change occurs to adjust to or try to solve contradictions. The author has further elaborated to consider a methodological proposal for achieving the transformation of work as Developmental Work Research, of which a later form can be found in [Engeström 1999]. Remembering the materialism of the mediations of human activity underlying this theory, we can then understand why ISD can be viewed as a case of Expansive Learning [Almeida, Roque 2000, 2002]. If we understand organisations as activity systems, then we can interpret organisational transformation through cycles of expansive transition, by which individual activities are transformed and adjust within the context of neighbouring activities, possibly in ways not anticipated. In the process, we can draw some conjectures about the assumptions frequently made in and about IS Development methods and why they supposedly so often fail, like assuming the deterministic nature of the process and the outcome, ignoring changes in motives and goals, ignoring actors, human and non-human, ignoring the multiplicity of disciplinary agencies involved. In sum, ignoring the influence of the current context in the formal, material and effective constitution of the ISD intervention, the current form of activity that is the context within which the intervention will be interpreted.

2.3. Context as Heterogeneous Social Network

A perspective of context as social network offers the ability to build understandings of the context for action based on interactions between actors. Actor-Network Theory (ANT) offers a language base for those wishing to exercise explanations of social phenomena supported on relationships between actors as the constitution of the actors themselves. ANT enables the exploration of both micro- and macrosociologies of the actor as network and of the network of actors, as a minimal ontology for an ethnomethodological approach [Latour 1999]. ANT enables the analysis of sociotechnical contexts that views technology not as neutral to human values and interests but as influencing relations of power and of people with their environment [Callon 1991]. Latour [1991] explains the use of the sociotechnical network as a model of the ensemble of relations that influence but do not determine a program of action. This body o knowledge grew from diverse sociological studies of science an technology in diverse domains and fits a basic terminology that have enabled the construction of elaborate explanations of sociotechnical development events. The central concept is that of the actor or author of inscriptions that get translated by other actors. By considering the actor as a network or center for translations that get influenced by the relationships established with that node and their direction, this "theory" opens the ground for heterogeneity. Both human and non-human actors may influence a program of action by their translations of each other's inscriptions. Neither a pure human voluntarism nor a technological determinism is assumed, but only the interplay between actors will or inscribed interests will account for the emergence of complex social reality. The force and interpretative flexibility of newer

inscriptions within previous alignments influence their translations. Alignments may provide stability regions or translation regimes that foster specific translations and programs of action.

Akrich [1992] talks about inscriptions and translations in the context of design. Inscriptions refer to the way designed artefacts carry with them patterns of use that foster specific programs of action. From the standpoint of the designer, these instruments are vehicles of his/her expression that will intervene socially when inserted in sociotechnical networks. An engineer becomes also a sociologist, moralist and politician, although apparently involved in mere technical matters. Latour [1991] tells us that trajectories of development can not be viewed in a single social context. One must try to understand the simultaneous production of "text" and "context". Any division between a social component and a technical or scientific production is necessarily arbitrary. The same author argues that the only non-arbitrary division should be between successive versions of statements (i.e. technical objects) more or less loaded with inscriptions and translations. And that we should learn to follow and document them.

For those interested in trajectories, for each technical trajectory there is a symmetric trajectory in context, corresponding to the transformations on the relationships from diverse actors with the focal object. Such an exercise would consider a set of relationships of variable geometry in interaction with an object also of variable geometry. Both suffer transformations in a historical process. Against visions of society or object as immutable, ANT proposes a view of a path of innovations where all actors co-evolve. This dissolution between what changes and the environment in which it changes makes more flexible what can and can not be done, realisable. That difference becomes a matter of positioning on a developmental trajectory. Irreversibility becomes a matter of alignment of interests between human actors and intermediaries. Nothing is intrinsically realistic or unrealistic because social reality is not a finite state but a phenomenon always requiring maintenance.

2.4.   Towards a Sociotechnical Heterogeneous Engineering

It is in the context of the previous discussions on context that we wish to pose the hypothesis of a new approach to ISD as a form of social engineering. As social actors wish to produce sociotechnical inscriptions we envision context as media. That media is constituted by social relationships that we intend to shape by intervening in the material mediators supporting those relationships, or constitute their expressions. These media may span from computational, psycho-sociological, organisational, managerial, or any other disciplinary tradition.

