KBST: A Support Tool for Business Modelling in BSDM

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Abstract This paper describes a knowledge-based support tool for business modelling with IBM's Business System Development Method (BSDM). The tool, KBST, is designed to support the activities and capture the results of BSDM workshops, where senior business managers together with a BSDM facilitator develop business models. In this paper, we show how case-based reasoning techniques can be used to build domain specific knowledge into such a tool and how this can provide guidance in building appropriate business models. It is also shown that the application development package HARDY, a hypertext diagramming tool, provides a good platform for a BSDM support tool.

Key-words Business Modelling, BSDM, Enterprise Modelling, Hypertext, Knowledge-Based Support Tool, Case-Based Reasoning, Business Process Re-Engineering.

1 Introduction

IT systems which are built using traditional software development methods do not usually accommodate all aspects of a business in sufficient detail; non-IT aspects of companies are frequently left out during the analysis and design phases of a new system. This lack of a business-oriented view, which describes the context in which an IT system operates, often leads to great difficulties when cross-functional operations within an organisation must be supported, or when frequent changes within an organisation must be dealt with [2] [6].

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Business System Development Method (BSDM) was designed to address this problem by building a *business map* before commencing system requirements analysis. This map describes the entities and processes which define the fundamental business environment of a company. In addition to this *Map* activity, BSDM recognises and describes *Need*, *Shape*, and *Run* activities [5]. The latter three loosely correspond to traditional software engineering tasks, but are strongly influenced by the results of *Map*. Maps are constructed during workshops where a facilitator with BSDM experience encourages senior managers to share their views of the business. Typically, the diagram parts of the maps are drawn on white boards, using a variety of aids such as 'Postit' stickers, whereas the textual parts of the maps are written on separate sheets of paper.

BSDM is a commercially used method which helps company managers to understand and improve their businesses. A tool which can automate various aspects of modelling with BSDM is crucial for the efficient use of BSDM for the following reasons:

- It is not unusual that a business model includes several hundreds of components. It can, therefore, be rather difficult for the user to keep track of the model, unless appropriate cross-referencing functionalities are available.
- Diagrams in business models are frequently revised while the model is being developed. An appropriate tool can make editing of diagrams faster and easier.
- BSDM provides a set of standard sub-models which capture common business scenarios for many organisations. These sub-models are very useful for comparison with newly created models, or as guidelines for creating new models. An automated tool can provide easy access to these sub-models.
- Stylistic conventions recommended by BSDM methodologists can be incorporated in the tool; the tool helps the user to follow these conventions and correct the user whenever he/she uses non-standard constructions.
- The tool can be used to provide automatic validation and checking of a BSDM model.
- The tool can generate high-quality reports for analysis of the model.

In this paper, we are largely interested in a support tool for Map, since traditional CASE tools do not provide sufficient help for this initial enterprise modelling activity. The users of our support tool are expected to be both the BSDM facilitators (for editing, browsing and documenting of maps between and after workshops) and company managers (for browsing maps after workshops).

Case-based reasoning techniques are used to provide the user with intelligent support for his/her modelling activity. To be able to provide this support we

provide an underlying formal representation of the main BSDM elements and use this to analyse a business map developed by the user.

The rest of the paper is organised as follows. In Section 2 we present the motivation behind developing a tool such as a KBST and why we feel it necessary to apply AI techniques in this area. The objectives of our project are defined in Section 3. Section 4 gives a short overview of business modelling with BSDM. A description of the tool follows in Section 5. The particular aspects of case-based reasoning in this project are explained in Section 6. Section 7 provides an evaluation of the current state of the system and how well it addresses the issues described in Section 2. The paper is concluded in Section 8.

2 Motivation

Currently the documentation of BSDM maps is paper-based, i.e. no computers are used during the process of building a map; once the map is complete it is drawn with a drawing program. CASE tools provide some support, but they are designed for the activities during *shape*, thus the predefined working procedures and environment constrain the person working in *map*. This situation is considered unsuitable by BSDM experts in industry. What is needed is a package which allows the user — in general users are not computer experts — to view maps quickly and easily. Direct support for BSDM specific diagrams is needed. Furthermore, the items in a BSDM diagram are associated with textual information, which is currently stored separately from the graphical model. It is desirable to integrate the various views of the same business area within one application.

