METHODOLOGICAL REFLECTIONS ON COLLABORATIVE WORK PRACTICES IN SIMULATION MODELLING: A SHORT JOURNEY TO ELSEWHERE

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ABSTRACT

Effective collaboration is at the heart of simulation modelling. By looking at the investigations undertaken within other discipline domains, e.g. Computer Supported Cooperative Work (CSCW), we highlight methodologies issues that could be applied in the area of simulation modelling to support a more effective project timeline and to stimulate a discussion about the next generation of tools for collaborative simulation.

Keywords: *Simulation Modelling, Collaborative Work, Groupware, Distributed Cognition and Common Information Space.*

INTRODUCTION

"Simulation modelling is impossible without collaboration" is possibly one of a very select set of truisms that one might make of this decision support technique. However, to confirm this we site Robinson and Pidd's (1998) study of end user expectations. They identify "effective collaboration" as being one of several critical factors of success. Poor collaboration between simulationists and stakeholders may not always guarantee poor results from a simulation study but it will certainly contribute towards it.

Of the work in this area there are interesting and invaluable lessons in how we might work together in a simulation study. However, if a criticism might be made, these are written by simulationists for simulationists. As part of a wider series of events, the GROUPSIM Network (a UK Government funding program to investigate strategies in infrastructures for collaboration simulation modelling www.groupsim.com) has begun to foster promising cross-disciplinary studies. One theme that has emerged is on the importance of research method used to study collaboration. This paper reports on one important aspect of this work by presenting an overview of methodologies used in an analogous and complementary field – a short journey to elsewhere if you will.

The paper is structured as follows. First we present some observations on the study of collaborative work practices. We then present an emerging theoretic framework used to study collaboration. The *Common Information Space* for collaboration is then presented with some methodological concerns. The paper then finishes with some brief observations from a study and some conclusions.

STUDYING COLLABORATIVE WORK PRACTICES

In general, being a social and organisational phenomenon, collaboration incurs some costs. Additional work is required in order to achieve cooperative activity, beside the effort spent toward the task (Schmidt, 1994). The cost is both visible at individual as well as at an organisational level since supplementary resources need to be strategically planned and marshalled in its support. Collaboration costs but its benefits balance the outlay invested in its establishment and maintenance. In particular, the advantages of collaboration lie in the overcoming of individual's limited capabilities, providing constructive opportunity for mutual critical assessment, confrontation of perspectives, combination of differences and the enhancement of individual capacity.

Space and *tools* constitute the technical resources of any human activity and defines the context where activities take place. Kirsh (2001) defines with *activity context*, a structured amalgam of informational, physical and conceptual resources whose interactions are not yet clear. Understanding the network of relations between the several components that make up a collaborative system represents the intent of many researchers in the area of Computer Supported Collaborative Work (CSCW) in order to plan a proactive approach to the design of technological and organisational solutions for collaboration. (Bannon, 1992; Bannon and Hughes, 1993; Grudin and Poltrock, 1997).

While Human Computer Interaction focuses on the study of the partnership between individuals and technological equipment and on the interaction

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engaging single users with considerably small equipment (Bannon and Huges, 1993), CSCW, on the other hand, embraces a broader spectrum of human activities. The intention of supporting collaboration as it occurs in the real world and through real practices involves a redirection of the analytical tools employed in the research and a new range of methodologies for the collection and analysis of data and evaluation of users experience. Extending the territory of observation for studying co-operative activities results in the identification of a new unit of analysis as a complex arrangement embedding artefacts, emergent behaviours and mediation. In order to consider such a unit of analysis, the required paradigm of cognitive science to frame the study needs to be enforced by approaches that allow a broader view on the phenomena under analysis, involving disciplines and new methodologies able to enrich the insights about collaboration (Bannon, 1992; Suchman, 1983). A cognitive theoretical framework such as Extended Cognition, in conjunction with disciplines as Anthropology and Ethnography can support the understanding of medium-to-long-term user study, involving participants in *real settings and under natural circumstances*.

A further tenet within CSCW community is that designing technology is not just about designing artefacts but also social practices and possibilities that are realised through their employment (Flores *et al*., 1988). In this perspective, space is the setting that surrounds us. It is not just through the physical properties and the interactions between space, artefacts and human body that we construct a meaningful environment to our activities. We perceive and understand the workspace not just by looking at the locations of artefacts and three-dimensional arrangements, but also by making sense of the resources and of the way we can use them (Harrison and Dourish, 1996). Space seems to be the structural precondition for socio-cultural reality: the *place*, a collection of people, believes, rules, artefacts and interpretations. It is through ethnographically oriented studies that we might regard different activity contexts in order to understand how artefacts and space affect the settings where collaboration occurs.

