A Generic Business Modelling Framework for Integrating Organisational, Social and Information Systems Concepts

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Abstract

Designing contemporary information systems is a process aimed at the efficient integration of people, technologies and procedures. Organisational and social implications of a (re)designed system need to be addressed at an early stages of development. The work presented here provides a general and flexible business model specification environment, the BMSA (Business Modelling System Architect) framework, which can be used in conjunction with various methods that deal with enterprise requirements analysis in a pluralistic and integrated fashion. The BMSA approach is founded on three basic premises - (a) organisational modelling and work design, (b) modelling the business process and (c) automated tool support. These issues are bound together by a set of design principles. The BMSA conceptual foundation is based on the UML notation. This allows interfacing with other development methods and tools. The supporting tool comprises of the following systems - the Repository System, the User Interface System and the Picture View System. At the heart of the tool is the Repository. The proposed framework is flexible in terms of standardisation, independence, reuse and future expandability of models.

Keywords: *organizational modelling, work design, business modelling.*

1. Introduction

Business analysts are being asked to develop increasingly complex and varied information systems, that need to cater for the changing and dynamic market conditions of the new economy. Formal approaches as well as modelling tools incorporated in CASE technology are being used to aid the business modelling activity, leading to a high level of specification. The right specification enables user's understanding, control and guidance in the development of the system. However, recent failures in the business process design/reengineering and advances in computer and communications technology have led to a

critical reappraisal of these design methodologies. Failure to pay due attention to human and social factors is regarded as one of the main reasons for failure. Indeed one of protagonists of BPR Thomas Davenport has described it as "the fad that forgot people". Many commentators argue that organisational and social implications of a designed system need to be addressed at the early stages of development. The approach presented here advocates generation of modelling specification in close cooperation with analysis methods in a more pluralistic and integrated fashion.

Modelling is a central activity in the process of *requirements specification*. Requirements Engineering (RE) processes aim at producing a correct, complete and consistent business process and system specification that will cover all aspects of the area under investigation. In order to be able to elaborate on any changes within an enterprise, RE conceptual models must reflect on organisational, social, operational and technological facets.

The BMSA approach is concerned with a set of formal meaningful perspectives of the system for the purpose of business process modelling. The approach has been influenced and benefited from findings and experiences of organisational design, social approaches, workflow technology and business engineering approaches of Buchanan (1985), Handy (1985), Katzenbach and Smith (1993), Wilson & Roselfeld (1990). The organisational paradigms provide useful foundations for concepts to describe organisational structures, behaviour and collaborative work, although, the majority of these methods can be viewed as a way of thinking and modelling rather than a way of working or controlling. A set of design principles that bounds all issues together is presented. Furthermore, interactions between the framework proposed and other approaches is proposed. At the meta-level, BMSA is expressed in Unified Modelling Language (UML) notation. UML is emerging as a de-facto standard meta-language used for production of specifications. It is particularly useful for BMSA in that it enables close integration with other methods and makes development of supporting tools based on common generic concepts.

This paper is organised as follows. Section 2 will discuss the role played by organisational factors that underpin the BMSA approach. Foundations of the BMSA approach are in Section 3. Section 4 gives small examples. Section 5 outlines design and implementation of the tool. Section 6 summarises our findings and gives conclusions.

2. The Need for Organisational and Social Embedding.

Recent new practices and research in RE are directed towards overcoming the excesses and failures of the business modelling methods and tools of the nineties. Apart from their *complexity*, organisations are increasingly *dynamic* as they seek to rationalise, innovate and adapt to changing environments. A continuous process-oriented renovation with the help of IT is sought in order to improve efficiency and competitiveness. In a modern working environment enterprises may find their work being distributed at various locations. Issues such as enterprise integration, co-ordination and control come into play. The emphasis of RE approaches therefore, needs to shift from the 'system' view to wider context-based 'business' view of the organisation. Issues of organisational structure, culture, communication between people, user’s level of skills and motivation are all important factors

that need to be taken into account if the business project is to succeed. Despite the large number of available business analysis and modelling approaches, users and developers continue to experience difficulties.

