An Audience Centred Approach to Modelling for Business Processes ReEngineering

Geetha Abeysinghe, Peter Henderson, Keith Phalp and Robert Walters
Declarative Systems and Software Engineering Group
Department of Electronics and Computer Science
University of Southampton
England, UK

Abstract

This paper describes a method for process modelling which is designed to provide guidance to the business process modeller. The method has evolved from our experience of attempting to apply software process modelling approaches to business processes. A major influence on the method has been our observations that a pragmatic approach to notation selection is required in order to maintain a meaningful dialogue with end-users.

Business process modelling methods typically fall into two camps. General methods attempt to describe the managerial activities which surround the modelling itself (Coulson-Thomas, 94; GISIP, 95). Specific methods, on the other hand, tend to concentrate on the details of a particular notational approach. However, as with programming languages or design methods, no single notational approach is best suited to all problems. Ideally, the process modeller should be able to incorporate the appropriate notational approach into some coherent generic modelling method.

This paper addresses the needs of the modeller at the detailed level without prescribing a specific notation. This is achieved by describing categories of modelling activities which the modeller should undertake within process modelling, and suggesting how notations may be used within these categories. Our method is generally applicable, and is illustrated here by models of processes within the Construction industry.

Professor Peter Henderson is Head of the Declarative Systems and Software Engineering Group at University of Southampton. He is programme co-ordinator for the EPSRC managed research programme, Systems Engineering for Business Process Change (SEBPC). He leads the investigations on the PROCESS (Modelling and Mapping the Business Process) project, funded by EPSRC and in two Esprit funded projects: GISIP (GIS Integrated Processes project, recently completed) and CORE (COnstruction Industries Process ReEngineering).

Dr Keith Phalp has worked as a Research Fellow in Business Process Modelling within the Declarative Systems and Software Engineering Group at University of Southampton (on the PROCESS and GISIP projects) for the past three years. Dr Phalp has experience of modelling notations, methods and tools. He has a PhD in Software Process Modelling and an MSc in Software Engineering. He has recently accepted a post as a lecturer at Bournemouth University.

Dr Geetha Abeysinghe has also worked as a Research Fellow in Business Process Modelling within the Declarative Systems and Software Engineering Group. She has a PhD in Computer Science, an MSc in Computer Studies and expertise in process modelling methods and techniques. Dr Abyesinghe is now a lecturer at Middlesex University.

Robert Walters joined the Declarative Systems and Software Engineering group in 1996 to work on the COnstruction Companies Process ReEngineering project (CORE). Before that he worked for Barclays Bank Plc for 14 years and as a programmer and software analyst for a further two years.

1. Introduction - Modelling Business Processes

The method described by this paper has evolved within the context of experience of applying software process modelling techniques to a number of different business processes (an idea outlined in: Scacchi, 94). The method attempts to formalise the kind of activities which are necessary to successful modelling programmes. The aspects of process modelling described are those which are concerned with the detailed modelling and analysis, carried out at the level of the modeller. This in contrast to many modelling methods which take a far more organisational or management view. Hence, the method outlines process capture, how best to structure and present models, and how different notations for process analysis may be incorporated into an overall modelling scheme. The method has been significantly adapted in response to the following lessons learned about the nature of modelling business processes.

- Capturing the Business Process. Business process users will not invest their time in understanding complex formal modelling approaches. To be able to have meaningful dialogue about the business process it is necessary to have a diagrammatic notation which process owners and users can easily understand.

- Analysing the Business Process. To have a thorough understanding of the process it is necessary to have a degree of formality which is not present in the majority of diagrammatic representations. This increased understanding may be achieved either with more formal models, or by using enactable models and examining process scenarios.

  Enactable notations, such as RolEnact (Henderson, 95; Abeysinghe et. al, 97a), do allow the modellers and users to achieve a greater understanding of processes, but the users need to be shielded from the formality of such notations.

- Presenting the Business Process. Even simple diagrammatic models very quickly become overly complex. This is a particular problem for presentation. For example, in high level views pertinent details and discoveries made during the modelling are typically obscured by inappropriate details. Mechanisms are needed to structure models which allow inappropriate detail to be moved down the model hierarchy. These structured models may be used both to provide alternative views of the detailed process modelling and analysis and to highlight areas of interest.