Although user friendliness and integration of different views within one package are important, they can be provided without the need of any AI techniques; a good hypertext system would suffice for this purpose. For any modeller it would, however, be of great benefit if the tool had some knowledge about BSDM maps and thus could provide intelligent support in the process of building a map.

One area in which the application of AI techniques looks promising is the reuse of generic models. Generic models describe certain kinds of scenarios which are common to many businesses. The similarities of these scenarios are reflected in the corresponding business maps, i.e. they have the same or similar structure. IBM provides a set of generic models which help the modeller to develop and analyse his/her own model (business map). To take advantage of this library of generic models it is necessary for the tool to have some understanding of a map, so that it can make useful comparisons between existing generic models and newly designed user models. We believe that the best way of building this kind of knowledge into our tool is to apply case-based reasoning techniques.

3 Objectives

The primary objective of this study was to develop a prototype support tool for BSDM business modelling to test the applicability of case-based reasoning techniques in this field. A second issue was to investigate how well such a tool can be developed using the application development package HARDY [8], a hypertext diagraming package with the expert system language CLIPS 6.0 embedded in it [1].

We aimed at providing a tool which provides the following benefits to the user: 1) easy and efficient diagramming of BSDM maps, 2) integration of graphical and textual data, 3) alternative viewing of the same data, 4) quick referencing of data, and 5) analysis of user models based on a library of generic models.

As a primary design goal we tried to keep the look-and-feel of the tool similar to the BSDM paper forms currently in use. This should enable users to become more easily familiar with the tool.

In Section 7 we will return to discuss how well these objectives have been achieved.

4 Business System Development Method

In BSDM, before the actual analysis and design of a system, a business map of a company is developed. This map describes the fundamentals of a business; it is not specific to matters of IT. The map should present a stable and global view of the company. Building such a model requires upper-level management of the company to participate in one or more BSDM workshops. These workshops are typically organised and held by an expert business modeller and facilitator.

A business map includes two aspects: entities and processes [3] [4]. An entity is a class of things which the business needs to manage. The entity model describes entities and the dependences between them. The process model reflects business processes and the long-term policies of an organisation. A process may include several entities and the corresponding dependences in its scope. Within this scope, the business rules to create or change occurrences of included entities are described. BSDM uses diagrams to visualise such business maps. An example of a BSDM map, as it is displayed in KBST, is shown in Figure 2.

[1] HARDY was developed at the Artificial Intelligence Applications Institute (AIAI), The University of Edinburgh.

5 Knowledge-Based Support Tool for BSDM Modelling

5.1 System Overview of KBST

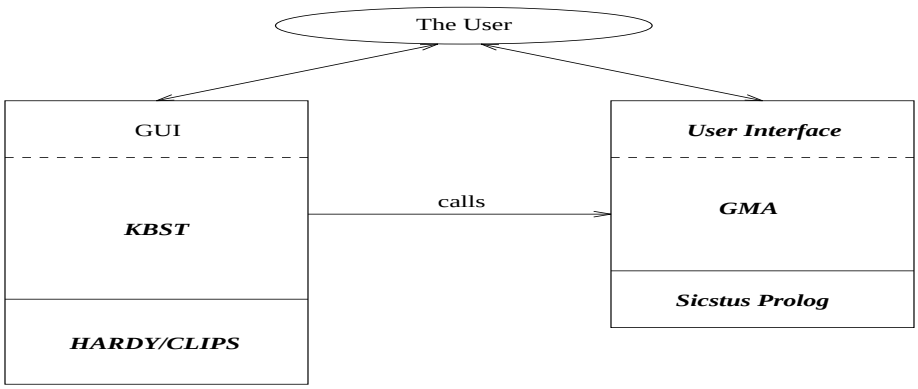

Figure 1: The System Overview of KBST

The prototyped BSDM modelling tool described in this paper contains two primary components: KBST and GMA (Generic Model Advisor). KBST provides user support for creating and viewing BSDM business maps. GMA is our case-based reasoning engine for further analysis of these maps. Before GMA is introduced, the overall design and functionalities of KBST are given in this section. Figure 1 shows the system overview of KBST.