Many of the business modelling approaches continue to focus on functional requirements without paying sufficient attention to the other non-functional issues. The result is a final product, which is unsatisfactory and fails to comply with the business objectives of its users. One of the reasons behind their failure and shortcomings is the fact that the role of the human and social dimension that affects the design process and the design product have not been fully represented. Issues of organisational structure, culture, communications between people, user's level of skills and motivation are all-important factors that need to be taken into account if the business project is to succeed. The conventional business methods do not have many (if any) formal representations for these issues. The above are either ignored or it is assumed that analysts keep notes of the relevant factors somewhere at the back of their mind, as they examine and evaluate the relevance and importance of the various organisational and human factors from the business perspective. This implies that he/she uses some way of thinking, rationalising and evaluating in order to reach the correct decision. This has motivated new research, which is attempting to capture the emerging rational cycle in some form of formal representation. This way of thinking is finding it's way in the modelling areas. Frameworks now adopt conceptual formalisms to represent a number of elements capturing the organisational and human environment, e.g. relationships between agents, viewpoints integration, links to organisational objectives, etc.

From the above it is evident that there is a need for computer-assisted modelling techniques that capture various perspectives of the business process development. Current technology already incorporates some facilities by using conceptual models, thus taking advantage of the formality and unambiguity that the models offer. This may not be enough. To improve and facilitate the communication between users and analysts and to relate to change, the BMSA approach advocates that many benefits can be accrued by the application of the proposed techniques in the modelling process, thus integrating the formality of the business process modelling concepts with requirements engineering methods.

The majority of the business process design projects considers or implies some sort of *'organisation change'*. Apart from restructuring changes other themes come into the picture. In a modern working environment enterprises may find their work being distributed at various locations. Issues such as enterprise organisation, co-ordination and control come into play. The emergence of new patterns of work is being seen in enterprises. Generally, an analyst is trained in the so called 'hard' approaches and concentrates on designing (or reengineering) aspects of the business process, which do not devote much importance to issues of organisational behaviour and the implications of the new changes. In such cases the analyst has to rely on his/her skills and intuition.

3. Foundations of BMSA.

The BMSA approach is a combination of 'hard' facts of modelling moulded with 'soft' insights of the modelling process. It is founded on three basic tenets (as shown in Figure 1): organisational modelling, process modelling and tools development. The BMSA framework may interact with other frameworks from areas of RE and IS development. BMSA is a modelling conceptual framework, it is not a method or a methodology. It contains generic meta-constructs that enable the production of specifications as needed by other approaches or frameworks. The business model produced can be used as a basis for defining the requirements of information systems.

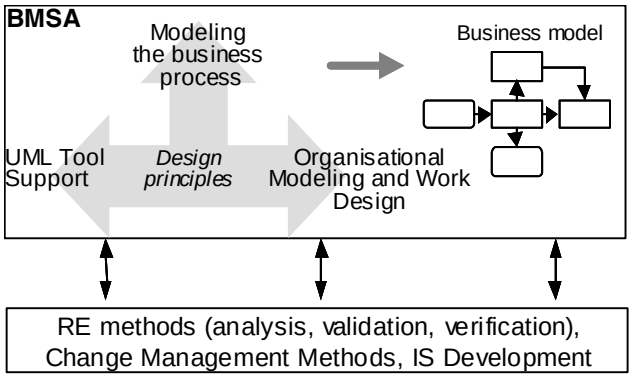

Figure 1. Foundations of BMSA framework

One of the main objectives of the BMSA approach is to provide effective and flexible conceptual modelling formalisms for a structured way of representing the enterprise knowledge. The models are formal, executable and contain a comprehensible representation of the business process, and can be used to represent the dynamic and complex reality of the enterprise. The BMSA models can be used by various applications. For example, models can be used in analysis of change. Production of a design model of the current situation allows the analysis of the business process of an organisation. The qualitative problems of the enterprise may then be captured and evaluated by the quantitative representations. Together with the examination of the models of the current situation a possible set of solutions can be suggested. Experimentation and evaluation with models of possible future solutions and comparisons with models of the current situation, allows for an effective solution to be found. Such an approach allows it to be tested using a simulated solution prior to its real-life implementation.

