39 SUPPORTING COMPLEX ADAPTIVE PROCESSES WITH LIGHTWEIGHT PLATFORMS

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This paper begins by describing the evolving environment towards greater adaptability in today's business processes and the limitations of current methodologies in providing ways to support such processes. Support systems require ways to integrate social connectivity and interactivity into business processes in ways that enable the process to be dynamically changed. The paper describes models that identify requirements for such systems and convert the models to lightweight implementations that support flexibility. It uses ideas from complexity theory and social patterns to create the models.

1 INTRODUCTION

Dynamic changes in the execution of many current processes are placing greater and greater emphasis on designing systems to support users to make process changes. Such agile business processes must integrate all process components into one manageable entity and provide ways to easily and quickly change the process structure to respond to changing needs. This paper refers to such processes as complex adaptive processes based on the definition of complex adaptive systems (CAS), (Holland, 1995) as made up of many agents (which may represent cells, species, individuals, firms, nations) acting in parallel, constantly acting and reacting to what the other agents are doing.

The control of a CAS tends to be highly dispersed and decentralized. The overall behavior of the system is the result of a huge number of decisions made every moment by many individual agents.. This paper addresses ways to model CAS and show ways to convert these models to computer system architectures that support knowledge workers. In this sense, process complexity is where the process emerges in that it changes as the situation evolves. Knowledge complexity is where new knowledge must be created as a process proceeds. Thus transaction processing, as for example payroll processing, has a well defined structure and knowledge that is relatively stable. Product development, on the other hand, is where the process can change as a product evolves and new knowledge must be continually developed. For example, the requirements a new product must be defined, and refined as new ideas come up and feedback is received from potential users. Each such new input will lead to some new task or action as determined by the product developers. The paper focuses on supporting processes where process and knowledge complexity is high and ways to support the workers in such systems. Workers in complex adaptive processes are often known as knowledge workers (Davenport, 2005, Chen,

Edgington, 2005). The work of knowledge workers is characterized by greater emphasis on connectivity and interactivity, autonomy and quickly changing practices that require changes in connectivity and interactivity. As a rule they do not follow prescribed processes and efforts to reengineer the work of knowledge workers into prescribed forms have proven unworkable (Davenport, 2005).

The paper will first define the special properties of complex adaptive systems and their impact on modelling and design. It will then propose ways to model such systems. The paper will then describe modeling methods for complex adaptive processes and describe their implementation in lightweight technologies, which allow knowledge workers to change their working relationships and comprehend, and assimilate new technologies in their work (Swanson, Ramiller, 2004).

2 WHAT ARE THE NEW DESIGN CRITERIA?

Complex adaptive processes are currently not well-defined in any formal manner. Our challenge is to define the special characteristics of adaptive processes and provide ways to design them. A more theoretical approach is provided by complexity theory (Merali, McKelvey, 2006) and that of complex adaptive systems (Holland, 1995). The criteria here include:

- The ability to self organize at local levels in response to a wide variety of external changes,
- The creation and quick establishment of self contained units that address well defined parts of the environment,
- Loose coupling between system elements and a control system to reorganize the structure to respond to external change,
- Ability to organize connections between units and support the changed connections and interactivity.
- Aggregate smaller units into larger components with consequent changes to the connectivity and interactivity,
- Realization of simple interfaces between model components.

Our contribution will be to develop modeling methods that support the special characteristics of complex adaptive systems and convert the models to support systems, which facilitate the work of knowledge workers in complex environments.

3 IMPACT ON MPODELLING AND DESIGN

The impact of this trend is two fold, namely:

- Design methodologies must be able to cater for the dynamic nature of processes and include specific criteria in modeling that emphasize such dynamic nature, and
- Create technical solutions that support user driven change, which are referred to as lightweight technologies in this paper.

There has been work on support for small groups (Sutcliffe, 2005) on complex tasks but there are few widely accepted systematic methods to develop large complex

adaptive processes. Many current designs often attempt to re-engineer what are predominantly open systems. However, it is increasingly noted that social relationships are important in knowledge processes such as for example medical systems (Zhang, 2002), where greater emphasis is needed on user analysis and communication. Thus rather than developing systems that provide prescriptive processes, what is needed are infrastructures and the services that can be quickly brought into the process to serve an unanticipated need.

4 MODELLING METHODS FOR COMPLEX ADAPTIVE SYSTEMS

The proposal here is that models of adaptive systems be made up of the three components shown in Figure 1. These are:

- business activities, which must be modeled as loosely connected and the connections can change over time and which can be easily reorganized,
- social networks that model the people relationships, and
- knowledge as that keep track of the connectivity and interactivity in the social and work networks.

