Responsibility modelling

An issue which we have been grappling with is how to model distributed work, carried out by human or automated agents. We are currently exploring the use of responsibility as an abstraction in such models. Responsibility is convenient because it is a natural notion and because it allows some types of work that cannot be sensibly represented as workflows to be modelled.

We define a responsibility to be:

> *A duty, held by some agent, to achieve, maintain or avoid some given state, subject to conformance with organisational, social and cultural norms.*

The key points in this definition are that a responsibility is a duty, which implies that the agent holding the responsibility is accountable to some authority for their actions, that responsibilities may be concerned with avoiding undesirable situations and not just with accomplishing some actions and that, in discharging responsibilities, agent behaviour is constrained by laws, regulations and social/cultural conventions and expectations.

In some cases, responsibilities may be procedural, where the agent follows a defined process. However, many responsibilities are knowledge-based and the agent assigned the responsibility decides how to discharge that responsibility, based on their knowledge and experience, local circumstances, etc. Even for procedural responsibilities, agents may have discretion in how to cope with exceptions, busy periods of work, etc. In all cases, deciding on whether or not a responsibility has been properly discharged depends as much on how the work was done as on what was or was not achieved.

A **responsibility model** is a succinct description of the responsibilities in a system, the agents who have been assigned these responsibilities and the resources that should be available to these agents to assist them in discharging their responsibilities.

Currently, we have focused on planning models i.e. models of intended responsibility. Of course, responsibilities are actually dynamic in that the responsibilities themselves, the agents and the resources evolve in practice, depending on circumstances.

The domain in which we are currently exploring the use of responsibility models is that of civil emergency management. This involves the emergency services and local and national government working together to cope with some emergency, such as flooding, terrorist attack, aircraft accident, etc. We have been investigating how we can use a model of responsibilities as a way of revealing planning vulnerabilities and the requirements for systems support by the emergency coordination centres. The case studies that we have used have been based on emergency plans for dealing with extensive flooding.

The role of the emergency coordination centres in the UK is to coordinate the work on the ground of the different agencies involved. This involves prioritizing actions, maintaining an overview of the situation, facilitating information exchange across agencies and communicating with the media. The agencies involved (fire, police, ambulance, etc.) have their own command and control systems and information systems and do not want a unified command and control system. Communication between agencies is normally managed by liaison officers in the coordination centre.

In this case, the requirements are for an information management system that allows the information to be shared across agencies, that facilitates the transmission of information to people dealing with the emergency and that logs decisions taken by coordinators. Logging is critical both as a means of learning from experience after the recovery phase of the emergency has been completed and as an accountable record of actions.

Our responsibility modelling notation identifies responsibilities, agents (organizations or roles) who have been assigned these responsibilities and resources used to discharge responsibilities. Figure 1 is a model of the responsibilities involved in evacuating an area in the face of an imminent or actual threat (from flooding). Responsibilities are denoted by round-edged rectangles and agents are named in angle brackets. Dependencies between responsibilities (such as decomposition into sub-responsibilities) are indicated by links between the responsibility icons.

Responsibilities have a set of attributes and an associated description that can take a number of forms, depending on the type of responsibility. For responsibilities that are normally discharged
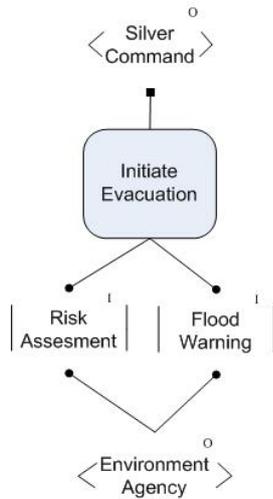
Figure 1:
Responsibility model
of evacuation
coordination
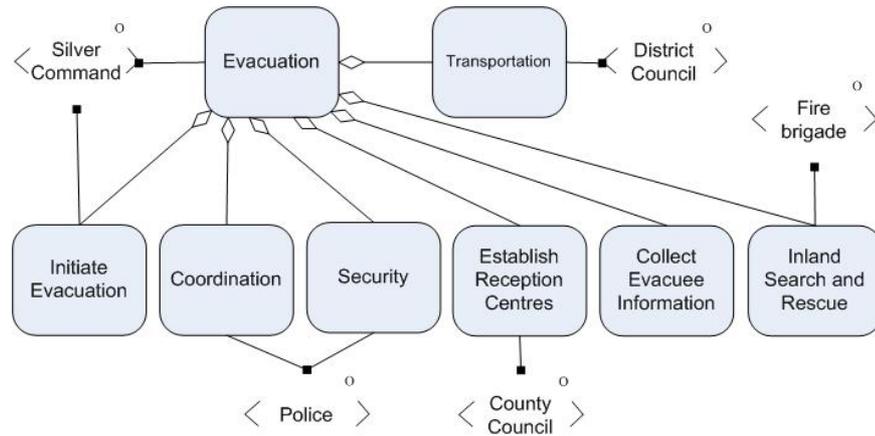
in the same way, the description can be a workflow model. For knowledge-based responsibilities, the description is usually textual. Attributes may include the goal or goals associated with the responsibility, the context where it is normally discharged, pre and post-conditions defining assumptions, etc.

To explain Figure 1, Silver Command (the name given to the coordination centre) initiates an evacuation given situation information (flood warnings, weather forecasts, etc.) and a risk analysis. The police coordinate the evacuation process and are responsible for safety and security during the evacuation. If people are trapped, the fire service are responsible for search and rescue but they may not be involved if the evacuation is in advance of a predicted flood. Two levels of local authority are also involved. The district authority must provide transport for the evacuees and the county authority must provide safe accommodation, food and water, etc. Other agencies, such as the ambulance service, may also be called on if there are ill or infirm people to be evacuated, but we have simplified our model to exclude these.

Figure 2: Resources
associated with a
responsibility

Notice that the responsibility 'Collect Evacuee Information' does not have an agent associated with it. Drawing up the responsibility model revealed this vulnerability in the emergency plan. It did not define which agency should collect this information.

We can also associate resources with responsibilities as shown in Figure 2. A resource can be information or some physical entity such as a flood barrier, vehicle, etc. In this case, the responsibility 'Initiate Evacuation' requires information resources (named between vertical bars) in order to discharge that responsibility. The Environment Agency must provide a flood warning (which indicates when local rivers may flood in the near future) and a risk assessment, which shows the areas that would be affected by a flood and so should be evacuated.

Application in the LSCITS project

We see responsibility modelling as a means of modelling complex IT systems where we can represent organisational, human and technical agents using the same abstraction.

An initial area that we will explore is the use of responsibility models for vulnerability analysis where we can use a HAZOP-style approach to test the models for specific vulnerabilities such as unassigned or misassigned responsibilities.