Modelling Business Processes using the Soft Systems Approach

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Abstract

This paper describes a project which modelled the business processes involved in the commercial sales process in a small company, using Checkland's soft systems approach. The aims of the project were:

- to elicit a model of the commercial sales process which could be used to identify areas for improvement;
- to evaluate the soft systems approach as a tool for business process modelling;
- to evaluate HARDY, a computerised tool for editing hypertext-based diagrams, as a support tool for the soft systems approach.

The results of the project showed that soft systems is a viable approach to business process modelling; its strengths include the ability to structure a loosely defined problem, the modelling of an agreed 'ideal' system, and the identification of key attributes of each process. However, it also has weaknesses, principally in the limited guidance available on how to construct soft systems models. In the course of this project, it was discovered that guidance on model construction can be obtained from another source; if a business process required knowledge-based reasoning, then the CommonKADS methodology for the analysis and design of knowledge based systems can supply a generic model of that process, which could then be instantiated to the task in hand.

1 Overview of the Soft Systems Approach

The soft systems approach is based on the work of Peter Checkland at Lancaster University [Checkland, 1981]. Checkland's thesis is that systems thinking – conceptualising real life as a system of interacting processes – is a useful way of understanding these processes; but the approach which is used to analyse 'hard' systems (software systems, or other mechanistic systems) is not suitable for analysing 'soft' systems (systems which involve human activity or human judgement, such as the activities of business management). He therefore proposes his own approach to the analysis of 'soft' systems, which has become fairly widely used, because it has proved useful in solving problems in 'soft' systems [Checkland, 1981] [Checkland & Scholes, 1990].

The essence of Checkland's approach is to identify one or more problem areas in a system, and then to model **only** those business processes which are relevant to that problem area. Checkland calls this identification of a **relevant system**. The modelling is done by representing processes as nodes in a diagram, and indicating the flow from one process to another using arrows. Complex processes are often expanded into sub-processes in separate diagrams.

An example of soft system modelling is shown below:[1] it concerns a consultant who was having problems providing his client with the type of report which the client desired. The "relevant system" chosen is to consider the consultant/client relationship simply as a transfer of advice from one party to the other; all other aspects of the consultant/client relationship are ignored. The resulting "advice transfer system" is represented diagramatically, as shown below:

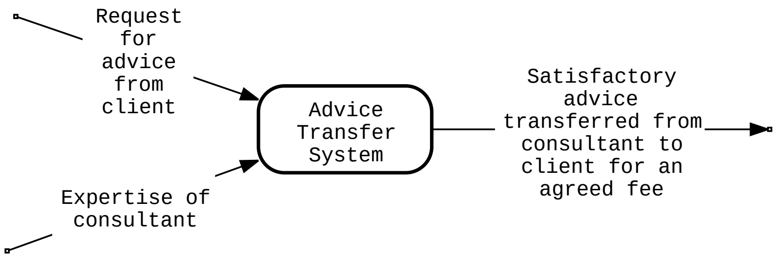

Figure 1: The advice transfer system at the highest level of abstraction

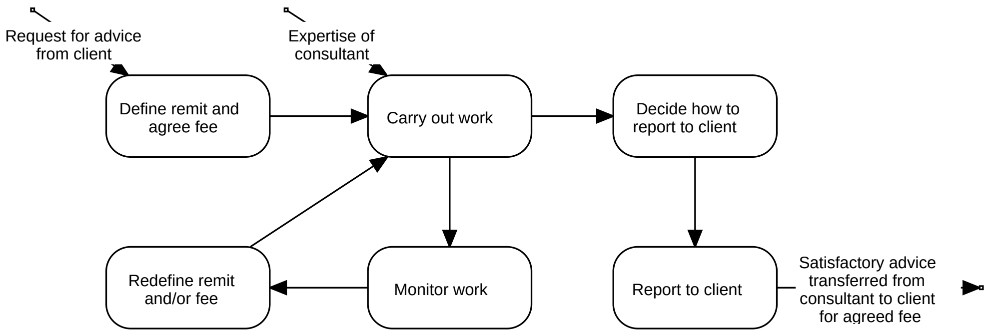

Figure 2: The advice transfer system expanded into individual processes

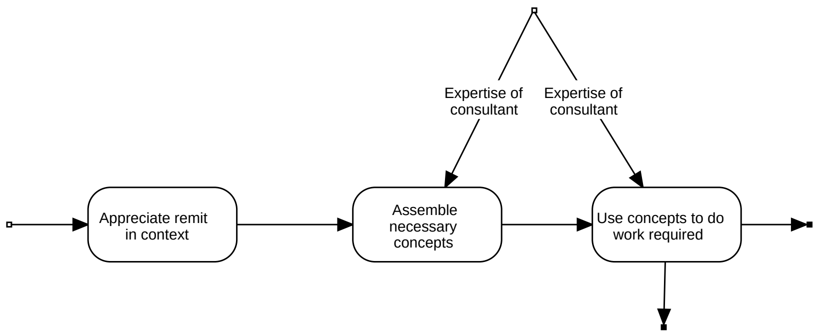

Figure 3: A breakdown of the processes required to perform "Carry out work"

[1] This example is copied from a diagram in [Checkland, 1981]

In addition, Checkland's approach encourages the soft systems analyst to identify a number of attributes relating to each process. These attributes are:

- Actor – who (or what) normally performs the action
- Customer – whom the action is intended to benefit
- Owner – who has authority over decisions made
- Environment – the environment in which the soft system operates
- Worldview – the underlying assumptions which participants in the soft system hold. For example, in the British coal industry of the early 1970s, it became clear that the managers on the Coal Board and the miners had quite different attitudes towards coal-mining. The Coal Board was keen to maximise the use of its expensive capital equipment, a policy which required the machinery to be operated five or six days per week. However, many miners were keen to earn enough money to get by while spending as little time as possible underground, which required them to work four or even three shifts per week [Checkland, 1981].

The combination of these three approaches (identifying a relevant system, decomposing complex processes into subprocesses, and identifying key attributes of each process) produces a rich representation of a particular business process.

Once a "relevant system" has been defined, Checkland's recommended approach is to model the *ideal* version of the relevant system. This is achieved by presenting the model to key participants in the process, and iteratively refining the model based on elicited comments until all participants agree that the model represents the ideal processes in this soft system. Only then does the focus of modelling switch to processes which are actually carried out; these processes are then compared with the ideal model, and differences are used as a starting point for recommending improvements to the process.

2 Example of the soft systems approach: sales modelling

The soft systems approach was used on a project which set out to model the commercial sales process in a small company. To this end, knowledge about the processes involved in sales was elicited from a number of experienced individuals in the target company. On the basis of initial interviews, it was decided that the biggest areas of uncertainty in the sales process were in the following up of an initial proposal for business, and in the estimation of the likelihood of closing a potential sale. It was therefore decided that the "relevant system" for this project was a "Bid

Management System", in which the sales process was represented as a system for preparation, refinement, and resourcing of proposals for business ('bids').

From the interviews which had been carried out, an initial attempt was made to identify the top-level processes involved in the management of a bid. This model was computerised and represented graphically, using a hypertext and diagramming tool known as HARDY [Smart, 1993]; the usefulness of HARDY is evaulated in section 3. This top-level model was then compared with the interviews at a detailed level, with the result that two processes (*Monitor progress of bid* and *Present & discuss a work proposal with prospect at an appropriate level of detail*) were expanded into subprocesses. The diagrams generated were then printed out, and used as a basis for discussion in further interviews with the key individuals in the target company. This led to considerable refinement of the models, and further expansion of *Monitor progress of bid* into a second level of subprocesses.

The final top-level model of the Bid Management system can be seen in Figure 4. An example of one of the low-level subprocesses – the estimation of the likelihood of a bid being completed – can be seen in Figure 5.