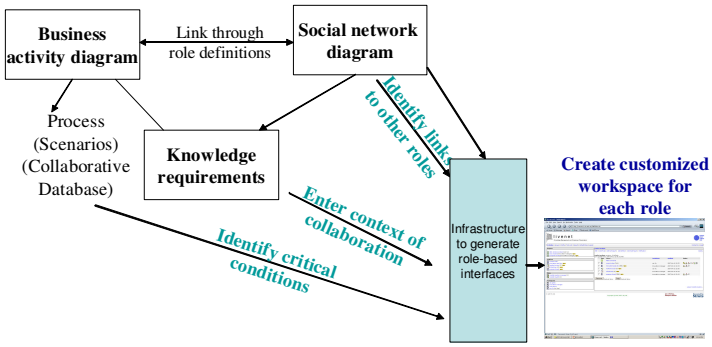

Figure 1 - The blueprint for modelling adaptive information systems

The models must combine the business activities with work and social networking as an integral part of the systems and seeing it as a link between the different activities. The knowledge requirements go beyond simple transaction databases but include records of social interactions integrated into the activities. They will be focused on the knowledge needs of roles within the social structure.

The model components will then be mapped to technologies, in most cases workspaces. The goal here will be to develop an infrastructure that can be used to generate workspaces specific and furthermore to change these dynamically as a situation evolves. Our goal is to show that these three components can indeed model adaptive systems and that there are systematic ways to go from the model to an implementation as the form and function in Gregor and Jones (2007) and develop constructs that provide the dynamic capabilities within this blueprint and constructs to realize architectures based on the blueprint.

One important aspect of this research is the evaluation of any new proposed modelling constructs. The relative novelty of complex adaptive processes precludes an analytic evaluation and suggests a more descriptive approach to evaluation

(Hevner, 2004). At the same time we will draw on existing theories and social structures (Gregor, 2007) to form the evaluation criteria.

4.1 Modeling Business Activities

The business activity models are based on a conceptual model for collaborative systems (Hawryszkiewycz, 2005). The main concepts are activity, role, participant, and artefact. Figure 2 illustrates one instance of such model for evaluating an idea for a new product. Here there are four activities shown as clouded shapes. There three roles shown by Figures and four artifacts shown by the disk shapes. Any number of participants (not shown in this simplified diagram) can be assigned to each role. The model shows that the client and marketing manager interact in activity 'analysis of marketing needs' to develop a market report. Figure 2 illustrates the most fundamental parts of the model with more details found in (Hawryszkiewycz, 2005). The additional detail include various discussion or interaction artifacts and ways to initiate events in one activity that are passed to roles in other activities. The model semantics support dynamic changes to the model and the special characteristics of CAS as:

- They allow activities to be reorganized through changes to roles, and artifacts,
- New activities can be set up and linked to existing activities through roles and artifacts,
- The activities are loosely coupled through their roles,
- New connections can be organized through events or shared discussions,
- Higher level activities can be created to aggregate the activities of existing activities.

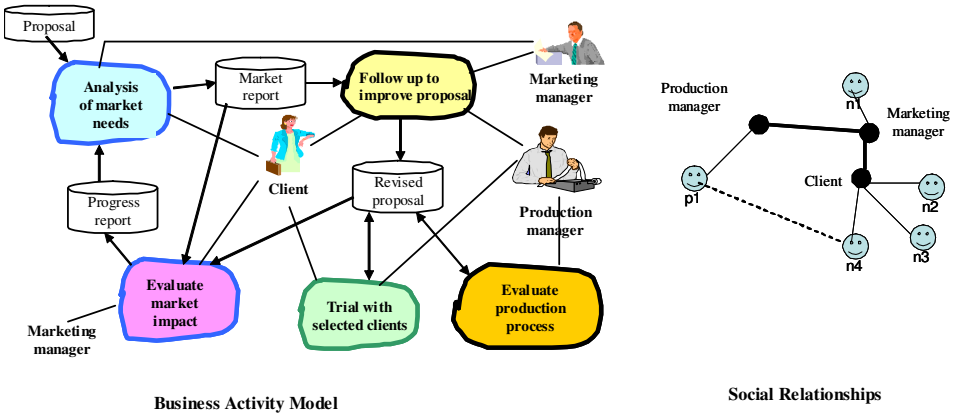

Figure 2 – Business activity diagram

4.2 Modeling the Social and Work Relationships

The social relationships diagram in Figure 2 identifies the interplay between processes, people and technology. It shows people as taking different roles in different activities and thus ensuring the sharing of knowledge. In the social

relationships diagram in Figure 2 the roles are shown as black dots. The faces are individuals, who take on these roles. Thus n2 is a client and p1 is the production manager. The thick lines between the roles indicate work connections, which define the essential communication paths for the participants. The dotted lines show informal connections. For example p1 and n4 have an informal connection, which is not part of the work process.