A THEORETICAL FRAMEWORK

With the intent of simplifying the analysis of complex phenomena, naturalistic approaches have confined the study of cognition to lab experiments and observations. This selective attention to some aspects of human activity has neglected the complexity that shapes our cognitive capabilities, which are intrinsically linked to the social and historical context where they occur. Several schools of thought, motivated by the intent of re-contextualising human intelligence, identified a larger unit of analysis able to account for the role of external resources in the moulding of human plans, actions and collaboration. A composite theoretical framework labelled as Extended Cognition has bought forward the concept of mediation where physical and cognitive tools are considered as catalysts and products of the higher human psychological functions. Tools are embedded into the relation we establish with the outside world changing the nature of the interaction with it. Once they are embedded in activities, artefacts are mediating links between individuals and the world. Vygotsky (1978) and the Soviet School of Cultural Psychology have identified a complex unit of analysis, the *activity*, as a triad of *subject-tool-object*, that was further developed by the *Activity Theory* (AT). AT regards collective activities and expands the basic ideas of artefacts and their mediation in everyday life.

The basic triadic relation *subject-tool-object* identified by the Soviet School is stretched with the intention of embracing a broader context that provides the configuration of resources involved in human performance. Within the network established by the components of the *activity system*, artefacts represent the media supporting our cognition and the *loci* where it is externally distributed. The augmentation operated by the AT creates a more comprehensive understanding of the artefacts' mediation between people and context, and therefore generates a more predictive framework for informing the design of artefacts. Tools become not mere filters through which we perceive reality, but actors that help define our objectives and ultimately our identity.

A more radical perspective on human activity is taken by *Situated Action*, a theoretical framework that finds its origin in ethnometodology and branches from traditional cognitive science, rejecting the tautology for which "cognition is *just* computation" (Suchman, 1987). Situated Action is a radical account of human behaviour that is not based on plans or on cultural universals but on the *situatedness* that characterises human acting (Salomon, 1993). The emphasis of the approach resides on the interaction between the individual and the environment (Nardi 1996), resulting in a new unit of analysis: the *person-acting-in-setting* (Suchman, 1987). The contribution of Situated Cognition to the overall theoretical framework resides in its interpretation of human activity as contingent re-orientations of resources performed *in situ*. This is to achieve the most suitable arrangement that allows us to undertake a potentially successful next step in the course of action.
Suchman (1987) suggests that activity is an emergent phenomenon whose values are developed at the same time that the activity unfolds. Activities are not driven or structured according to preconceived plans. Once we are engaged in an event, we try to direct its course in an opportunistic way, in a step-by-step computational process performed within the immediacy of the situation we are experiencing. The specificity of the circumstances where the activity occurs can not be

transcended. Situated Action accounts of actions as if they are always determined by material and social circumstances. Thus our activities can not be fully understood if their study transcends the context where they occur. This makes human actions unpredictable to determine, while consistency can be found in the set of transformations aiming to structure the resources for the activity. For Situated Action, the achievement of intelligent strategies is based on the use of circumstances and this provides a correction to the simplified view that cognitive science has held. The elegant theoretical structure of traditional cognitive science is rejected and reveals its fallacies when human action is studied as a phenomenon not solely centred on human mind.

The contingent nature of human cognition has been further investigated by a cognitive approach, *Distributed Cognition* (DCog). The framework emphasises the distributed nature of cognitive processes and the transformation that information undergoes in order to get into a specific format that is the most appropriate for the performance of a task. DCog incorporates external and internal resources into a larger cognitive system, the *socio-technical system*, where human and technological components are both regarded as media for information representation and transformation, despite their intrinsic differences. The *socio-technical system* is based on the principle that components, being they humans or technologies, hold information representations that are manipulated, co-ordinated and propagated, changing the state of the overall system which, by a set of transformations accomplishes its cognitive task. People and artefacts are media that carry fragments of information that are necessary for the ultimate goal of the *socio-technical system*.

It is through observational studies that DCog promotes the understanding of complex cognitive systems with the intent to discover strategies that a distributed cognitive entity opportunistically chooses to take in order to achieve the desirable state, given its environmental circumstances. Artefacts change the nature of the task making them less 'cognitively expensive' by engaging human skills that are not limited. In ideal situations we delegate to the environment and to the artefacts the load of information we cannot mentally deal with, and the processes we cannot compute internally, yet being able to achieve an effective performance.

The theoretical approach of *Extended Cognition* configures a new landscape for the study of intelligence as a property that is manifested as *people in action*. With the intent of establishing the realignment of mental and physical nature of human intelligent behaviour, the Soviet School of Psychology, Activity Theory, Situated Action and Distributed Cognition shorten the distance between theoretical *apparatus* and the realm of design of new information technologies. The aim is to stimulate a theoretically informed design (Hollan *et al*., 2000), which accounts for the social and environmental embedded nature of human cognition.