The BMSA meta-model is made of four logical sub-models known as packages, as show in Figure 2. A package in UML is defined as a general-purpose mechanism for organising elements into semantically related groups. These are the *Task Model*, the *Resource Model*, the *Organisational Model* and the *Business Rules Model*. Other sub-models maybe added by the user as required such as the goal model and the information systems model. (We assume that any state of the art model is suitable). The basic meta-model of business modelling concepts in BMSA is given in Figure 3.

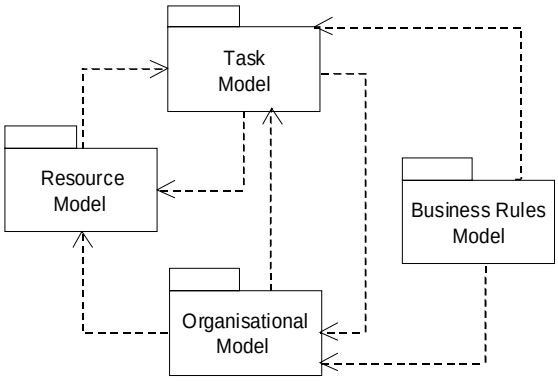

Figure 2. Top-level UML packages in BMSA metamodel

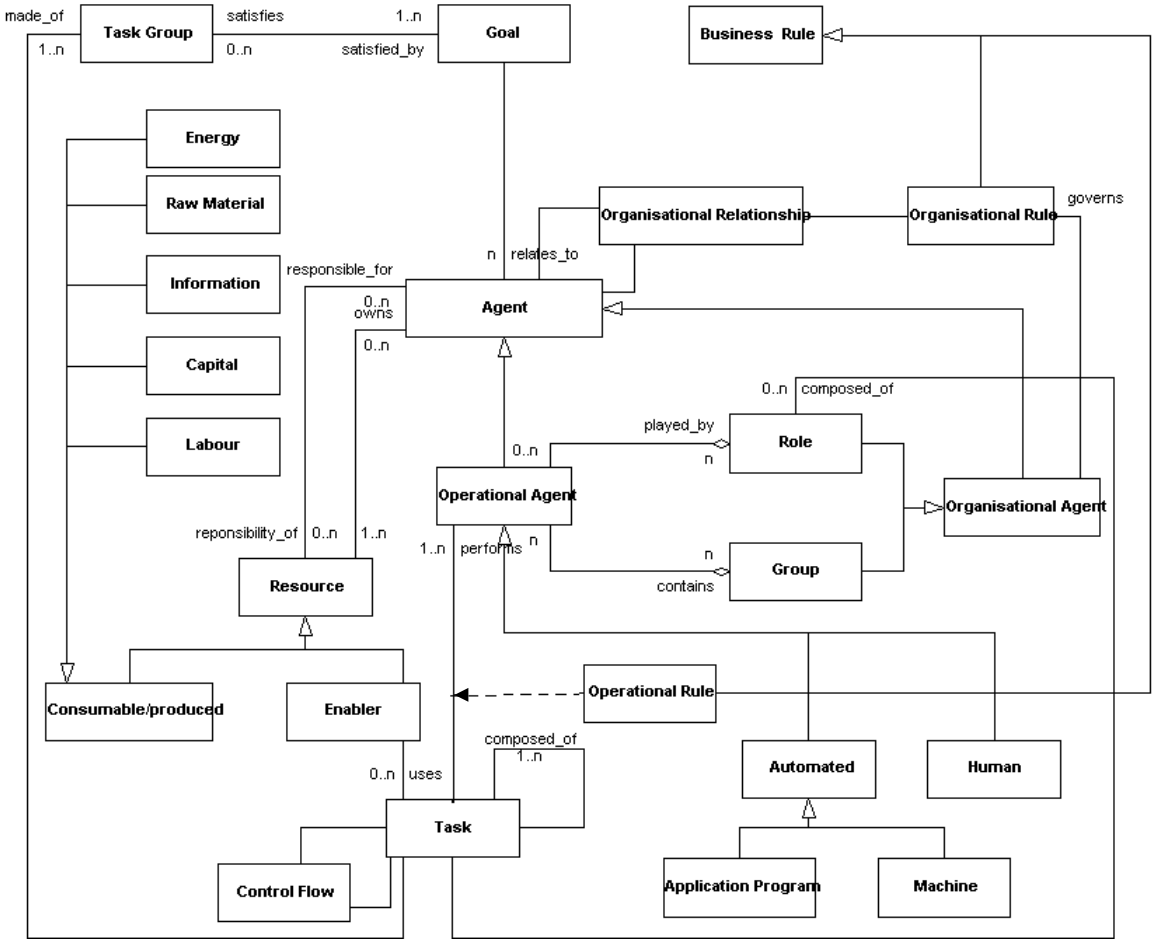

Figure 3. BMSA meta-model

The *Organisational Model* represents organisational constructs and their inter-relationships. The organisational constructs can be used to represent humans, groups, divisions and automated agents. The inter-relationships represent various types of relations between the organisational elements. For example, relations between agents in terms of responsibilities, authorities, dependencies and ownership can be expressed.

The *Task Model* provides for purposeful representation of the enterprise's activities. Tasks are grouped together in accordance to the goal that they are trying to fulfil. The dynamic aspects of the model adopted many concepts from the workflow technology (WfMC). This makes this model more powerful than the traditional process model, which allow tasks ordering and synchronisation and a limited predefined assignment of actors/agents to tasks. This model goes further in way that it allows modelling and simulation of execution type situations. The task design process is carried out in close co-operation with the organisational design process. The enterprise's organisational setting must be consulted in order to identify the future work teams, role players and agents who will be able to perform these tasks.

Within the business process environment a generic term 'resource' is used to combine all types of resources. The *Resource Model* presented is generic. Refinement and identification of resources is domain dependent, and can be further carried out in more detail at a lower level of analysis as required. We classify resources in accordance with their consumption, generation and use. Tasks depend on resources for their execution. Each individual task consumes and generates some resources. The workflow of task execution directly depends on the input and output flows of resources to and from the task respectively.

The modelling specification activity is controlled and guided by the constraints imposed by the policies and rules of the organisation. Business rules help to formalise and document the knowledge about the enterprise domain. The rule-based paradigm is commonly used for modelling the business policy of the enterprise. It has been used to carry a formal analysis of mapping concepts from enterprise to information systems. The *Business Rules Model* further expands previous definitions to accommodate