5.2 Representation of a BSDM Model

The fundamental task of KBST is to capture the conceptual and textual information in business maps. KBST uses blue[2] rectangular boxes to represent *entities*, grey rectangular boxes to represent *processes*, clear rectangular boxes to represent *alternative parents* [3] and clear rounded rectangular boxes to represent *common dependences*. A *dependence* is represented as an arrow between boxes. Small, yellow rectangular boxes are used as notes or labels — similar to "postit notes". These notes are not part of BSDM's notation, but are commonly used during a BSDM workshop by the facilitator to record comments on the model which do not belong to any particular BSDM object [1]. The detailed meanings of BSDM notations are beyond the scope of this paper, the interested reader is referred to the BSDM manual [5].

[2]KBST makes extensive use of colours for better clarity of diagrams. Since no colour text processing is available for this paper, these colours cannot be shown.

[3]A construct used during the initial stages of modelling.

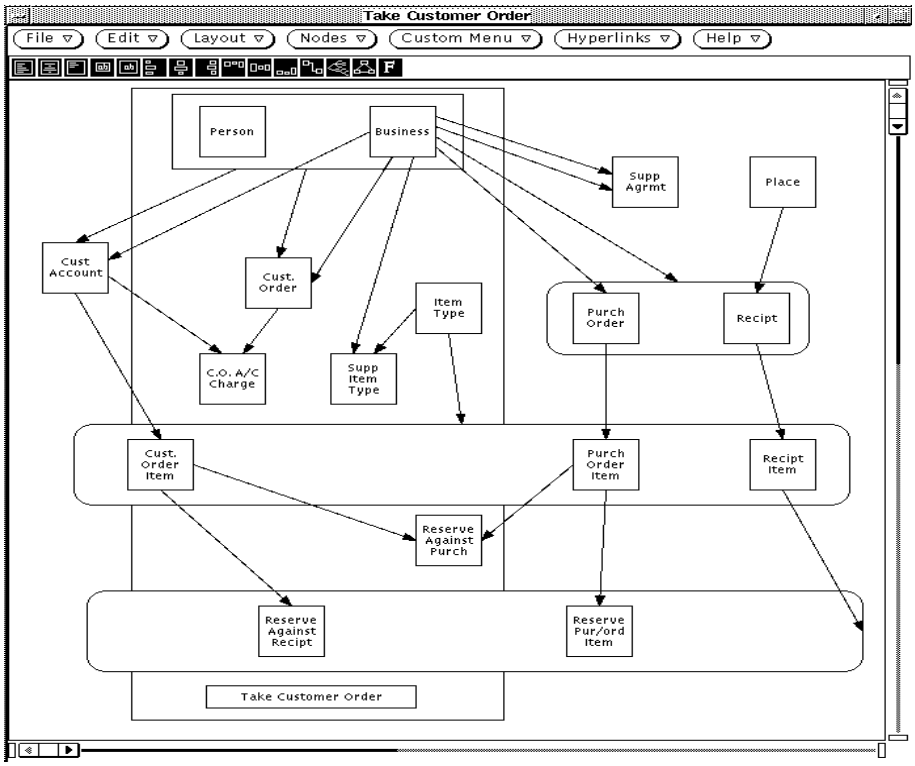

Figure 2: A BSDM Map

KBST allows the user to create, manipulate, view, search and store BSDM models. A corporate business map is typically built for one business area at a time, and each business area is presented in a view of the overall model. Figure 2 gives an example of a view of a business map in the business area of supply and distribution. All small rectangular boxes are entities, arrows model dependences, the large rectangular with the label "Take Customer Order" inside models a process. This map captures information such as the parties placing and receiving orders, the accounting for orders, and the type of items requested. The map shows that there may be business organisations that wish to place orders with this company, and business organisations from which this company may have to purchase supplies to satisfy customer orders. The aspects of taking a customer order are included in a process called "Take Customer Order". The entities to the right of this process deal with matters of purchasing from a supplier. The arrow from the "Business" entity to the "Purch(ase) Order" entity, for example, reflects the fact that purchase orders have to be placed with a business organisation known to the company. There are several rectangulars

around groups of two or three entities. These are used to described so-called *common dependences* and *alternative parents*, the meanings of which are beyond the scope of this paper. The interested reader is referred to the BSDM manuals [5].