A Practical Example

Figure 3 illustrates the model for outsourcing. It shows three parts, namely:

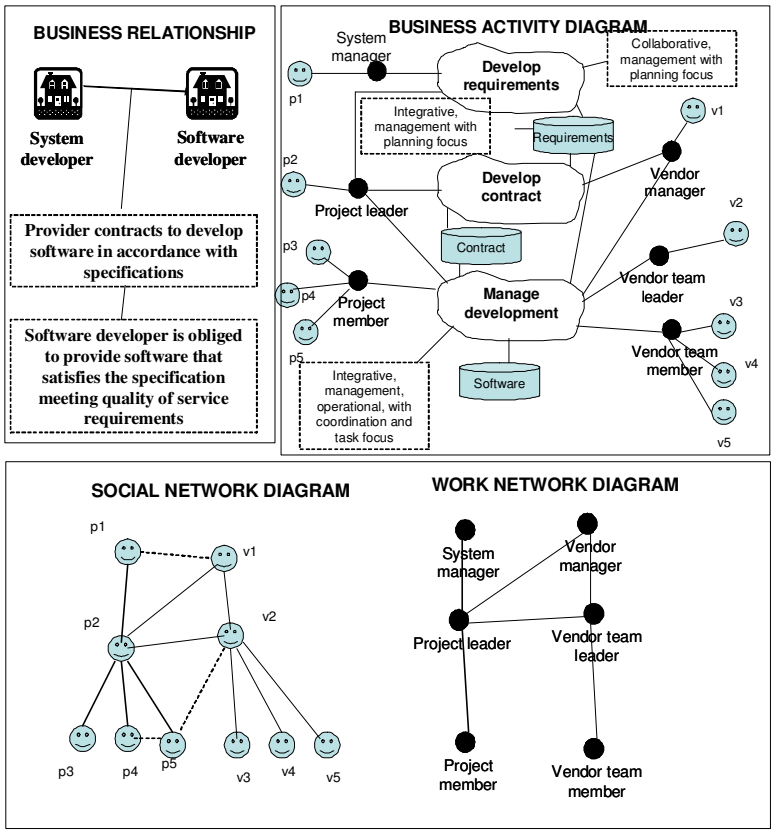

Figure 3 – A Model that combines functional and Social Analysis

- The business relationships that shows that a system developer contracts with a software developer to develop software modules,
- The business activity diagram shows the kind of activities that take place in the relationship. It shows the activities by the clouded shapes, the roles by the black dots and artifacts by the disk shaped figures. The participants are shown as faces. Only the broad level activities are shown. Thus for example the contract development involves the project leader and the vendor manager. Currently p2 is the project leader and v1 is the vendor manager. It should be noted that one

person can take more than one role. A scenario would describe the actions that take place. The activities include:

- Develop requirements, where the system manager and the project leader decide what is to be outsourced and develop the requirements,
- Develop contract, where the project leader and vendor manager
- Manage system development, where the teams work together to create the software.

- The work network is derived from the business activity diagram. It shows the interactions that are required as part of the business activity. For example there is a link from the vendor manager to the project leader as they take part in the same activity, namely, develop contract. The social network diagram is derived from the work diagram by showing links between people assigned to the roles. Thus there is a link from p1 to p2. The social network diagram can also show many of the informal interactions within such a system. These are often the result of personal contact or the fact that people are collocated.

4.3 Catering for open system requirements

The modelling method supports the earlier defined special characteristics of adaptive systems. The way they do so is shown descriptively (Hevner, 2004) in the table below.