new concepts arising from organisational modelling, which is carried out as part of a business process definition and execution-type rules adopted from workflow technology. The OCL (Object Constraint Language) can be used to specify constraints and invariants on modelling concepts such as classes, collaborations and states. OCL concepts can be adjusted to be used in representing policies and rules, as is seen in some recently emerging work such as in Eriksson (2000).

The use of the BMSA framework follows four design steps. These are outlined below and represent a synergistic approach based on a number of relevant disciplines as seen in works of van Meel (1993), Mumford (1995), Cherns (1987).

Design Principle 1 - establishing process boundaries

This principle is concerned with establishing business process boundaries in an enterprise. The traditional boundaries are complex and are based on many control and hierarchical principles within an organisation. Boundaries can be located based on functionality, market, location, etc. We use the notion of "cross-functional" business processes, where process tasks

are linked across boundaries in order to effectively fulfil a business goal. The advantage of using this approach is that it removes many unnecessary links, flows and approvals between the departments or working units. By having business units in place it will be possible to determine the IS design requirements and the type of supporting technology required, i.e. client/server, internet/mobile architectures.

Design Principle 2 - designing the working groups

Once the process boundaries are established, the next stage is to organise the working environment. In terms of organisational design, the social approaches advocate a group-oriented production. The term refers to the number of tasks buffered together and allocated to individuals or groups. Such "autonomous working group" acts as a building block of the design. Generally, people are grouped together according to the necessary skills. The group is usually comprised of trained multi-skilled workers performing a variety of tasks. The concepts involved in work organisation are based on the principles suggested by the socio-technical design discipline, in particular in the works of Mumford (1979). Benefits of teams, their types and criteria for success are widely described by the BPR discipline. The concept of "team-oriented" information technologies is introduced. It emphasises the synergistic relationship between technological and human/organisational enablers of the processes. Information systems design provides a means of task automation and coordination. Automating the working environment of each employee through the provision of access to a personal workstation allows these systems to be designed to accommodate a variety of tasks to fit in the overall group-oriented division of labour. With the help of IT/Internet/communication technology coordination and control of the collaborative work among various groups/individuals crossing many locations and time boundaries can be established.