Thus, should we, as ISD practitioners, be able to re-center our attention on developing the relations that make up each actor-network in our context, as well as the network that delineates the context itself, with all its consequences? We think this perspective promises to be more inclusive than that of any purely technical and objective one, as that of designing computational artefacts. This sense grows as we acknowledge the diversity of forms of mediation that make up actual social networks and that can be the target of this development. To summarise, this conception is based on some **fundamental concepts:**

- A view of context both as a dynamic figure-ground dichotomy and as an autopoietic flux of interactions that shapes understandings.

- The pervasiveness of mediation in human activity and mediators as development targets.

- An understanding of the role of human activity as unit of context, for sense making or interpretation of each other's actions, and of expansive learning as a model for the process of transformation.

- Sociotechnical networks as media and relationships as the fabric of reality that the developer aims to influence and shape.

- Heterogeneous social engineering as an old phenomenon and now a new conception of development.

We then conceive of a form of engineering, of social nature, that operates on the relationships that constitute a heterogeneous sociotechnical network, on a historical and cultural perspective of its development. With its interventions, new forms of activity could emerge that are the ultimate goal or intention for the transformation.

3. The Context Engineering Framework

3.1 Genesis

Several authors have reflected on the special character of design activities, in several fields, from Architecture to Engineering. Alexander talks about the search for a solution as a process of fitting diverse factors within a professional language [Alexander 1970]. Schön talks about *reflection-in-action* as the essential character of any design activity, the "conversation" that the professional establishes with the situation [Schön 1983] and of engineering as a movement-testing experience. From the reflection on our practice along several ISD projects, and guided by the conceptual foundations previously discussed, we arrived at the methodological framework depicted in figure 1. This is not intended as an algorithmic proposal, as is tradition with method proposals, but the schematic representation of the relationship between a set of essential movements. These movements spawn from the development dialectics between context and artefacts, then generalised for any kind of mediator. The model is partly inspired by a desire for compressing the traditional engineering cycles (analysis, design, construction, test, deployment) between the diagnostic of the situation and the generalisation of the new form of activity, fitted with the expansive transition learning model (from need-state to generalisation and consolidation).

This framework intends to bring to evidence the dialectical relationship between particular conceptions or models of context and its role on the formulation of interventions, such as the design of artefacts. This diagram reflects yet the typical source of the information used in each activity, as its starting point, and the main product, at its arrival, here expressed as models of context and of mediators. As the model of context represents our sociotechnical whole, each mediator is a focal part of that whole brought to the fore for specific disciplinary action, within that context.

3.2 A Framework of Movements

With its focus on context, the framework divides our development concerns into six main activities: diagnostic, innovation, creation, evaluation, adaptation, generalisation, and a consolidation phase. When interpreted as the basis for a method to manage contextual change, these activities may be understood as six movements or "operators" to be juggled in a planned or contingent manner. Either way, the main contribution of this framework may be that of bringing to the fore the importance of explicitly dealing with the formulation of context as an intersubjective understanding of the situation underlying the development, i.e. how the actors involved see their context as a common ground. Building on these assumptions, we propose a set of activities to represent the essential movements within that framework.
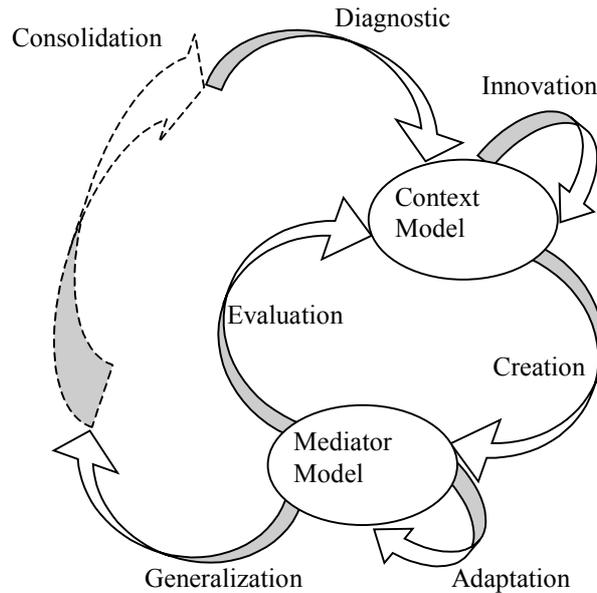
Figure 1. The Context Engineering Framework