A COMMON INFORMATION SPACE FOR COLLABORATION

The need for a larger unit of analysis in order to analyse how we work together finds application in the concept of Common Information Space, CIS. Bannon and Bødker (1997) identify CIS as the shared informational environment required for grounding the communication and co-ordination of cooperative activities, i.e. how we collaborate. CIS is meant to refer to both the artefacts that carry information, the representation of information, and the meaning attributed by the user to these representations in a shared space. The value of utilising the notion of CIS in understanding collaborative work *in situ* is its focus on the seamless interweaving of people, artefacts, information and activities.
Sharing information for collaborative activities can lead to problematic situations in either co-located or distributed settings (Reddy *et al*. 2001). When actors are physically and temporally separated, expensive strategies need to be employed in order to package the relevant context of information that needs to be communicated. Interpretation and negotiation problems can also arise if participants, sharing the same space and timeframe, do not work toward a common interpretation of the information at hand.

In general terms, we hope to use the general concepts of CIS to tease out from field research a greater understanding of the difference between a physically supported collaborative space, with its rich resources and a virtual or distributed collaborative space, which all tend to function in a more impoverished form. In doing so we highlight why the current design of information technology that users employ in such spaces do not truly support their current collaborative needs.

METHODOLOGICAL CONCERNS

In a study of collaborative activities in order to capture the complexities of the various CIS under investigation, ethnographically inspired fieldwork observations and interviews were undertaken to document users' activities, their context of work and the artefacts they employed (Spinelli and Brodie, 2003a; 2003b). The first study in the research focused on three design teams co-located and distributed; while the research on mobile work turned its attention to collaboration in a variety of remote and mobile settings, such as at airports and on trains.

The field data collection spanned approximately eight months. Observational work was supported by methods such as digital video recording of events; digital photography, contextualised interviewing and participatory user data reviews which helped to capture the richness of interaction that was occurring in the various CIS under review. Furthermore, participants took part in collaborative sessions where they reviewed some of the observational data and offered valuable insights and understanding of the critical collaborative scenarios observed. These served to highlight implicit work practices and workarounds elaborated in the attempt to avoid the disruptions that the use of technology in collaboration can cause.

CO-LOCATED AND DISTRIBUTED COLLABORATION

In order to select the study sites, it was important to take into account some considerations that have methodological and content relevance to the research. Firstly we aimed to select organisations that could provide the opportunity to follow an entire project or at least a well-identified phase of it in order to see the establishment, evolution and maintenance of the co-ordination patterns. Also it was worthwhile pursuing the opportunity to observe more than one team in order to compare and contrast the different way of organising collaborative work.

The study was framed within a consistent domain of observation. Three organisations were selected on the basis of the activities they performed. The overall choice was made considering the nature of the collaborative activity as the most important aspect to emphasise for the selection of the work context(s) to observe. This was in order to avoid too many differences that would not allow the comparison of the observations. The three teams that were shadowed were all involved in design activities of different types, as listed below:

- the conceptual design of an information appliance;
- the engineering design of an innovative public building; and
- the design of a new set of national standards in construction procedures.

INSTANCES OF COLLABORATION

Three diverse instances of collaborative work emerged from the observations:

- a *physically-centred* collaborative space (the project space), a dedicated environment where a group of professional designers collected and manipulated information in order to support their activities;
- a *virtually maintained* space, resulting from the combination of web application and tele-video conferencing technologies for the collection, retrieval and storage of organisational knowledge to support problem solving activities;
- a *locally distributed* space arising from the collected use of several digital devices (mobile phones, faxes etc.) and protocols of communication (circulation of the people, email, snail mail etc.);

All the instances of collaborative space observed in this study do not find counterparts just in the physical world. They resemble more a collection of established organisational practices and technologies used to achieve collaborative tasks. This observation led us to postulate that we cannot rigidly define collaborative space by simply considering its physical boundaries. This consideration thus directed our research towards the identification of those tasks that make up the dimensions of collaborative work and of those features that seemed to be crucial across the field observations in supporting collaboration. Further results from these studies can be found in Spinelli and Brodie (2003a, 2003b).

CONCLUSIONS

This paper has given an overview of methodological observations from disciplines that study the nature of collaboration. The purpose of this paper is to raise awareness of methodological issues in the study of collaboration in simulation modelling. It is hoped that this "short journey to elsewhere" will provoke thought and debate in this area that will lead to better collaboration and reduced simulation project costs.

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