Design Principle 3 - establishing control methods

Traditionally control aspects over task executions have been built along hierarchical structure. Allocation of primary and control tasks to various players together with complex hierarchical management structures may hinder response time of the enterprise to external factors. The aim is therefore to create a net of self-regulating groups that can undertake decision-making local to the business process. Control aspects are built into the execution of primary tasks as explained in the work of van Meel (1993). The purpose is to create self-regulating subsystems that can make decisions on the control aspects of a business process. A number of social and BPR approaches call for a decentralisation of decision-making process as much as possible. This kind of arrangement passes the responsibility for control and regulation of tasks to an autonomous working group or individual (e.g. approvals, authorisations). From the viewpoint of the information systems a well-planned cross-functional management information system may be required. Such system will rely on communications technology thus providing access to information external to the group and is integrated within an enterprise-wide network.

Design Principle 4 - relating design artefact to design process

The design principles should be applied recursively to both the *design process* and the *design artefact*. (In our case the *design artefact* refers to the business model specification, and the

design process refers to the RE analysis method that is driving and controlling the business specification production.) This implies that any future design product, which advocates self-control and self-regulation on the part of its members, must be reflected in the design process. An approach advocating participation of futures players of the design product in the design process seems as logical as inevitable. If in the future, newly redesigned organisational structure (design product) suggests a self-regulating empowered working groups then the design methods are geared at structuring a creative participative design process rather than being prescriptive. Cherns (1987) describes this principle as the "compatibility principal" between design products and processes. While realising the benefits of this principle, the designer should be aware of other issues that arise in relations to interactions between various individuals and groups, inability of users to verbalise knowledge, providing incorrect knowledge, being unaware of the knowledge, etc. These issues have been addressed by RE disciplines.

4. Modelling with BMSA.

In this section we demonstrate the use of modelling concepts in the production of an example specification. As mentioned earlier BMSA leads to a production of specifications (way of modelling) in conjunction with other methods (way of working). For example, change methods dealing with transformation of business processes and re-engineering of information systems will benefit from modelling specification given. In case of the transition of high-level requirements to systems supporting these requirements a suitable approach has to be used, such as EKD in Loucopoulos (1997). It consists of an integrated set of techniques and interrelated methodological components. At the centre of the approach is the development of enterprise knowledge models pertaining to the situations being examined. The definition of such models is carried out using appropriate modelling techniques and tools. In this case the BMSA meta-modelling framework is suggested. For example let us consider some utility corporation which is undergoing change. A change design methodology will be applied to drive this change. In order to be able to analyse and reason about current and future situations a business model specification is needed. The analytical framework will therefore be represented by *way of thinking* (the design rationale), the *way of controlling* (RE processes), the *way of working* and the *way of modelling.* The BMSA framework falls under the *way of modelling.*

The following are small examples of possible models. Let us consider an example of dynamic task modelling. Figure 4 shows the dynamic activity model for the business process "`Service request for Installation construction`". The control flow represents execution by showing how work flows through the model. This is accomplished by representing units of work as tokens that flow through the activity diagram. It can be seen that the tasks "`accept offer`" and "`refuse offer`" are carried out alternatively. The tasks "`receive deposit`" and "`sign contract`" on one hand and the "`create service order`" on the other hand are carried out concurrently.

The BMSA approach allows organisational model constructs to be used to represent any type of organisational structure. Figure 5 shows traditional hierarchical organisational structure that can still be found in many organisations. The structure of the future organisation should reflect new types

of cross-functional processes. This implies that working groups encompassing individuals across the boundaries of traditional structure are being created. These new working structures have been labelled 'Business Units' as shown in Figure 6. A Business Unit may contain other working groups and interactions. A number of Business Units have been suggested. For example, the "`Distribution Business Unit`" has two divisions- the "`Supply Division`" and the "`Network Division`". Examination of the "`Supply division`" gives details on the roles required within this division, the personnel, their relationships and particulars. All constructs can be assigned to the corresponding elements of the meta-model in a similar way as shown in Figure 5.