Diagnostic − A movement we perform to obtain a shared understanding about the current (organisational) context. What activities do we perform and how do we do them?' What are the relevant actor-networks and their development trajectories? The outcome of this activity is a representation of the context, as a starting point for development. As representations of context we have tried mapping activity systems and value nets for strategic analysis [Parolini 1999]. The subject of this activity may be as complex as the object itself, and can be understood as an actor-network that, at least temporarily, shares relationships with the network that is the object of analysis. Social and disciplinary rules influence the subject's relation to the community and practices and interests relate the community to the object of the activity. The pressure for a definitive version of context may depend on the perception of its impact and life span as the process cycles between a view of context and of the mediators and through generalisation and consolidation. If we think of it as just a starting point to be followed by innovation attempts, that pressure may be significantly relieved.

Innovation – Aiming to propose new activities and networks. This movement is an attempt at conceptually thinking-out-of-the-box. Team members may ask questions oriented towards considering new technology adoption, but the main focus is the new forms of activity. The motive should be to build a model for organisational transformation and the outcome the idealised form of the expected new context (or activities) that could be useful for creating appropriate artefacts. Mapping and building an understanding of the underlying actor-networks and their historicity can help figuring out what could be plausible moves.

Creation – The objective is to produce artefacts for the projected new context or activities. This is traditionally the role of Software Engineering and Interaction Design methods within ISD frameworks, that corresponds to the specification and production of prototypes and microcosms for experimentation. During this process the situation is translated into idealised inscriptions to achieve desired goals. User involvement can be fostered by producing experimental prototypes that can be used for enacting the final form of activity and letting the user become truly capable of expressing his/her views in a explicit way that would have otherwise stayed tacit under conversation. This would enable the goal of user requirements construction and valuation, and ultimately emancipatory expression.

Evaluation – The movement performed in order to achieve a decision on whether we should revise our knowledge of the context, refine the mediator for the selected context, or proceed towards the generalisation of its use. This decision depends upon the nature and relevance of the information the team gathers while performing the evaluation and that, in turn, is likely to be influenced by the specific approach to evaluation (what you are looking for). Evaluation can be traced back to a dual view: either we are seeking a mediator to fulfil a predefined set of requirements, or we are interested in a valuation of the transformation produced by its introduction. In the second view, a significantly broader appreciation of its impact could be achieved.

Adaptation – The movement performed in order to produce a change in the artefact without implying a redefinition of the modelled context. The Adaptation might be accomplished by the team or by the users, since it might be an adaptation of the artefact or an adaptation of the previously intended use, or both, in any case possibly leading to a re-evaluation of the artefact and associated context. This represents the kinds of innovations that happen daily and maybe silently, sometimes only noted and valued when their accumulation involves a broader rethinking of the activities.

Generalisation – The deployment of the mediators modelled, from the microcosm where they were developed and on to the target settings so that their use can be consolidated. Notice that by deploying artefacts and other mediators we are also, tacit or explicitly, deploying the new form of context that must interact and possibly compete with the current, established set of activities. The relationships between proposed mediators and other new and old forms of activity should be considered as it may influence generalised adoption. In this process, relationship alignments may be key for the effective inscription on the social network.

The **consolidation phase** represents the adjustment of the new form of activity within the context of the neighbouring activity systems, as suggested in the Expansive Learning Cycle [Engeström 1987]. This phase represents the process of adaptation that occurs after the generalisation of the new instruments, when a new form of activity emerges through its interaction with the neighbouring activities, possibly in unanticipated ways. Translation regimes favour specific translations and the predictability of adoption, such may be the role of tutoring as well as the user's supportive relationship with more experienced users.

These activities aim at work with both Context and Mediator models as microcosms to understand the impact of the introduction of mediators in communities of practice, along the actual development of those mediators, acting as classes of methodological movements available to IS practitioners. By working with models of both context and mediators, this framework demands rapid and cheaper iterations to continually evolve and account for the pace of changes in organisational environments. Each IS development process could be a combination of these activities on a sequence unique for each particular situation that derives from the specific demands of the situation and actual evolution. Considering the possibility of different development rhythms between mediators and or situations and their interdependence can raise interesting research questions. The movements can also be viewed as a matrix of research challenges requiring more detailed work.