5.3 The Use of KBST to Support BSDM modelling

User Friendly As many BSDM modellers are not IT specialists, much effort was devoted to making the tool as user-friendly as possible. The underlying data objects are represented in their nearest form in the original BSDM method. All operations within KBST are mouse-menu-window activated by the user; on-line help and work progress messages are also provided for the user.

Manipulation of Data and GUI The first step in building a BSDM business map is to create a BSDM window, or a BSDM "card"; this can be done with only a few mouse/menu operations. The user can then create entities, processes, dependences, etc., through KBST's "Nodes"-menu.

There are several forms used in KBST which are the equivalent or extension of BSDM paper-based definition forms: Entity Description Form, Attribute List Form, Attribute Description Form, Process Description Form and Process Scope Description Form. These forms are presented and manipulated by KBST through its GUI; their data are accessed by direct mouse-menu operations on the desired object. Clicking on an object in the map activates Clips functions which are built into KBST. These functions control the access to object specific data via additional window interfaces. For example, clicking on the process "Take Customer Order", in the map shown in Figure 2 opens up a new window (figure 3) which contains the "Process Description Form" [4] for this process. We will not discuss details of this form here, because it is beyond the scope of this paper and would require us to explain BSDM in more detail.

Other Functionalities Additional functionalities were also implemented: e.g. a Card Browser which consists of a catalogue of all cards in KBST; a *card* is a window which shows a section or all of a map. These cards are alphabetically ordered by the card name and the card can be shown by simple mouse activation from the catalogue.

An entity can exist in multiple processes and cards. An Entity/Process/Card searcher allows the user to search for all processes and cards in which a particular entity is included. This is particularly useful, since it allows the user to view the same data (e.g. for an entity) in different contexts.

[4] The Process Description Form of KBST contains more information than a BSDM Process Definition Form. It also provides information about the process scope which can be seen by the user if they push the button "Process Scope Description" in figure 3.