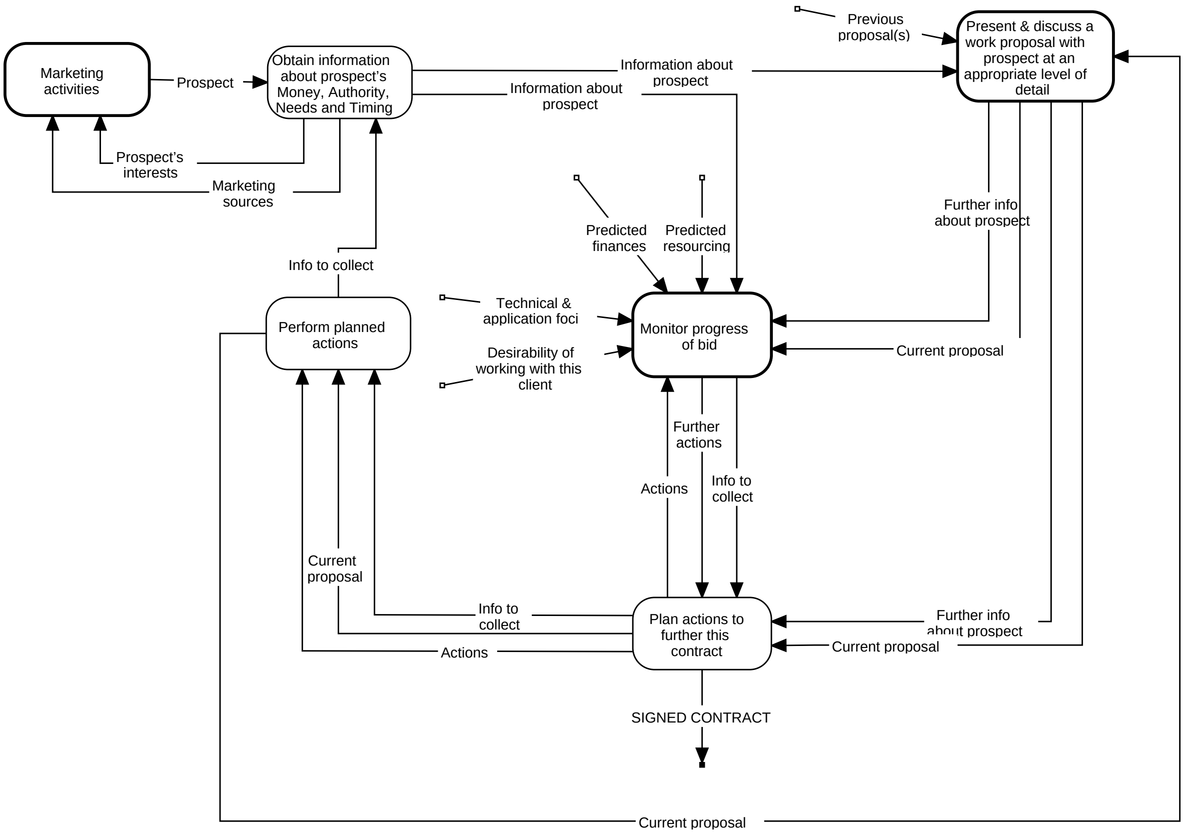

Figure 4: The top level of the Bid Management system.

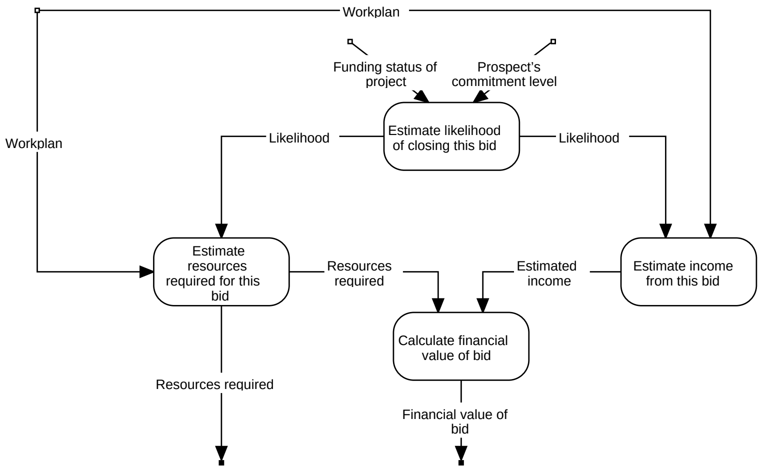

Figure 5: Processes involved in estimating the likelihood of a bid

3 The use of HARDY on the sales modelling project

HARDY is a diagramming tool which supports the creation of nodes and arcs whose shapes, sizes and attributes are defined by the user. These nodes and arcs are displayed on "cards" (individual windows) which are connected by hypertext-style links. A wide variety of manipulations can be performed on the diagrams; in addition, HARDY supports an integrated programming language which allows the definition of menu options which automatically carry out one or more diagram manipulations. On this project, HARDY was used on a Unix workstation running X Windows; it is also available on PCs under Microsoft Windows.

The facility for a user to define formats for nodes and links is a very powerful one, as it allows HARDY to be customised to produce graphical support tools for a variety of methods and approaches. For this project, formats were defined to support the features of the soft systems approach. It can be seen from section 1 that the soft systems approach requires representation of:

- individual processes which are carried out as part of an overall process;
- attributes attached to individual processes;
- data flows between processes;
- the ability to have more than one data flow to or from a process;
- the ability to break down a single process into a sequence of subprocesses.