2. Method for Modelling

The proposed method mirrors our observations about the nature of process modelling, concentrating on producing three types of models:

- Capture Models: used to capture and understand the process.
- Analysis Models: used to gain a more thorough understanding of the process.
- Presentation Models: used to structure models and to show results to process users.

The method revolves around the iterative production of these models. Initial process descriptions are produced in Capture models. These Capture models are then used as the basis for more detailed models for process analysis. These Analysis models are then used as an input into the production of models for presentation. Presentation may highlight further areas of interest for more detailed analysis, and so on.

The sequence of Capture, Analyse, Present happens a number of times in moving from initial models, which are used in order to gain process understanding, through to later models which may be of proposed new process redesigns. As each kind of model is presented changes are suggested by the process users which are fed back into subsequent versions. Initially these changes are required in order to make sure that the model is representative of the current process. Later models are used to show the results of process analysis, for example to suggest where improvements may be made. Finally, models are used to discuss redesigned or reengineered processes. Figure 1 depicts how each phase repeats and feeds on to the next as the models change from those used to capture the process to those used to describe the new (proposed) process.

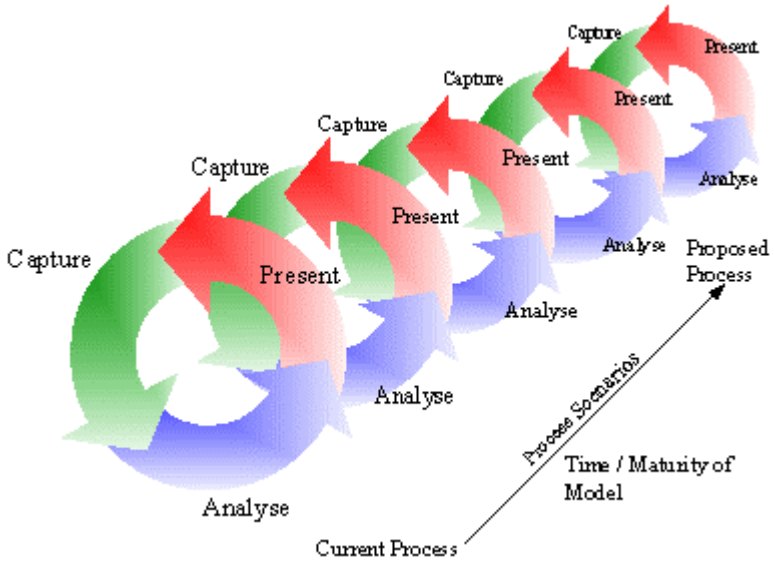

Figure 1: Overview of the Modelling Method

2.1 Notations and Modelling Phases

A significant departure of this method is that it does not prescribe the notations to be used in each category, and a goal based approach is taken to choosing an appropriate representation mechanism. Hence, the method can be used by a wide variety of modellers and with a wide range of modelling tools - from very specific process modelling tools and notations, to simple drawing tools.

As described above, the method assumes that each phase is revisited many times, as the process models evolve. In early iterations the models produced describe the current concrete process. These models evolve through abstract models, to further more concrete models which represent proposed process scenarios. The description of modelling method below is intended both to give a brief overview, and to serve as a structure for the following, more lengthy descriptions of each phase.

- Capture
    - Establish the notation for process capture.
    - Gather evidence about the process from multiple sources.
    - Produce model.
- Analysis
    - Produce / revise analysis models based on previous analysis and / or capture models.
    - Process Analysis. Simple analysis may consist of inspection. More thorough analysis will use rigorous or enactable models.
    - Augment model with findings from analysis, and produce alternative process scenarios.
- Presentation
    - Choose presentation mechanism based on what is to be highlighted, and the intended audience. E.g. dynamic issues, RolEnact (Abeysinghe et al., 97a), Process Architecture Overview: POSD (Henderson and Pratten, 95, Abeysinghe et al., 97b).
    - Present inconsistencies, findings, or process scenarios. Use models to facilitate discussion.
    - Use structure from presentation models as a guideline for reports.

