Fact-Based Modeling and Business Process Modeling
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ABSTRACT: The paper deals with the paradigm of fact-based modelling and its relation to value-oriented business process modelling. Fact-based modelling is a conceptual approach for information systems modelling. It can be also considered as a synonym for object-role modelling (ORM). Value-oriented business process modelling represents resource-event-agent (REA) ontology and its REA value model. Analysing REA business process the paper derives an adequate fact-based model of the REA business process, which can be easily mapped to ER diagrams of the relational database.

Keywords— business process modelling, object-role modelling, REA ontology

I. INTRODUCTION

The quality of a database application crucially depends on its design. To help ensure correctness, clarity, adaptability and productivity, information systems should be specified at the conceptual level first, using concepts and language that both designers and customers can easily understand (Halpin 2001). Fact-based modelling utilizes Object-Role Modelling (ORM) notation and approach to create a conceptual model of information system that is comprehended both designers and customers.

Business process modelling is currently the best way to understand activities of an enterprise. Value oriented approach represented by an REA value model is one of the business process approaches that utilizes mostly UML class or object diagrams to model business process. The Unified Modelling Language (UML) was predominantly focused on object-oriented programming and can be used for database design as well assuming stripping of object-oriented implementation details. Specifically the class diagram provides an extended Entity-Relation (ER) notation that can be annotated with database constructs. UML’s object-oriented approach facilitates the transition to object-oriented code. On the other hand, Object-Role Modelling (ORM) that represents a fact-based approach provides a better way to capture and validate data concepts and business rules with domain experts. ORM also focuses on structural changes in the application. By omitting the attribute concept, ORM allows to communicate in simple sentences. ORM diagrams (pictures) simply capture the world in terms of objects (entities or values) that play role (parts in relationships). ER notation as well as UML notation allows relationships to be modelled as attributes. ORM models the world in terms just of objects and roles, and hence has only one data structure – the relationship type. As a consequence, ORM diagrams take up more room than corresponding UML or ER diagrams. The aim of the paper is to find out a “semantic” connection between business process model expressed in UML class diagram and fact-based model utilizing ORM notation and approach.

The structure of the paper is as follows: In Section 2, REA value model representing a business process is described. Object-role modelling, its basic features and possibilities for utilization is presented in Section 3. Section 4 addresses the concrete example of ORM application on REA value model. Section 5 discusses achieved results and Section 6 concludes the paper.

II. REA VALUE MODEL – BUSINESS PROCESS

The REA ontology belongs to value modelling business ontologies and links together business process modelling with underlying economic phenomena. The REA ontology benefits from the presence of a semantic and application independent data model, an object-oriented perspective, and abstraction from technical and implementation details. In addition to other aspects, it offers full traceability of all activities that influence the value of the enterprise’s resources. That enables the possibility to calculate the value of the enterprise’s resources on demand. Furthermore, the REA ontology contains rules for formulating well-formed models of enterprise processes [3]. The goal of the economic agent’s processes is to increase the value of its economic resources. All well-formed REA models obey a fundamental rule, that there is no increase of the resource value for free, that is, for an economic agent every increase of a resource value is always paired with some decrease of the value of some of its resources. This fundamental feature of every REA model is that it answers the question why an enterprise performs a given activity. In other words it explains why the economic events occur [5].

The REA value model represents a model of a business process and creates a principal view provided by the REA ontology. The operational level is created with three kinds of entities, an economic resource, an economic event and an economic agent. An Economic Resource is a thing of given value that is scarce, and has utility for economic agents. In business applications, economic resources are changed or

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converted for another economic resource. Examples of economic resources are products and services, money, raw materials, and labour. An Economic Agent is an individual or organization capable of having control over economic resources, and transferring or receiving the control to or from other individuals or organizations. Examples of economic agents are customers, employees, vendors, and enterprises. An Economic Event represents either an increment or a decrement in the value of economic resources that are under the control of the enterprise. Some economic events occur instantaneously, such as the sale of goods; some occur over time, such as rentals, labour acquisition, and the provision and use of services. Apart from entities, the REA value model declares relationships between both different entities and between entities of the same type. The most important of these relationships is the duality relationship that links decrement events with an increment event.

The policy level of the REA exchange model [1] is created with a Contract, Commitment, Resource type, and Agent type. The Commitment is a promise or obligation of economic agents to perform an economic event in the future. Examples of commitments in exchange processes may be a promise or obligation to sell goods and receive payments. Each commitment is related to an economic event through a fulfillment relationship. Decrement commitments relate to increment commitments by the reciprocity relationship. A contract is a series of things or activities that should be done during a given time interval. In short, a contract is a collection of increment and decrement commitments. Fig. 1 illustrates general exchange process.