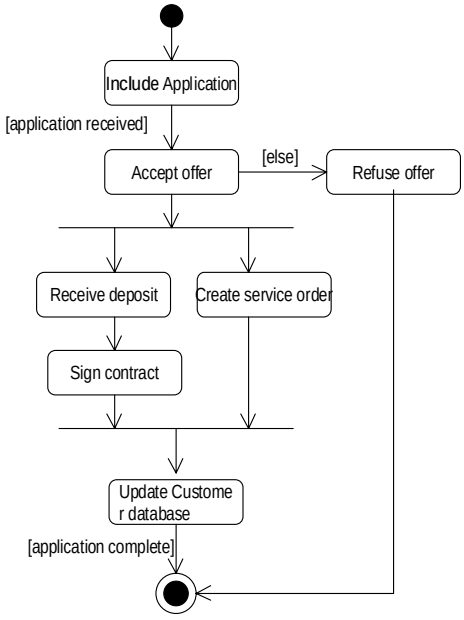

Figure 4. Example Activity Diagram

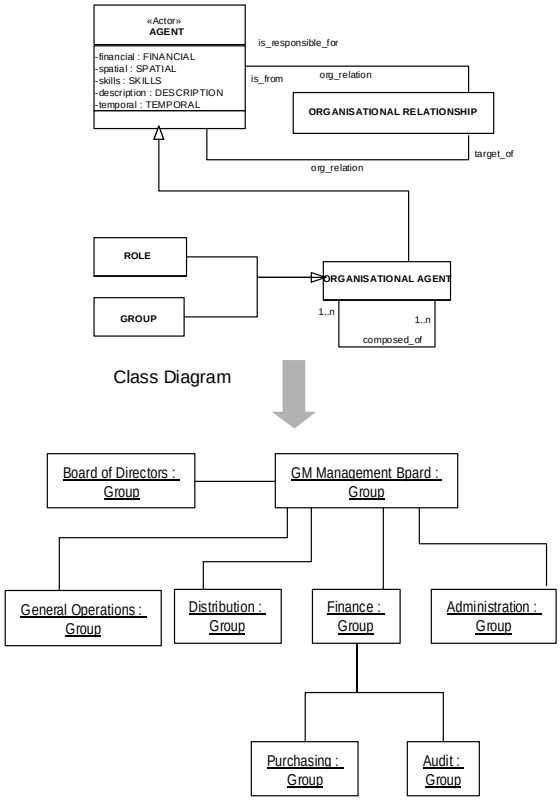

Figure 5. Organisational Structure model

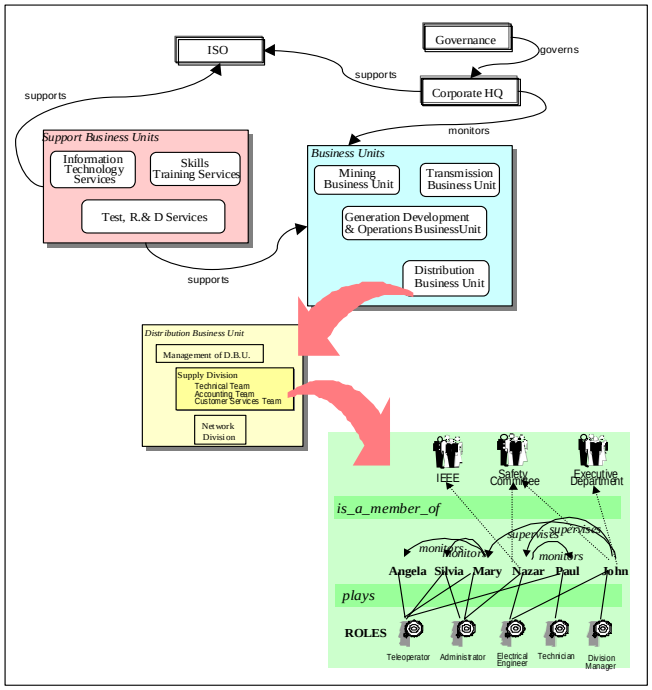

Figure 6. Working Group structures in organisation

5. Architecture of the BMSA tool.

The BMSA system must be able to provide support for combining the repository-based metamodel representations with the graphical presentation of the views in the scenario-type form. The architecture of the BMSA system is depicted in Figure 7.