3. Process Capture

3.1 Selecting Notations

Selection of a diagrammatic notation for process capture depends on the specific goals of the modelling, and what analysis notation it is expected will be used. As with the selection of metrics (Basili and Rombach, 87) a goal based approach is appropriate to selecting modelling notations, and a hierarchy of goals (or modelling purposes), questions and notations (or techniques) can be constructed[1].

Capture models are usually either procedural (e.g., data flow approaches; such as: Yourdon, 89), or behavioural (e.g. role based approaches such as: Ould, 95).

Our experience is that procedural approaches appear to be most useful for what we term cumulative modelling (Phalp, 96), where modelling aims to achieve some overall improvement, for example reduction of cost or cycle time. These cumulative models typically view business objects as raw material passing through the process, and people as resources for carrying out the required activities.

In contrast behavioural approaches examine the actions and interactions of groups of individuals, or systems, typically describing the business process in terms of roles (Handy, 76). This approach is well suited to providing process guidance, since the process can be viewed in terms of what activities (actions, interactions and choices) are available at any given point (state) in the process execution.

1 A simple approach to notation selections is described in (Phalp, 94).

3.2 Gathering Evidence

Before producing models, it is necessary to gather information about how the process currently works. This may be achieved by examination of multiple sources of evidence, including procedures documents, interview transcripts, and other process products. Hence, an appropriate design for the correct gathering and interpretation of this data is necessary. For example, case study design guidelines are presented in (DESMET, 94).

As further evidence is gathered it is useful to produce informal models to validate understanding or interpretation of the process, and to focus discussions with users.

3.3 Producing Capture Models

Capture models normally consist of relatively intuitive diagrammatic representations, but a problem with such diagrams is that they sacrifice rigour for ease of understanding. The experience of the PROCESS project suggests that it is necessary to produce capture models for initial evidence gathering[2], process elicitation and validation, and then to map such models to more formal notations which allow for more rigorous process scrutiny (see Abeysinghe and Phalp, 97 and Phalp, 96). In theory these models could be of many different kinds, however, the major proviso is that they should be easy to understand for the uninitiated.

It is important to realise that the sources of evidence about the process will be contradictory, and that in reality there will be many process descriptions contained within them. Although it is difficult to separate out such views, it is important to attempt to separate the theoretical process from the actual process. Ideally, explicit and separate models of the theoretical and actual processes should be produced, so that process deviations and anomalies can be identified and described by reference to the models. Practical considerations make this difficult, and it is not likely to be an efficient way of producing a description of the actual process. A pragmatic alternative is to produce a description of the theoretical process, and then to produce a description of the actual process. Indeed, even having such separate descriptions may often be impractical, and in this case models will be produced which are an amalgam of evidence gained from documents (procedures), people (interviews and workshops) and observation.

However, it is vital not to try to impose a new process, without having an understanding of the way the process currently works, and attempts to do so frequently result in failure (Rodden, 94). Hence, many authors agree that process modelling should start by observation of the current actual process (Rodden, 94; Tamai, 93).

2 However, evidence gathering should not be considered as an activity that happens prior to modelling. Evidence is gathered throughout the modelling process, and thus evidence gathering will also occur whilst detailed, and structured models are being produced, and these models will be revised to take account of new information.

4. Analysis Models

4.1 Constructing / Revising Analysis Models

Process analysis implies that some rigour is added to the modelling activity. In some cases the same notation may used for both capture and analysis. For example, the group has used ProcessWise WorkBench diagrams (a primarily data flow approach) to capture Construction Industry Processes. Further understanding was gained both by adding further detailed layers to these diagrams, and by undertaking analysis of associated process. An alternative is to use a diagrammatic notation for process capture and then to use a more rigorous model for process analysis. For example, the use of Role Activity Diagrams for process capture which are mapped either to more formal models, such as Hoare's CSP (Hoare, 85), or to enactable models, such as RolEnact.