3.3   Context and Mediator Models

The Context Engineering approach that we describe aims at the proactive co-evolution of context and its mediators, both objects of development practice. By proactive we mean that we want to purposefully drive contextual change. By co-evolution of context and artefacts we refer to their interdependence, as new artefacts are introduced and new motives emerge. In

order to achieve the desired goals, we consistently found a need for a shared representation of the context that would enable:

- The communication between designers, managers and users of IS artefacts as to the objectives, subjects and roles played, social values and constraints and organisational practices with impact on IS design, adoption and use.

- The construction and evaluation of business scenarios and their traceable impact on IS and organisation designs, as mediators for human action.

While in the beginning we looked essentially for a way to expeditiously represent important contextual information relevant to IS design, we soon came to realise its importance as a way to share future views of the organisational context. Such an instrument seems to be essential if we aim at the proactive design of mediators as enablers of human interaction, be them computational artefacts, values, norms or practices. We designate this instrument as a Context Model and it may assume any form satisfactory for the performance or the required activities.

As a mediator's model we shall consider any representation that serves the needs of the activities previously described, specifically:

- Effective support and communication of designs (with minimal overhead)

- Usefulness for the purposes of evaluating the transformation, from concepts like feasibility, utility, usability, to the quality of experience or the potential value of new enabled developments.

Effective design communication may be evaluated on the basis of the quality of design results and fitness for the given activity. Whatever our choice of representation for the model of the mediator, it should provide good traceability to the enactment of activities that justified our design decisions. This is fundamental for the designer to be able to evaluate design decisions based on associated user requirements. As with any Software Engineering effort, traceability between design and context is key to bridging the traditional creative gap between requirements and solution.

4.   Context Engineering Guiding Principles

A view of information systems as sociotechnical phenomena. Not only of the social interaction between human actors but also of their interaction with artefacts and of its influence on the emerging organisational patterns of behaviour - of the sociotechnical constitution and genesis of those collective patterns of behaviour that we chose to understand as the object of ISD.

A view of ISD as emancipatory movement. Departing from a critical and subjective perspective of information systems development phenomena, but not restricted to it, e.g. recognising the materiality in mediation in physical and mental artefacts, development will be guided by the emancipatory role. But "practitioner as emancipator" may be contradictory. A participatory exercise, difficult as it may be, can be the key to self-development as true emancipation. ISD is then viewed as an instrument and not an end in itself.

Human and non-human actors, heterogeneous symmetrical interactionism. If we recognise the materiality in the diverse forms of mediation, in helping shape human action, we will be driven to consider a middle ground between human voluntarism and technological determinism. Neither human action is the expression of free will, independent from their technological infrastructure, nor will the artefacts fully determine the outcome of human

actions. Both carry action programs with them but also some degree of flexibility to translations in actual circumstances.

IT and organisation may be aligned both ways, or none. It is really circumstantial and teleological. The myth of alignment is still going strong. Yet, we can identify situations where and when alignment is not only difficult but also undesirable. Misalignment can be creative. The idea that IT must be aligned with organisational goals and strategies is but a possibility. It can also be aligned with current performance, with the environment (e.g. inter-organisational). Or IT can be transiently and purposefully misaligned, as a trigger for change, to make the organisation follow the lead from technology. And, of course, it may not, but the point is that designing for alignment is just one teleological possibility.

Models, as languages, and their use, are expressions of intersubjective understandings. If we want to pursue the goal of emancipation through IS development, then we think we have to find ways for the diverse actors, conceptors, effectors and users of technology to materially express their views and build their own relationships with the media and the process. For that, we think of models as expressions of intersubjective understandings: the common ground that enables the collective constitution of meanings and interpretations. We think this view of models remains a challenge, as currently the previous sharing of technical languages is still a requirement, and there can be barriers between disciplinary traditions.

5.   Principles for Context Engineering Processes

No a priori process, in favour of a contingent view of development as flux and improvisation. When we propose the context engineering framework we think of it as a possible mapping of the action oriented problems in explicitly duelling between context and media. We do not propose them as an algorithm for performing development. In fact, although we think that an immediate instantiation of the framework is possible with currently known techniques, it could easily drift towards a more conventional view of methods. We think that we do best to recognise the adaptation that goes on in real life. Practitioners may use this framework for guidance to think about where they are and what they have done at a moment in development and consider what next move they wish to take to further their development goals, contingently. Since we understand ISD to be a complex phenomenon its result could be understood as an emergence and our actions only attempt to influence what emergence we would like. Not the design of emergence, but of what we guess to be its underlying conditions. And that's one reason why we talk about engineering the context.