The formats which were defined in HARDY to support the soft systems approach were as follows:

- **Processes** were represented as nodes on as hypertext card, labelled with the name of the process.
- **Attributes** of a process were defined as attributes of each process node. HARDY supports the creation of named attributes for both nodes and arcs;
- **Data flows** between processes were represented as arcs with arrowheads between process nodes. Each arc can be labelled to show what data it is transferring.
- **Expansion of a process into subprocesses** was represented by linking another hypertext card to the node representing 'parent' process, and displaying all the subprocesses on the new card. The title of the new card is the same as the label on the 'parent' process. HARDY can automatically create "expansion" cards, as well as highlighting nodes which have been expanded by emboldening the border of that node.

The resulting diagram style can be seen in Figures 1 to 5, which were all created using the specified formats. The use of HARDY with these formats facilitated the creation, and greatly simplified the refinement of the soft systems model of the Bid Management system. Once the model has been defined, the full model can be redrawn in about half an hour (by hand, it would take a number of hours) and saved into a set of PostScript files in amatter of seconds.

4 Advantages & disadvantages of the soft systems approach

Advantages of the soft systems approach, as identified in the project described above, were as follows:

- The main reason for choosing a soft systems approach to the above project was that it offered hope of introducing a structure to a loosely-defined problem situation, by identifying and focusing on a "relevant system". This was achieved by the identification and modelling of a Bid Management system.
- In the course of the initial interviews, it emerged that different individuals used different approaches to sales. The process of modelling a relevant system which is agreed by all participants to be ideal not only sets up a benchmark against which to measure individual approaches, but actually synthesises the

individual approaches to produce the ideal system. This is a strong plus point for the soft systems approach, because it means that the recommendations at the end of an soft systems analysis stand a reasonably good chance of being accepted by all parties.

- The process of identifying actors, customers, owners, environment and worldview is also valuable, in that it helps to identify unstated assumptions, unwieldy patterns of authority, and disagreements on underlying principles (the worldview).

However, this project also highlighted some weaknesses of the soft systems approach:

- The chief weakness emerged when an attempt was made to produce an animated version of the soft systems model, in which "process flow" could be observed. Such an animation could be very useful in helping participants in the process understand and validate the model. However, the soft systems approach permits multiple inputs and multiple outputs to processes, without explicitly recording which outputs depend on which input(s). The lack of this information makes animation impossible.

  The only way in which a soft systems model could be animated would be to force the soft systems analyst to break down any process with multiple inputs into subprocesses until each process at the lowest level has only one input. This approach would require considerable effort on the part of the soft systems analyst; however, it has been used successfully in other process modelling methods, such as the IDEF3 method [IDEF, 1993], which has been successfully automated. It therefore appears that a very detailed process breakdown is necessary for the soft systems approach to achieve the maximum benefits of automation;

- Another weakness of the soft systems approach is the lack of guidance on selection of a relevant system, and on choosing what to model; these tasks, which are at the heart of successful soft systems modelling, are still something of a black art, learned by experience. Checkland has recently provided a little guidance on selection of a relevant system [Checkland & Scholes, 1990], but is unlikely to provide more; the direction of his research is towards soft systems as a way of thinking, rather than as a formalised approach to analysis.[2]

[2] In fact, Checkland's latest writings [Checkland & Scholes, 1990] are critical of the systematic use of soft systems in the manner described in section 1, which was derived from his earlier work [Checkland, 1981]. To argue the rights and wrongs of Checkland's latest views would distract from the focus of the paper; however, it is worth noting that on previous occasions, the science of Artificial Intelligence has taken theories of human thinking (e.g. production systems [Young, 1979]) and systematised them in order to facilitate the computerised representation of human thoughts

However, if soft systems is to provide a useful set of models of a business process, guidance on modelling would be very useful.

In summary, the soft systems approach is useful in identifying loosely specified processes, and in drawing together disparate approaches to a process; however, it lacks guidance on its use, and requires a lot of time to produce a detailed model. The use of computerised support is veryu helpful in speeding up the production and maintenance of soft system models.

5 Guiding soft systems modelling using CommonKADS inference structures

Given the lack of guidance on soft systems modelling provided by Checkland, it is possible that guidance provided for other approaches to process & task modelling might be helpful for the soft systems approach. In the sales modelling project, the CommonKADS methods for guiding the development of knowledge based systems made a contribution to guiding the mdelling of particular processes.