4.2 Process Analysis

The majority of business process re-engineering analysis consists solely of inspection of diagrams. This inspection is usually aided by applying some heuristics, and looking for common inefficiencies in process design (see Ould, 95, Chapter Nine). Typically a number of models will be produced including, a concrete model of the current process, a more abstract model of the current process, and one or more concrete models of proposed processes. The analysis will look to minimise certain features in the new process redesign, for example it may aim to reduce communication, or to increase the cohesion within roles. Indeed, some authors have suggested that there is a need for measures or counts on these features to aid this inspection of static or diagrammatic models (Phalp and Counsell, 97).

4.3 Process Scenarios

Having carried out process analysis it is usual to consider one or more proposals for process change. This can be facilitated by producing a number of process scenarios. The kind scenarios produced will be dependent both on the purpose of the modelling and the capabilities of the modelling tools. For example, in order to reduce cycle times a systems dynamics model may be most appropriate, whereas in order to examine the dependencies between roles a RolEnact scenario might be used. Scenario analysis will be used in order to select the best proposal (or proposals), which will then be presented to the users.

5. Presentation Models

As with the choice of a notation for detailing, the choice of a technique for presentation depends on a number of factors. The goal however, is now different: the aim of these models is to present findings from the modelling exercise.

Many presentation models may be produced, each tailored in consideration of the purpose of the model and its target audience. Initial presentation models may be used in order to verify understanding of the process. Further models are used to present process findings, and suggest changes to process. Later iterations of presentation models are used to present process scenarios to end users, to validate their behaviour, and choose among alternatives.

Finally presentation models are used to form the structure of a document which describes the process. Both RolEnact models and POSD models serve this purpose of

providing a convenient mechanism for document structuring. (This use of model for structuring is described in (Abeysinghe et al., 97c)).

6. An Example of the Method Applied to a Business Process

The example for this paper is the tendering process of a building contractor. This process has been studied in detail in the CORE (CORE) project and detailed models created. Typically the contractor wins work by succeeding with bids made for work in response to invitations to tender from prospective clients in competition with other contractors. The process is concerned with the generation of these tender documents. The final tender that is presented to the prospective client is often a large and complex document of many parts, including documents concerning insurance cover, quality assurance and other matters as well documents relating to the proposed building method, and costings for materials and labour.

The following sections will outline how Capture, Analysis, and Presentation models of this business process were produced, and how these models were used both by the modellers and the end users.

7. Capturing The Business Process

The capture modelling of the example process utilised the ProcessWise WorkBench Standard (PWBS) (ICL, 95) tool which creates dataflow-like diagrams. Diagrams consist of three major types of object:

- Processes describe the activities or actions involved, and may be decomposed further. These are shown as ellipses.
- Business Objects are passed between processes. PWBS provides several shapes for business objects including rectangles with an irregular lower edges and the book-like shapes shown in Figure 2.
- Roles which carry out or have responsibility for processes. At the lowest level of the diagram hierarchy, every process must have a role which performs it. Roles are shown on the diagrams as circles.

The principal rule for the creation of diagrams is that each process communicates by taking input from a business object and sending output to a business object. Some structuring of this model has been done using the ability of PWBS to create “expanded” processes. The full model has a total of twelve “views”. In the diagram below which shows the uppermost view of the model, those processes that are expanded in another view are shown with a heavy outline. (Note that these expanded processes may also include processes that are expanded).

8. Analysis of the Business Process

For the example construction industry process numbers were applied to the detailed models and several of the analysis options and methods available within PWBS were used. In PWBS, each object in a model has a table of values attached to it. Some of these values are input by the modeller and others are calculated by PWBS according to the built-in analysis rules.

In order to carry out an analysis of a model, the entities in the model must map onto identifiable, observable objects in the real process. Otherwise it is not possible to obtain appropriate figures for the input into the analysis. In practise it appears that this requires the model to be highly detailed.

Numbers have been added to the model of the example process to allow the use of volume, cost and elapsed time analysis methods of PWBS (see Figure 2). The addition of these numbers to the model required considerable effort both to elicit the data from the actual process and to manipulate the model to satisfy the preconditions of the analysis methods. The result of the analysis effort was to create a model which contains a great amount of numeric detail about the process, but level of detail obscures the real results of the analysis effort.