Model to make the intersubjective constructions explicit and debatable. (Some would say interobjective - that's a philosophical question we chose not pursue here.) We think of models as expressions of past, present or future realities, as currently accessible referents to absent social localities, as shrink-wrapped versions of the "real phenomena", but as yet possessing the relevant relationships and dynamics we wish to acknowledge and deal with. When built on top of shared languages, models enable the construction of intersubjective, explicit and debatable understandings. Then we can think of user requirements construction and alignment, whatever our positioning may be.

Build early to make the mediators experimentable and the process participative. Interpreting our own experience, we identified several situations where the early availability of mediators enabled a fast return to the context of development and the effective expression by interested actors of their interests and tacit knowledge [Polanyi 1974] that escaped previous conversations. In these conversations, with actual artefacts and procedures, on a

microcosm that legitimates more active speech, we uncover relationships and actor-networks that were dormant or unspoken, enabling effective user requirements to be expressed.

Practitioner's toolbox: collect compatible contextual techniques as instruments to perform the movements. If we think of the movements as related development problems, we can research and collect useful instruments in the context of those movements. As those movements are related, so do their outcomes and so must be the techniques chosen. At some time or other the "users" will become not only participants but also practitioners of their own development, as they acquire the instrumental languages involved. This can be witnessed with personal productivity tools. As practitioners, we usually let the situation select the instruments and not the other way around.

Evaluate transformations, not just artefacts, and remodel your context. This is possibly a bigger challenge. If we can think of development as a way to achieve transformations, some of which via computational artefacts, and if we can find a way to value those transformations in relation to what they enable further, then we will have more reasons to rethink development beyond technical artefacts - e.g., if we consider the value associated with learning to perform some activity or use some technology and the kinds of new developments paths that open before us. That can motivate bigger transformations. Don't forget to re-model your context.

6. Conclusions

The authors briefly presented their proposal for a Context Engineering Approach to Information Systems Development. It essentially proposes a research agenda, inspired by theoretical and practical considerations, centred on the emancipatory goal and recognising ISD as a complex sociotechnical phenomenon. The idea of engineering context is intentionally provocative and those searching for immediate solutions, methods or techniques, may at first be disappointed. The intention is to enable an understanding of the problems in developing information systems that, while philosophically grounded, closely relates to common practice. In doing so we have attempted a sketch of the related problems centred on the notion of context as an integrated development target. To that extent we propose a set of fundamental movements to be performed as the situation and development intentions call for. In this framework, the mediators - concepts, relationships, roles, IT instruments, regulations, processes and procedures, etc. - are all plausible objects of development and can be understood to represent a social dynamics, that should be accounted for and played with as part of the development phenomena. We then sketch CE's general and process principles as challenges for those interested in fitting this approach with appropriate instruments.

References

Akrich M. (1992) The De-Scription of Technical Objects, in *Shaping Technology/Building Society : studies on sociotechnical change*, Wiebe Bijker and John Law editors, MIT Press.

Alexander C. W. (1964) *Notes on the Synthesis of Form*, Harvard.

Almeida A., Roque L. (2000) "Simpler, Better, Faster, Cheaper, Contextual: Requirements Analysis for a new Methodological Approach to Information Systems Development", *Proceedings of the 8th European Conference on Information Systems*, Vienna.

Almeida A., Roque L. (2002) "Some Reflections on IS development as Operator of Organisational Change - A perspective based on Activity Theory and Expansive Learning", *Proceedings of ICEIS'2002*, Ciudad Real.

Bergman M., King J. L., Lyytinen K. (2002) Large Scale Requirements Analysis as Heterogeneous Engineering, To appear in *Scandinavian Journal of Information Systems*, Summer of 2002.

Beyer H., Holtzblatt K. (1998) *Contextual Design: Defining Customer-Centered Systems*. Morgan Kaufmann Publishers.

Blackler F. (1995) "Activity Theory, CSCW and organizations", in *Perspectives on HCI - Diverse Approaches*, Andrew Monk and Nigel Gilbert editors, Academic Press, London.

Bodker S. (1991) *Through the Interface*, Lawrence Erlbaum Associates.

Callon M. (1991) "Techno-economic networks and irreversibility", in *A Sociology of Monsters: Essays on Power, Technology and Domination*, John Law editor, Routledge.

Checkland, Scholes (1999) *Soft Systems Methodology in Action*, Wiley.