The CommonKADS methods [Wielinga *et al*, 1993] have been developed under ESPRIT funding, and are due for completion in May 1994. CommonKADS provides a series of models which represent the analysis and design of a knowledge based system (or expert system). These models include an *inference structure* – a model which represents the reasoning steps performed as part of the overall task, independently of the procedural ordering of the reasoning steps, and of the fine detail of the domain objects which are being reasoned about. These inference structures are built from two components – reasoning steps (*inference functions*) and the types of knowledge which form the input and output of these reasoning steps (*knowledge roles*).

CommonKADS provides a library of "generic" inference structures, which are used as a starting point for the development of inference structures for particular projects. This library has proved very useful in a number of projects (e.g. [Kingston, 1991] [Kingston, 1993]). Selection from the library is done on the basis of the type of task which is being performed; typical task types include diagnosis, configuration and design. The chosen generic inference structure is then instantiated (and possibly customised) to represent the reasoning steps for the task in hand.

In the course of the soft systems modelling of the Bid Management system, it was noted that at least one of the subprocesses – that of producing a workplan which

and activities. This approach often produces great benefits in the acquisition and representation of expert knowledge, even if the original theorists have been dismayed at this application of their work (for example, George Kelly, who developed personal construct theory, has reacted negatively to the emphasis on the repertory grid as a technique [Hinkle, 1970]).

was acceptable to both a contractor and a client – appeared to be a knowledge-based task, requiring a fair amount of experience in order to perform it well. Investigations were therefore made to see if one of the generic inference structures in the CommonKADS library could provide a framework for the representation of this process. It was decided that the inference structure for *exploration-based design* tasks closely mapped to the processes involved in negotiating a workplan.[3] Exploration-based design involves suggesting a design which conforms to known constraints on the solution. If the design is rejected, the reasons for rejection are taken as further constraints, and another design is suggested; this process is repeated until an acceptable design is produced.

The generic inference structure for exploration-based design can be seen in Figure 6, and the soft systems model which represents the process of negotiating a workplan can be seen in Figure 7. The inference structure shows *inference functions* such as **refine** and **transform** which take certain types of knowledge (*knowledge roles*) as input, and output other knowledge roles. For example, the inference function **refine** takes a design problem as input, and outputs the domain entities associated with that design problem. The soft systems model shows processes (such as **Devise/revise a workplan** and **Prepare a proposal**) connected by dataflows (e.g. **workplan**).

It can be seen that the inference functions map onto processes, and the knowledge roles map onto data flows; the generic labels in figure 6 have been instantiated to problem-specific labels in Figure 7. For example, the **domain entities** are instantiated to the **workplan**, and **transform-2** is instantiated to **Prepare a proposal**. The only necessary alteration to the structure of the model was the addition of a feedback of newly identified constraints to the selection of a previous proposal. This is necessary to represent the fact that, if a client should place severe restrictions on a particular proposal, it may be necessary to select a different type of proposal (perhaps one which involves collaborative work rather than subcontracted work) from the proposal library

It therefore seems that the KADS library of interpretation models can be used to provide guidance to the modelling of knowledge-intensive business processes.

[3] In fact, the inference structure for exploration-based design is not yet a part of the CommonKADS library of generic inference structures, although it may be added to the library. Its definition and justification can be found in [Kingston, 1994].