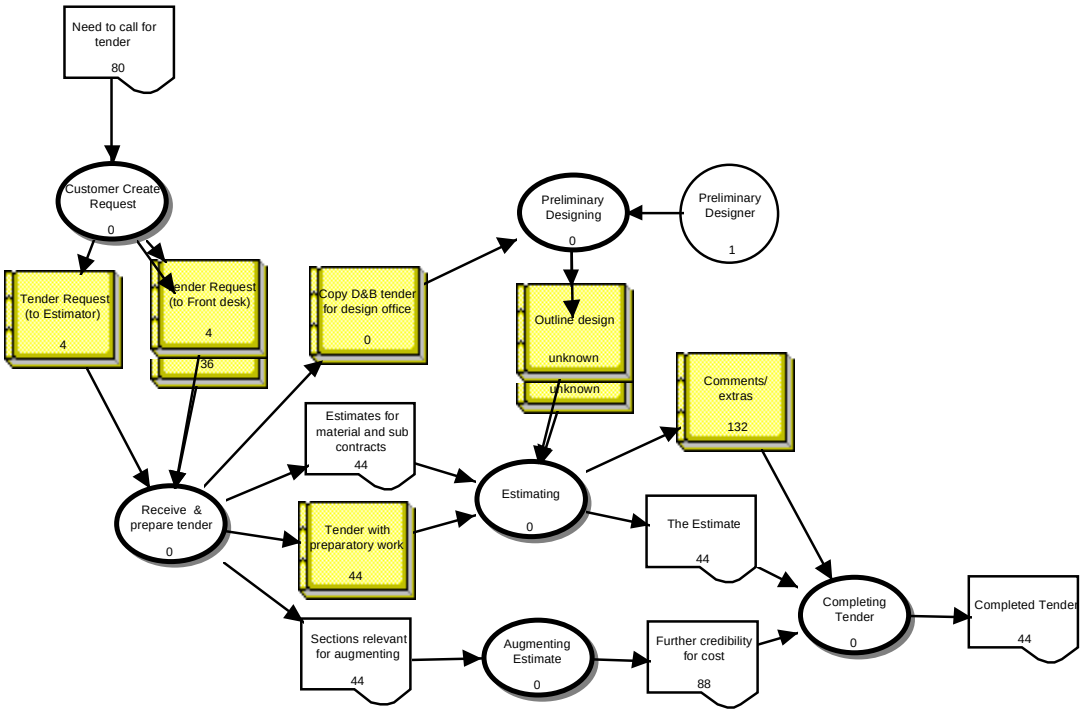

Figure 2: Analysis (PWBS) Model of Tendering - Top Level

Hence, presentation models were used to highlight these results in a more understandable way (see section 9.2 on Presentation of Structure and Costings Analysis).

9. Presentation of the Business Process

There were two kinds of models used for presentation to users. These models were used to highlight very different process issues. The first kind of (RolEnact) presentation models were used to discuss and verify quite detailed sequencing and interactions among process roles. The second kind of (POSD) presentation models were used in order to highlight the process architecture more easily, and to present costings analysis in an understandable format. This further illustrates the point that models must correspond to the purpose of the presentation, and also shows that different notations are appropriate for different purposes.

9.1 Presentation of Sequencing

A need arose during the examination of the process to verify with the users some sequencing issues. An enactable Role based modelling technique, RolEnact, was chosen to satisfy this need.

RolEnact is a formal process modelling language which is based upon a condition action paradigm. The user can run a model on a computer providing the ability to experiment with process scenarios. In this way the user gains a deeper understanding of the process under study and is able to identify errors in the model. RolEnact is described fully elsewhere (Abeysinghe et al, 97a).

When running a RolEnact model, the user is presented with a window on the computer screen for each Role in the model. The banner at the top of the window indicates the name of the Role. RolEnact permits multiple instances of a Role, so the Role name is suffixed with a number to ensure that this identifier is unique. Below the banner is a box which indicates the present state of the Role and space for an (optional) image to represent that state. Also shown is a list of possible actions for the Role (with those currently possible highlighted by the presence of "<=" after their names) and a button to press which will cause the highlighted entry in the list to be invoked.