There are three main components - *The Repository System*, *The Views Engine* and *The User Interface System*. The core of the system is *The Repository System*. *The Repository System* provides mechanisms for handling and storing the information regarding the metamodel, models and application's data. The repository acts as a source of information for *The Views Engine*. The information is collated and structured by *The Views Engine* and passed to *The User Interface System*. *The User Interface System* is responsible for converting this information into a graphical format, which can then be related to the user in a set of graphical representations. A user interacting with the system is also shown. The main user of the system is expected to be a business analyst, who is responsible for the overall application of system development. The future system's customer is also expected to be a user of the tool (depending on a number of factors) or at least a participant in the business process analysis/design activity together with the business analyst. To enable efficient control and interactions with the system, each aspect is graphically presented in the form of a *Picture View*.

In this paper we will briefly describe the repository development system as this is of most interest.

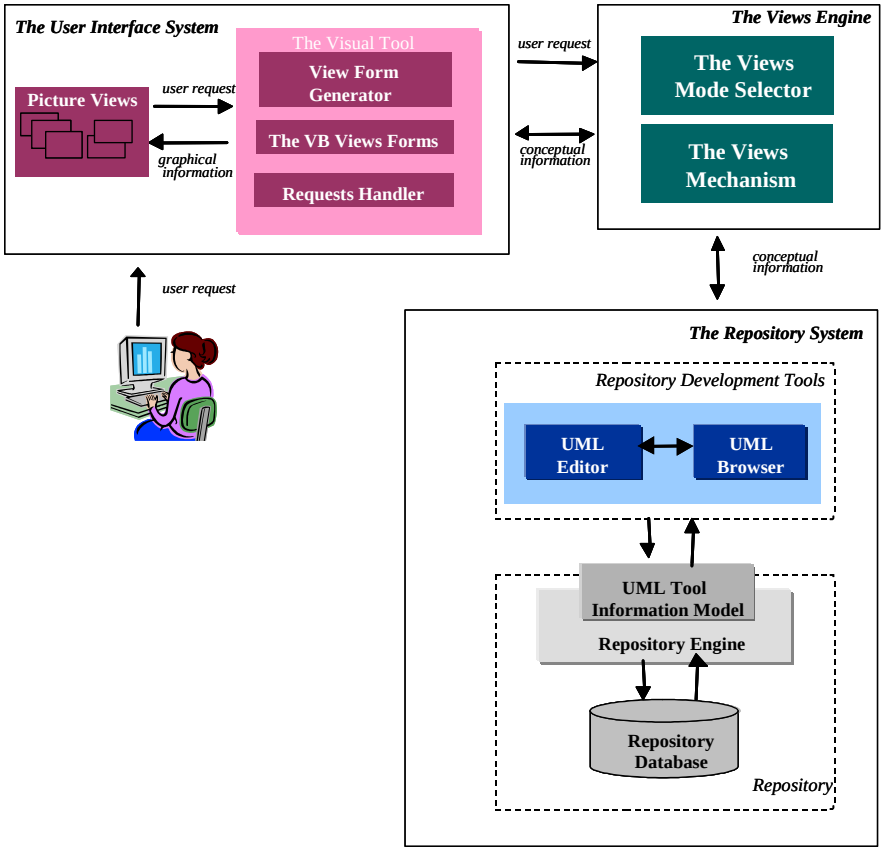

Figure 7. Architecture of the BMSA System

5.1 Repository Development Tools.

The BMSA tool was developed using Visual Basic components. The UML Tool Information Model has been implemented within the BMSA system using Microsoft repository technology. The BMSA tool allows the user to extend the existing information in the repository by adding an entirely new kind of information or extending existing kinds of information, or finally combining existing kinds of information with an entirely new kind of information.