Ciborra C. (1999) "A Theory of Information Systems Based on Improvisation", in *Rethinking Management Information Systems - An Interdisciplinary Perspective*, Oxford University Press.

Dilley R. editor (1999) *The Problem of Context*, Berghahn Books.

Duranti A., Goodwin C. editors (1992) *Rethinking Context: language as an interactive phenomenon*, Cambridge University Press.

Engeström Y. (1987) *Learning by Expanding: An activity-theoretical approach to developmental research*, Orienta-Konsultit Oy, Helsinki.

Engeström Y., (1999) "Innovative leraning in work teams: Analyzing cycles of knowledge creation in practice" in *Perspectives on Activity Theory*, Engeström Y., Miettinen R., Punamäki R.-L.. editors, Cambridge University Press.

Perspectives on Activity Theory, Cambridge University Press.

Hanseth O., Monteiro E. (1998) *Understanding Information Infrastructure*, manuscript.

Hirscheim R., Klein H., Lyytinen K. (1995) *Information Systems Development and Data Modeling - Conceptual and Philosophical Foundations*, Cambridge University Press.

Iivary J., Hirscheim R., Klein H. (1998) A Paradigmatic Analysis Contrasting Information Systems Development Approaches and Methodologies, in *Information Systems Research*, Vol. 9, No. 2, June 1998.

Iivary J., Lyytinen K. (1999) "Research on Information Systems Development in Scandinavia: Unity in Plurality" in *Rethinking Management Information Systems - An Interdisciplinary Perspective*, Oxford University Press.

Iivary J., Hirscheim R., Klein H. (2001) "Towards More Professional Information Systems Development: ISD as Knowledge Work", in *Proceedings of the 9th European Conference on Information Systems*, Bled, Slovenia.

Kling R., and Lamb R. (2000) "IT and Organizational Change in Digital Economies: A Sociotechnical Approach", in *Understanding the Digital Economy: Data, Tools and Research*, E. Brynjolfsson and B. Kahin, eds., Cambridge, MA: The MIT Press.

Kuutti K. (1991) "The Concept of Activity as a Basic Unit of Analysis for CSCW Research", in *Proceedings of the Second European Conference on CSCW*, Amsterdam, Kluwer Academic Publisher, 1991, pp. 249-264.

Kuutti K. " (1996) Activity Theory as a Potential Framework for Human-Computer Interaction Research", in *Context and Consciousness: Activity Theory and Human-Computer Interaction*, MIT Press, pp. 17-44.

Kuutti K. (1999) "Activity theory, transformation of work, and information systems design", in *Perspectives on Activity Theory*, Engeström Y., Miettinen R., Punamäki R.-L.. editors, Cambridge University Press.

Kyng M., Mathiassen, L. editors (1997) *Computers and Design in Context*, MIT Press.

Latour B., (1991) "Technology is society made durable" in *A Sociology of Monsters: Essays on Power, Technology and Domination*, John Law editor, Routledge, 1991.

Latour B., (1999) "On recalling ANT" in Actor Network Theory and After, Law and Hassard editors, Blackwell Publishers.

Monteiro E. (2000) "Actor-Network Theory" in *From Control to Drift: the dynamics of corporate information infrastructures*, Claudio U Ciborra editor, Oxford University Press.

Mumford E. (1983) *Designing Human Systems for new Technology: The ETHICS Methods*, Manchester Business School, Manchester.

Mumford E. (1999) "Routinisation, Re-engineering, and Socio-technical Design: Changing Ideas on the Organisation of Work" in *Rethinking Management Information Systems - An Interdisciplinary Perspective*, Oxford University Press.

Parolini, C. (1999) The Value Net: A Tool for Competitive Strategy, John Wiley & Sons, Chichester, England.

Polanyi M. J (1974) *Personal Knowledge: Towards a Post-Critical Philosophy*, University of Chicago Press.

Sharfstein Ben-Ami (1989) *The Dilemma of Context*, New York University Press.

Schön D. (1983) *The Reflective Practitioner: How Professionals Think in Action*, Basic Books.

Vygotsky L. S. (1986) *Thought and Language*, (revised by Kozulin, A.), The MIT Press.

Sawyer S., Rosenbaum H. (2000), "Social Informatics in the Information Sciences: Current Activities and Emerging Directions", *Informing Science* Vol3, No 2, 2000

Suchman, L. (1987) *Plans and Situated Actions*, Cambridge University Press.