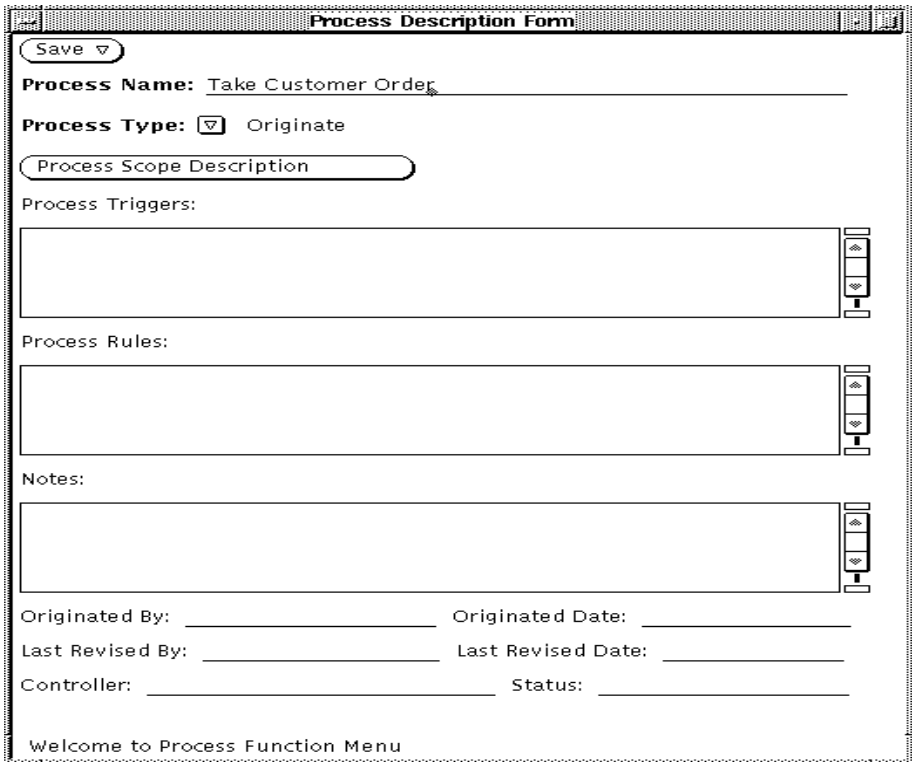

Figure 3: Process Description Form

A selected part or the whole of the stored textual and graphical information in KBST can be printed out to hard copy. A user BSDM model can be exported for further usage in GMA.

6 Generic Model Advisor

Companies, particularly within the same industry sector, exhibit similarities in their fundamental structures and processes, and hence, common elements are found in the corresponding BSDM models. IBM provides a set of generic BSDM models which can be reused or used as a reference for comparison with new models. We decided to develop a tool which makes these generic BSDM models available to the user, and analyses the user's model with respect to existing generic ones. By providing this facility, we hope to encourage good modelling practice and provide automatic analysis of models. The user can also explore why his/her model is different from the generic ones.

A Generic Model Advisor (GMA) has been implemented to take advantage

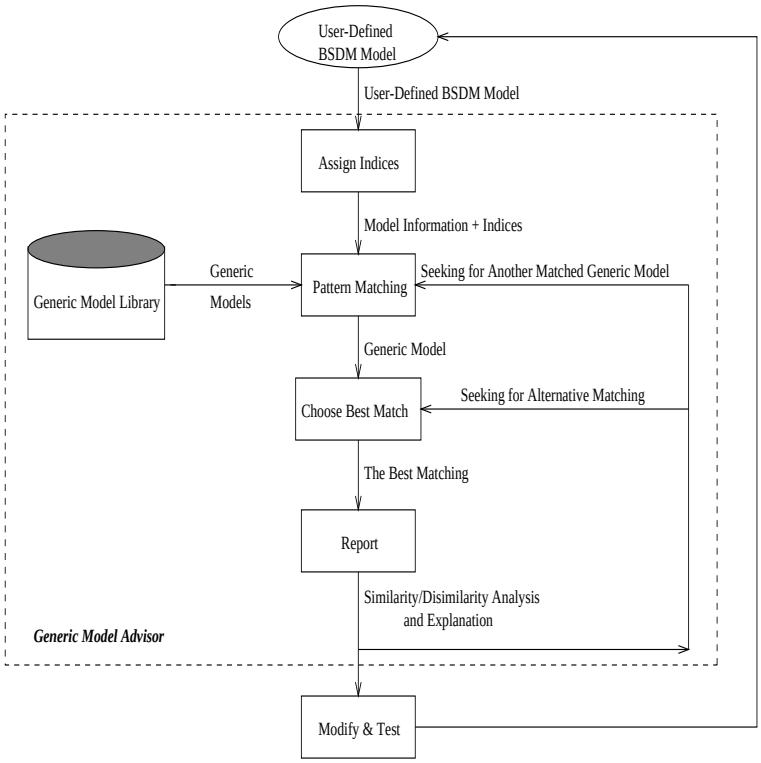

Figure 4: Architecture of Generic Model Advisor

of these generic BSDM models [1]. A Generic Model Library (GML) was built to store these models. Figure 4 shows the architecture and flow of GMA which resembles that of a typical case-based reasoning engine [7]. Given a user model, i.e. a business map, one view of this model is selected at a time and indices are identified and assigned to objects in that view. Those indices are then compared with indices of generic models in GML. A pattern matching algorithm in GMA is used to match the user and generic models. GMA then retrieves generic models with sufficient similarities from the GML and provides a comparison between them. It generates a report about how well and which parts of the user model match which parts of the selected generic model. If more than one possible match exists, the best match is described first. Suggestions for modification to the user model are also provided to the user, if appropriate. This kind of analysis enables the user to better understand his/her model and to identify possible omissions or errors in the user model.