Two interacting basic components of the *Repository Development Tools* were implemented, namely the *UML Browser* and the *UML Editor*:

- BMSA *UML Browser*

  The *UML Browser* was designed to offer the user a hierarchical representation of the UML model under investigation as shown in Figure 8. This mechanism is similar to the one used by the repository browser provided within the Visual Basic package. Once the repository is consulted a hierarchical structure of all the UML models present within the repository is created. The *UML Browser* is designed to view only UML

models and as such has been customised for UML. Each object has been given a particular icon to reflect its purpose. The user can then navigate through the model by selecting the branch of interest and expanding it.

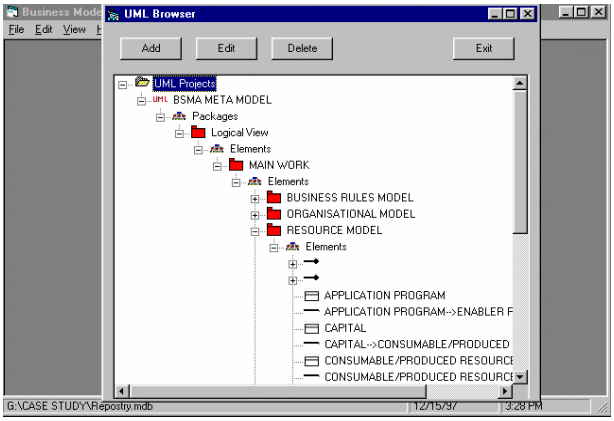

Figure 8. The *UML Browser* showing a hierarchical view of the UML Model

- BMSA *UML Editor*

  The purpose of the *UML editor* is to provide the user with the ability to populate a UML model contained within the repository. The editor is directly invoked from the *UML Browser*, using the Add command button. The editor has the ability to introduce a number of UML classes such as UMLInstance Class, that are otherwise unavailable using commercial editors. The editor checks the schematics and the logic of the object to be added and if correct adds it to the UML model (Figure 9).

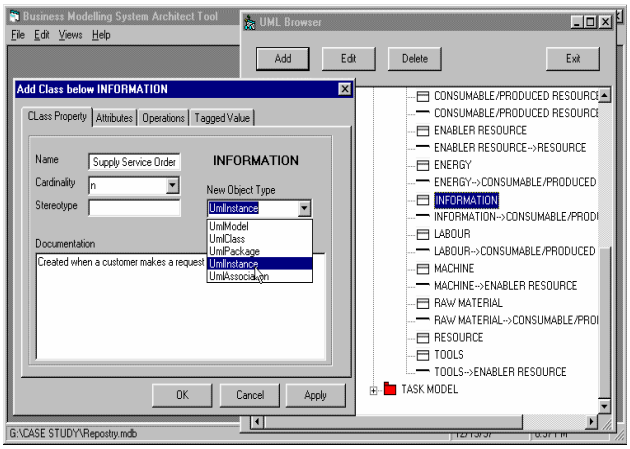

Figure 9. Adding an UMLInstance to the INFORMATION UMLClass Object

As the *UML Browser* is fully geared towards displaying UML Models, various UML objects such as Packages, Classes, Associations, Instances are easily identifiable from the icons placed alongside them. A legend for these icons is available as is the description of the logic used to create the tree and a brief description of the Active X components used.

6. Conclusions & Future Work.

In this paper we summarised the BMSA approach. In our view, BMSA is a powerful modelling framework that is method independent, thus allowing interactions with other RE and IS frameworks. The principles upon which the concepts were developed have roots in organisational design/modelling and workflow technology. A UML based tool has been developed using Microsoft Technology. As UML evolves we believe the modelling foundations presented need to be revisited in order to take full advantage of any new and proven developments. An extensive case study which deals with various perspectives and at levels of design is envisaged in order to fully test and improve this framework.

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OMG, OMG Unified Modelling Language Specification, www.omg.org.

WfMC, WfMC Specification - Terminology and Glossary, Workflow Management Coalition.

Microsoft Repository Documentation, Microsoft website www.microsoft.com.