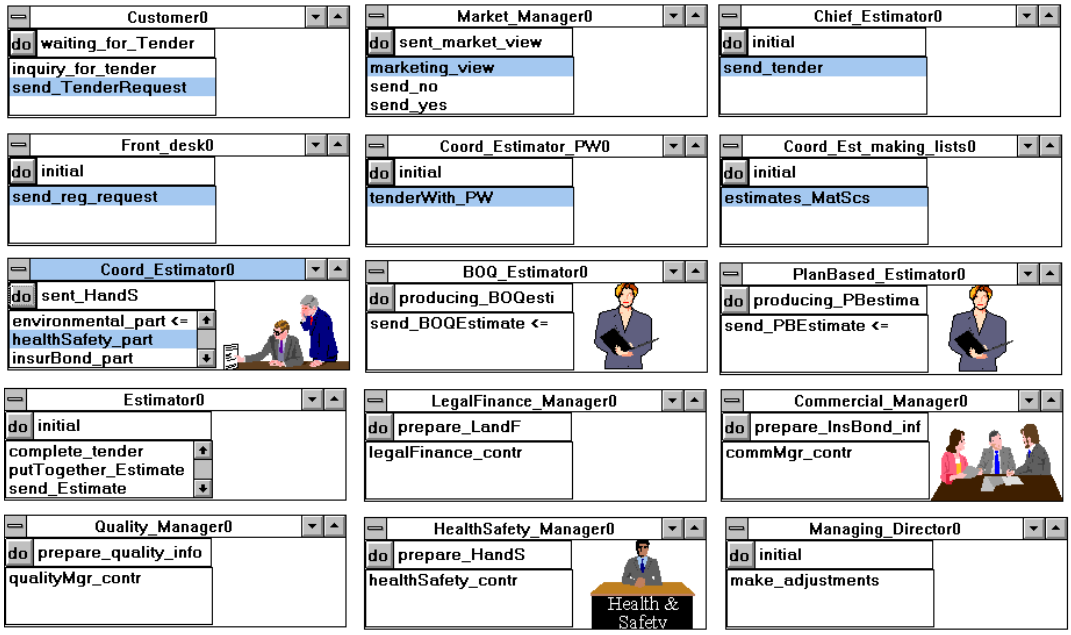

Figure 3: A portion of a typical screen during execution of a RolEnact model

To use the model, a user highlights selects a Role, highlights the required action from those available to that role and presses the "do" button of the Role. RolEnact then carries out the action and updates the states and lists of available actions for all the roles in the model. Execution continues in this way until the end of the model is reached (or, possibly, deadlock occurs). In addition to the windows for the Roles in the model, there is also a window for the controlling application. Figure 3 shows the full model of the example process in a typical state during execution.

For our example, (exceptionally) a member of the management of the company was familiar with process modelling allowing more freedom in the selection of models for some presentations than is usual. The results of the modelling were also presented using PWBS from other modelling phases, and POSD diagrams (see following section). However, despite this previous scrutiny the use of the RolEnact model still identified areas where further correction and refinement were needed.

The experience of the PROCESS project, and associated process modelling projects (CORE and GISIP) is that conventional complex process models are hard to present to process users. Even models represented in notations which allow for hierarchical decomposition may still be difficult for users to comprehend, and the overall structure of the model may be lost within the detail. Hence, these projects have sought a notation which will simplify the high level representation of processes whilst at the same time highlighting their overall structure.

9.2 Presentation of Structure and Costings Analysis

The notation used for producing structured models of Construction Industry processes was Process Oriented System Description (POSD) - (Henderson and Pratten, 95). This notation, and its associated structuring method has been used at the University of Southampton to structure and present complex process diagrams to end users in a number of business domains, notably Financial processes, Local Government (GISIP), and Civil Engineering (CORE). POSD is a particularly flexible notation since it consists of a single primitive - a behaviour. Behaviours in POSD are represented by rectangles. Behaviours may include or be decomposed into other behaviours, which may include processes, roles, information passing, interactions and so on. Where behaviours touch other behaviours this means that there is some shared behaviour. Typically shared behaviour means that there is some interaction or information passing between the behaviours. However, this shared behaviour may be quite complex, and POSD allows the modeller to show the same process with different viewpoints.