6.1 Indexing and Entity Hierarchy

Indices are used to distinguish cases in the case memory and to find appropriate matches between a given problem and previous cases. In the context of GMA, these indices must describe the differences and commonalities between BSDM models. For example, simply looking at the name or the graphical representation of a model is not sufficient to identify the common features of BSDM maps, since changing the name or position of symbols does not alter the information contained in it. For a more meaningful comparison of maps we use the entities and dependences between entities as indices. To be able to deal with different levels of abstraction between specific user models and generic library models, an *entity hierarchy* is used.

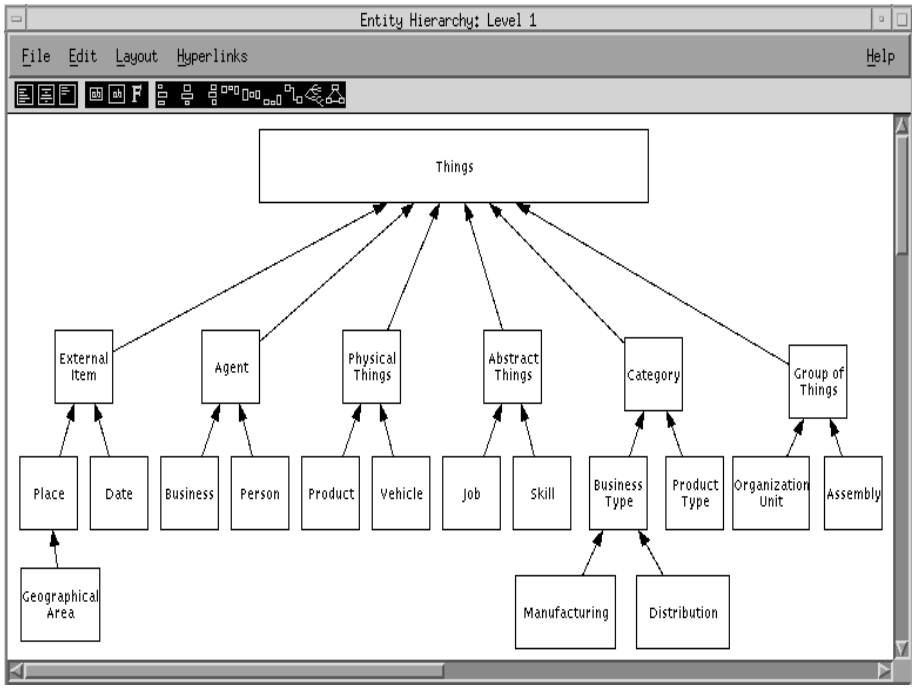

Figure 5: The Generic Entity Hierarchy of the Top Layer in an Entity Model

This entity hierarchy captures the *is-a* relationship between entities in BSDM maps. For example, manufacturing is a kind of business type which is a kind of category that the business manages. Such knowledge allows GMA to map the Manufacturing entity of the user model to the Business Type entity of the generic model. Hierarchies don't have to be tree structures: an entity at one level of abstraction may have an *is-a*-relationship with more than one entity at a higher level. Generic models are typically expressed in terms of dependences

between entities of higher abstraction, while user models often involve entities of lower abstraction.

Figure 5 shows the entity hierarchy which contains the suggested entities for the top layer (level 1) of a BSDM map. Rectangular boxes represent entity types which can be used in a business model. An arrow from entity B to entity A indicates an *is-a* relationship from B to A, i.e. B *is-a* A. Following the direction of the arrow, GMA can match an entity in the user model, Manufacturing, to an entity in the generic model, Business Type.

6.2 Pattern Matching Algorithm

As explained earlier, the dependences in entity models are the basis for matching two models. Two dependences match if their child and parent entities match. Two entities are matched if either they are of the same name, or one is the other's ancestor in the entity hierarchy. GMA's pattern matching algorithm tries to find a match for each dependence in both models: user model and generic model. GMA keeps track of which dependences of these generic models can be matched, and how the match was achieved. This information is later on used to determine the quality of matching.

When a generic model is retrieved from the library, the various possible matches between the generic and the user model must be evaluated. For each matching possibility a measure of similarity between the two models is computed; the most fitting match is presented to the user first.

