Chapter XXXVII
Socio-Technical Systems and Knowledge Representation

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ABSTRACT

The UK National Health Service (NHS) provides the opportunity to undertake local socio-technical system design to help staff maximize the opportunities of using mobile technology whilst minimizing the impact of change to existing patient systems. A real-world example from a local NHS socio-technical system is considered, that contains a collection of mobile clinicians and technology which provides home care to patients. The success of the Mobile NHS service has a high dependency upon the social aspects of the solution and draws upon a combination of people, resources, technology and economic events. This chapter considers multi-agent system architectures, to model social complexity, and capture system knowledge, and then outlines a prototyping technique as a means of implementing and testing the design model. It concludes that the practice of implementing a prototype ontology provides a valuable step in clarifying meaning and understanding of concepts at the outset.

There is no distinction of meaning so fine as to consist in anything but a possible difference of practice

—Charles Sanders Peirce, How to make our ideas clearer, 1878.

INTRODUCTION

Socio-technical systems have arisen in response to the challenge of understanding complex technical systems that are embedded in a human world (Trist, 1981). Multi-agent System (MAS) architectures are used to build complex technical systems using social concepts such as agents and intelligent agents, which often comprise of many autonomous entities that communicate across multiple organisational tiers. Gathering requirements for such systems and accurately implementing and testing them is a challenge.

As computing moves from single node systems into vast multimode networked systems capable of operating autonomously we need software solutions that are capable of operating with some degree of autonomy acting socially in our best interest. Woodridge et al. (2000) describe this as a software environment which is capable of autonomous action to meet design objectives. Such a system is described as an *agent*. Taking this definition one step further Woodridge, (2001) describes an *intelligent agent* as being reactive, proactive and exhibiting social behaviours. If an agent can embody reactive, proactive and social characteristics, then it also possesses the necessary characteristics to be able to transact with other similar agents. Agents can then transact to exchange knowledge. Methodologies for MAS development are still evolving and with the rapid expansion of Web Services and the Semantic Web (Berners-Lee, 1999), tools and architectures are now more in demand.

Hill et al. (2006) identify that whilst many approaches and tools assist various tasks required to develop a Multi-Agent System there still exists a gap between the generation of MAS models and implementation. Hill's work provides "A Requirements Elicitation Framework for Agent-Oriented Software Engineering". Hill provides a preliminary design framework using conceptual graphs to show how the Transaction Agent Modelling (TrAM) approach assisted the design of complex community healthcare payment models. Insight gained during the design process is used to enrich and refine the framework in order that detailed ontological specifications can be constructed. Conceptual Graphs (Sowa, 1984) are a system of logic based on Charles Sanders Peirce's existential graphs. Conceptual graphs are a flexible and extensible method for knowledge representation, they are particularly useful forms of semantic networks, as they also include generalisation hierarchies of types, relations, and complete graphs (de Moor, 2004). A proposed use of conceptual graphs would extend established methods of designing socio-technical systems such as using the Unified Modelling Language (UML). UML can be extended using conceptual graphs to support ontology engineering, conceptual graphs and semantic networks are examples of knowledge representation languages. They have the full power of first order logic and can represent model and higher-order logic, they have a direct translation into natural language. Conceptual Graphs consists of a "formal language" to access knowledge and meaning in both computer and people systems. Transactional Agent Modelling (TrAM) provides a framework employing conceptual graphs for enriching the requirements gathering process for multi-agent systems. For these reasons conceptual graphs are our formalism of choice to model social complexity.

Taking a real-world example such as Mobile NHS it is possible to analyse the complete system knowledge of a socio-technical system and then refine that analysis and test it through a prototype implementation. Having mobile access to data entry at the point of care electronically could ensure that the right data is captured first time and in real time, the correct treatment coding is used, assessments are completed in full, tighter security of data and governance of access is provided, and that decisions are fully auditable reducing the risks of miss-transcription. A mobile transaction offers the opportunity to remodel the old process and remove needless system boundaries to bring transactions closer to their intended goals (Launders et. al, 2007). Having mobile access to patient records could enable medical decisions to be supported at the point of treatment, they could allow for electronic patient records to be examined at a patient's home, improving the level of care at the same time as saving time, money and resources. This would lead to more patients receiving home treatment. A mobile clinical application that considers the socio-technical aspects of design such as the context of the treatment being provided at the same time as using knowledge of previous treatments provided and then applying inference to deduce more facts about the treatments, could prove a smarter system application. A smarter system application may be able to make the projection and alert that a treatment could be potentially dangerous or inappropriate for a given set of circumstances. An example of this could be a general practitioner (GP)

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