Behaviours can be decomposed into a number of other notations, but their main advantage in terms of structuring is that they allow a complex process diagram to be decomposed hierarchically, both in terms of its processes (or roles) and the information passing or interaction between them. This alleviates the ‘wire syndrome’ seen in many process diagrams, where the process is decomposed hierarchically by process, but high level diagrams - consisting of a few processes are still complicated by having a large number of flows between them. Hence, complex processes can be represented so that they are far more easy to understand, and so that their structure may be analysed - without being confused by the detail of information passing or interaction (Abeysinghe et al, 97b).

9.2.1 A Presentation Model of the example process

The diagram in Figure 3, shows the top level description of the detailed model shown in Figure 2. All of the details of interaction are represented at lower levels, touching behaviours indicating where there is shared behaviour. If this diagram is compared with the detailed model of the process, the same structure is revealed, each model consisting of five key behaviours, which are expanded in lower levels.

However, note that because the detail of business objects flowing between processes has been pushed down the model hierarchy, the description is far easier to comprehend, and the structure (architecture) of the process more apparent.

This particular view has numeric information added into the behaviours which has been extracted from the mass of numbers in the detailed model. This view of the model using POSD shows, at a glance, information that is difficult to observe in the detailed model.

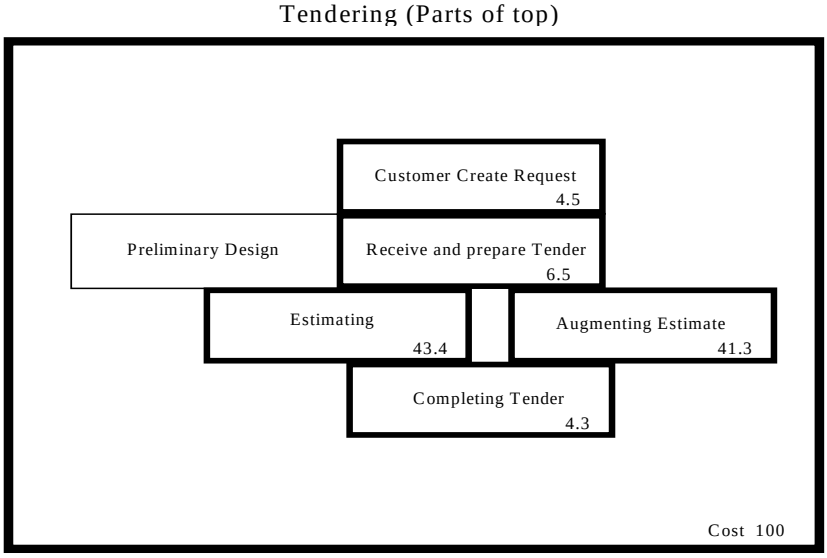

Figure 4: Structured Presentation (POSD) Model of Tendering

10. Issues: Mapping Between Models

In order to translate from one kind of model to another it is necessary to have a mapping mechanism. These mapping mechanisms range both in their level of formality and automation, from rules to translate RADs to CSP through to what are effectively compilers which take other role based diagrams and automatically produce RolEnact code. The detail of such mappings is the focus of other ongoing research within the PROCESS Project (see Abeysinghe and Phalp, 97). It is not the intention of this paper to elaborate these mappings but rather to present the overall method.

11. Conclusions

This paper has presented a method which formalises sensible modelling practise into a an integrating method. This method has evolved from experience of business process modelling. A key aspect of the method is that it allows the modeller to use a variety of notations, within a coherent framework. This means that notations may be used which are appropriate to modelling goals and tailored to the target audience. This allows for a more meaningful interaction between modellers and end-users.

Modelling activities are described in terms of three encompassing phases, Capture, Analysis and Presentation. The method, describes models which are suitable for each phase, and gives examples of suitable approaches. Hence, the modeller is guided through the modelling activity, without being restricted by a particular notational approach. An example business process (drawn from work on describing Construction

Industry business processes) has been used to illustrate the kind of models which would be produced in each of these phases.

A distinct advantage of the method is its wide applicability. The modelling method can be usefully applied by a wide variety of users using a range of notations and tools, from people employing simple technologies, to those employing state-of-the-art process modelling tools.