When comparing two matches, GMA prefers the one which matches all dependences in the user model with dependences in the generic model, i.e. a complete match. This is desirable, since all aspects of the user model are also represented in the generic model.

If both matches are complete matches, GMA looks next at how well the generic model has been matched to the user model, i.e. it chooses the match which includes the most dependences of the generic model. This is an important property since more than one dependence in the user model may be mapped to the same dependence in the generic model; it can happen that two different entities in the user model are mapped to the same, more abstract, entity in the generic model.

If both matches are partial matches, then the ratio of correspondence (Rcor) is used as the next criterion. Rcor is the ratio of the number of matched dependences and the number of unmatched dependences in the user model. If the two matches have the same Rcor value, the match which has less unmatched dependences in the generic model is chosen.

The highest scoring match is presented to the user first. Since the algorithm is heuristic, this may not be the most suitable generic model, but it is capable of backtracking to generate alternatives. Since the algorithm is comparatively simple, it is easy to explain to the user why a particular choice has been made.

6.3 Report and Explanation Facility

GMA produces a two-stage report for its matching results. The first part of this report informs the user about how many dependences of the user model could not be matched in the generic model. It also tells the user the number of dependences in the generic model which could not be mapped to the user model, as well as the ratio of correspondence (Rcor) of the match. This overview gives the user a good idea how well the user model and the generic model match each other.

The second part of the report provides the user with the matching details. It gives the name of the selected generic model and describes which dependence in the user model was mapped to which dependence in the generic model. Furthermore, it describes which dependences in both models could not be mapped.

In addition, simple explanations are given why the models could not be matched. For example, it may be the case that no corresponding entities existed, or even though matching entities were found, no corresponding dependences were found. This could be a hint to the user that he/she may have left out an important aspect in the user model.

7 Evaluation and Lessons Learnt

KBST was developed on Unix workstations using X and Motif, and on PCs using Microsoft Windows (Version 3.0 and 3.1). With the exception of the generic model advisor which was implemented in Prolog, all KBST code was written in CLIPS.

An alpha version of the system has been completed. This includes a faithful representation of BSDM maps, i.e. the look-and-feel as well as the computational representation of the maps closely match those in actual use today. The user interface allows the user to quickly create, browse and reference these maps.

A generic model library has been put in place and used as the case library for GMA, our case-based reasoning engine. Although the library currently only contains a subset of the full library provided by IBM, it has been successfully used by GMA for analysing sample user models. We have shown that by using case-based reasoning it is possible to build domain specific knowledge into a support tool for business modelling. In our specific case it helps the user to use generic models to 1) analyse and correct a given user model, and 2) suggest possible models for stereotypical situations.

BSDM is a commercially used method which helps company managers to understand and re-engineer their businesses. In order to apply BSDM efficiently, the use of an automated support tool is necessary. The use of HARDY as the basic application development platform has proved useful for such a tool. It allowed us to provide an easy-to-use and flexible user interface. It also supported the integration of textual and graphical data. KBST enables the user to analyse

a business model and understand the inter-relationships between its various components easily. Furthermore, the user can test his/her hypotheses with regard to a particular business area. At this stage, we felt that it was easier to implement a case-based reasoning system using Prolog than using CLIPS. A better integration of GMA into the tool is desirable.

We are currently working on a beta version of the tool which will then be tested during actual BSDM modelling engagements.

8 Conclusion and Future Work

In this paper, we have presented a prototype of a knowledge-based support tool for business modelling with BSDM. We used case-based reasoning techniques to exploit stereotypical problems in building business models. Our work has shown that building domain specific knowledge into such a tool can be of great benefit to the user.

The hypertext diagraming tool HARDY was used to implement most of the tool. Due to its diagraming features it proved well suited for the graphics oriented requirements of a BSDM support tool. Since HARDY is integrated with a CLIPS programming environment, it was also relatively easy to include BSDM-specific functionality in the tool.

We are currently looking at the possibility of building BSDM semantics into the tool which extends beyond the exploitation of generic models. To do so we are looking at ways of formalising BSDM and to create logical models of maps which we can then use to reason about their correctness and to simulate certain business scenarios.

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