III. ORM IN A DETAILED VIEW

Object-Role Modelling is a conceptual modelling method that views the world as a set of objects that play roles (parts in relationships) [4]. For example, you may play a role of walking in the country (a unary relationship involving just you) or you may play a role reading this paper (a binary relationship between you and the paper). Thus a role in ORM corresponds to an association-end in UML, except that ORM also allows unary relationships. The main structural difference between ORM and UML is that ORM excludes attributes as a base construct and treats them instead as a derived concept. Conceptual schema using ORM specifies the information structure of the application in the forms of: fact types that are of interest; constraints on these; and derivation rules for deriving some other facts.

A fact (or an instance of a fact) is a proposition that is taken to be true by the relevant business community. A fact type is a kind of fact that may be represented in the database [2]. The constraints represent constraints or restrictions on populations of the fact types. The derivation rules include rules that may be used to derive new facts from other facts.

The ORM model (left part of Fig. 2) indicates that employees are identified by their employee numbers. The top three roles (EmpName, Title and Sex) are mandatory roles. This is indicated by the black dots at the Employee square. The other black dot where two roles are connected (at the bottom of Employee) is a disjunctive mandatory role constraint indicates that an employee must have a social security number or a
passport number or both. The uniqueness of constraints (cardinalities in UML) indicates vertical lines over the roles. In Fig 2 it means that empNr, EmpName, Sex, and Country is unique for each employee. Two vertical lines over each roles (SocialSecNr, PassportNr) indicating that each employee number, social security number and passport number refers to the one employee at most. The dashed line over e.g. PassportNr indicates that this is a value not an object.

![Employee diagram](image-url)

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Fig. 10 ORM relationship types and UML class description source [Halpin, 2008]

IV. FACT-BASED MODELING OF REA VALUE MODEL

Careful analysis of the REA value model reveals that it is composed of two distinct parts, which are placed at the policy level and the operational level of the REA value model. Firstly, it is the planning part (located at the policy level), which is represented by the commitments entities and their related entities. Secondly, it is the part that represents real performance of the exchange process (located at the operational level) that and is modelled by the event entities and their related entities. By the related entities economic resource and economic agent entities are meant. While the planning entities stand for some future actions event entities and their related entities stand for real facts that really has happened or happened. These facts are most important because they express real facts that are stored in databases for further processing. They are situated at the operation level of the REA value model, see Fig. 1. Apart from the operational level entities there is the duality relationship that relates to decrement and increment economic events. Actually, this relationship is crucial relationship because it uniquely identifies corresponding event entities. It could be modelled by an association class but due to its importance this relationship is modelled by individual entity called duality entity. The fact-based model is illustrated in Fig. 3. The ORM notation is utilized in the diagram.

The diagram describes ten fact types between different objects. They are marked from F01 to F10. The duality object is an object from which possible trace starts. Fact types F03, F04 (inflow/outflow) identify character and amount of the economic resources and fact types of F09, F10 (has) determine exact date of fulfilment of the economic events. To be more precise, we could add other object called location that specifies
location of the fulfilment. This object was omitted in Fig. 3 due to simplicity of the figure. ORM diagrams have direct mapping to ER diagrams utilized in relational database design.

V. DISCUSSION

The main goal of the paper is to overcome the gap between business process modelling, for which UML class diagram can be used and conceptual modelling utilizing ORM technique. The REA value model plays a principal role in the REA enterprise ontology.

![ORM diagram of the REA value model](source authors)

This ontology is closely connected with object-oriented approach and that is why it utilizes UML notation for business process modelling. UML can offer a more compact notation, especially for the design of object-oriented software, and includes several mechanisms for modelling behaviour. ORM notation belongs to the other techniques focused on data modelling, in particular conceptual data modelling. It was generally founded to be more expressive graphically, simpler, easier to validate and more stable. For data modelling, ORM offers several advantages at the conceptual analysis phase, while UML provides greater functionality for specifying a data model at an implementation level suitable for the detailed design of object-oriented code. Hence it seems worthwhile to provide tool support that would allow users to gain advantages of performing conceptual modelling in ORM, while still allowing them to work with UML. Utilizing fact-based modelling, the REA value model can be divided into the model that describes business process and the model (expressed utilizing ORM notation) that can be easily mapped to relational database structures.

VI. CONCLUSION

REA value model is traditionally expressed in UML class (object) diagram. This diagram expresses all necessary entities and their relationships. Generally it is composed of two levels, the operational level and the policy level. However, when the results of the execution of this process are stored in the database only entities at the operational level are stored. That is why this level contains information that is necessary to store.

Applying fact-based modelling enable to define and create a fact-based model that very clearly and distinctly expresses all entities and their relations in the form of facts. The resulting diagram is easily mapped to ER relational database.

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