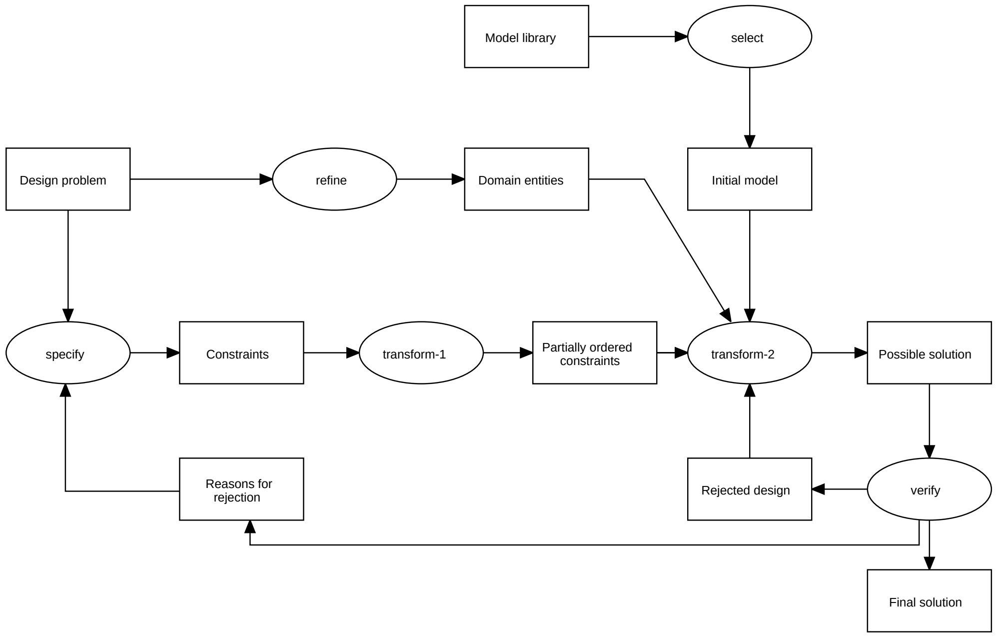

Figure 6: Generic inference structure for exploration-based design

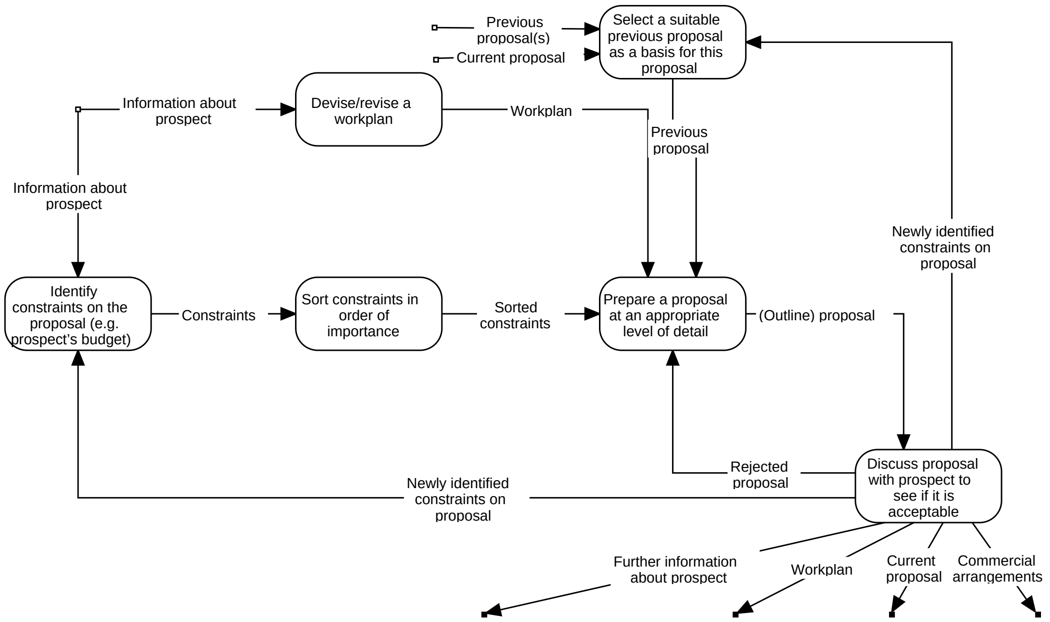

Figure 7: The processes involved in discussing a proposal with a client

6 Conclusion

The results of the commercial sales modelling project showed that the soft systems approach is a useful technique for modelling business processes, particularly if there are ill-defined problems in the process. The models generated are clear, informative, and can be used as a focus for interviews in the later stages of the project. Guidance on model construction is limited, unless a process is identified as requiring knowledge-based reasoning, in which case the use of the CommonKADS library of generic inference structures is recommended. The use of HARDY as a support tool was also judged to be a success; it supported rapid creation, modification, and printing of the models. The ability to produce a diagram format customised to the soft systems approach proved particularly useful.

It is anticipated that the link between the soft systems approach and the CommonKADS methodology will be developed further under an ongoing DTI-funded collaborative project known as ENTERPRISE [Fraser, 1993]. This project aims to provide a computer toolset to capture various aspects of an enterprise, analyse these aspects, explore and simulate options for meeting business requirements, and design workflow management systems to implement chosen options. In order to accomplish this, the project will need to define interfaces between representations of stored data, business models, and organisational knowledge. The link between the soft systems approach and CommonKADS provides a first step towards interfacing business process models with organisational knowledge.

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