References

Abeysinghe, G.K. and K.T. Phalp (1997), Combining Process Modelling Methods, Information and Software Technology, Jan. / Feb. 1997, Elsevier Science.

Abeysinghe, G., Henderson, P, Phalp, K.T. and Walters, R. (1997a), RolEnact: Role Based Enactable Models of Business Processes. Submitted to Information and Software Technology. A version of this paper is available at: http://www.dsse.ecs.soton.ac.uk/~kp/working/RolEnact.doc

Abeysinghe, G., Henderson, P, Phalp, K.T. and Walters, R. (1997b), POSD: Process Oriented Structured Description and it's use within Process Modelling: available at: http://www.dsse.ecs.soton.ac.uk/~kp/working/posd.doc

Abeysinghe, G., Henderson, P, Phalp, K.T. and Walters, R. (1997c), Putting the Quality into Manuals, available at: http://www.dsse.ecs.soton.ac.uk/~kp/working/qaman.doc

Basili, V.R. and H.D. Rombach (1987), Tailoring the Software Process to Project Goals and Environments, in Proceedings of the 9th International Conference on Software Engineering, Monterey 1987, IEEE Computer Society Press.

CORE: COnstruction Companies Process ReEngineering: Home page at: http://iwi.uni-sb.de/forschungprojekte/core/core-e.html

Coulson-Thomas, C. (1994), Initiating and Preparing for Re-engineering, in Business Process Re-engineering: myth and reality, ed. Coulson-Thomas, C., Kogan Page.

DESMET (1994), Case Study Analysis and Design Procedures (CSDA), National Computing Centre Ltd (NCC).

GISIP (1995), GISIP Guide, Deliverable of the (GISIP) Best Practices Geographical Information Systems Integrated Processes Project, Esprit Technologies for Business Processes Project No. 20915.

Handy, C. B. (1976), On Roles and Interactions, in Understanding Organisations, Handy, C. B., Penguin Modern Management Texts, Penguin Books, 1976.

Henderson, P. (1995), Making Models of Process Support in Enact, November 1995, available at http://dsse.ecs.soton.ac.uk/~peter/cv.html.

Henderson, P, and Pratten, G. (1995), POSD - Process Oriented System Design, Jan. 1995, available at http://dsse.ecs.soton.ac.uk/~ph/cv.html

Hoare, C. A. R. (1985), Communicating Sequential Processes, Prentice-Hall.

ICL (1995), ProcessWise WorkBench User Guide, PWB/usrguide/S5.4, International Computers Limited, August 1995.

Ould, A. M. (1995), Business Processes modelling and Analysis for Re-engineering and Improvement, John Wiley & Sons.

Phalp, K. and M. Shepperd, (1994), A Pragmatic Approach to Process Modelling, Proceedings of the Second European Workshop on Software Process technology, Vilard de Lans, Grenoble, France, February 1994, Lecture Notes in Computer Science, Elsevier Science.

Phalp, K.T. (1996), Models to Support Business Process Change, available at http://www.ecs.soton.ac.uk/~kp/

Phalp, K.T. and Counsell, S.J. (1997), Counts and Heuristics for Analysis of Static Models, ICSE'97 Workshop on Process Modelling and Empirical Studies of Software Evolution.

PROCESS: Modelling and Mapping the Business Process, EPSRC project, home page at: http://www.ecs.soton.ac.uk/~kp/process.html

Rodden, T., King, V., Hughes, J, and Sommerville, I. (1994), Process Modelling and Development Practice, Proceedings of the Second European Workshop on Software Process technology, Vilard de Lans, Grenoble, France, February 7-8, 1994, Lecture Notes in Computer Science, Elsevier Science.

Scacchi, W. (1994), Business Processes Can be Software Too: Some Initial Lessons Learned, Proceedings of the Third International Conference on the Software Process, Reston, Virginia, October 10-11, 1994, IEEE Computer Society Press.

Tamai, T. (1993), Current Practices in Software Processes for Systems Planning and Requirements Analysis, Information and Software Technology, vol. 35, num. 6/7.

Yourdon, E. Modern Structured Analysis, Prentice Hall, 1989.