Special characteristics	Modeling technique
The ability to self organize at local levels in response to a wide variety of external changes,	Adding roles, participants and new artifacts to an existing activity. Creating a new discussion to include a distant member to provide new expertise to an activity.
The defining and quick establishment of self contained units that address well defined parts of the environment,	Creation of new activity. For example quickly creating a new team from existing members to address a special problem.
Loose coupling between system elements and a control system to reorganize the structure to respond to external change,	People assigned to roles in more than one activity. Events in one activity can be received in other activities, with new events added as required.
Ability to organize connections between units and support the changed connections and interactivity.	Set up events to pass notifications between activities. Share documents and discussions as for example contract development and requirements..
Aggregate smaller units into larger components with consequent changes to the connectivity and interactivity,	Create a new activity that shares artifacts with existing activities.
Realization of simple interfaces between model components.	This is achieved by defining role based interfaces that provide easy links to other roles and activities.

Process emergence here can include creation of new business relationships as for example extending the service to another client, or setting up a transient team to identify the cause of a complex fault.

5 REQUIREMENTS OF TECHNOLOGY INFRASTRUCTURE

Returning to Figure 1 the social network identifies the kind of platforms needed. The business activity model provides guidelines on the kind of activities and their connectivity and interactivity between them. Each platform however has to be adaptable and match the communication practices on the activity. These are often referred to as lightweight platforms (Hawryszkiewycz, 2007). We have identified four level of platform for lightweight communication. These are:

- lightweight exchange, which provides the kind of support needed to support exchanges typically found in offices,
- lightweight collaboration, which supports joint work on artifacts or in informal coordination and planning activities,
- lightweight workflow where on one-off process is followed requiring some monitoring and reporting, and
- process management, which is support for repetitive workflow processes that may result as processes mature.

We have also developed a prototype to demonstrate how technology can support open requirements. The prototype supports the concepts and semantics of the business activity model, and includes ways to support social structures. These can be supported as groups of individuals. Particular individuals or entire groups can be assigned to roles in the business activities. A typical interface is shown in Figure 4.

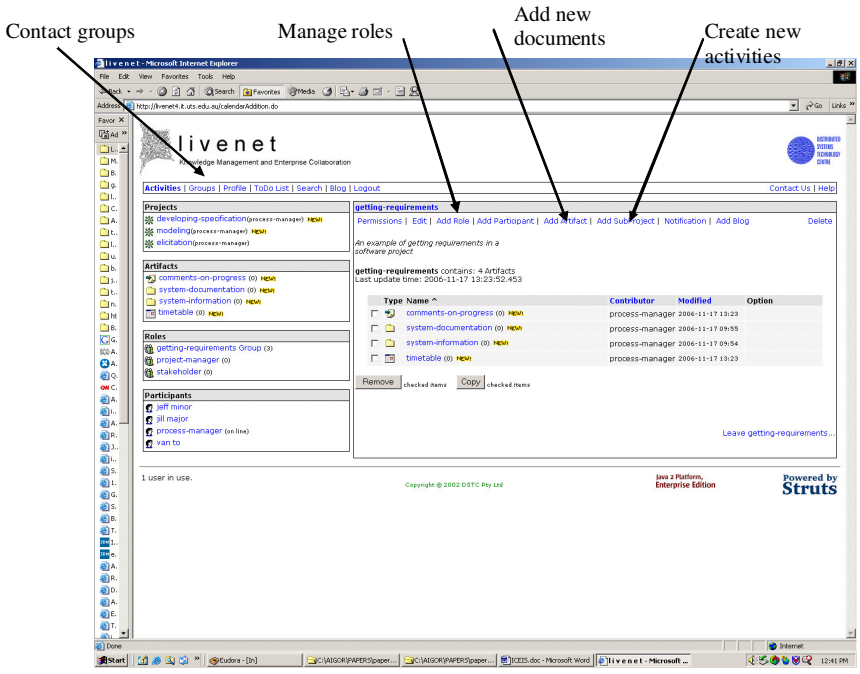

Figure 4 – Workspace for developing requirements

The commands provided though such interfaces satisfy the open system criteria.

- Process emergence with ability to grow by providing dynamic capability to create new groups or activities,
- Dynamic linking between new and existing elements either through people taking roles in the different activities or through an event and notification structure,
- Self-organizing ability for local relationships by allowing changes to workspace participants, new documents, or roles changed,
- Support for communication and collaboration through the addition of new social software as for example discussion systems

6 SUMMARY

The paper described the special requirements that must be met by the increasing number of information systems that are complex and must adapt to emerging business environments. It stressed the need to include work social networks as part of an analysis process and their integration into business activity modelling. The models produced in this way can then be used to create lightweight platforms that support work practices in such environments. The paper illustrated one way to model such systems and convert the model to an implementation that dynamically supports system change.

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