

A Look Behind Conceptual Modeling Constructs in Information System Analysis and Design

Remigijus Gustas, Karlstad University, Sweden

ABSTRACT

Information systems can be conceptualized in a number of ways. Most methodologies propose to analyze separately process and data semantics by projecting them into totally different diagram types. This system analysis and design tradition is very strong in most modeling approaches such as structured analysis as well as object-oriented design. Structural and behavioral aspects are complementary. They cannot be analyzed in isolation. Lack of a conceptual modeling approach, which can be used for verification of semantic integrity among various types of diagrams, is the cornerstone of frustration for information system architects. Inconsistency, incompleteness and ambiguity of conceptual views create difficulties in verification and validation of technical system architectures by business experts, who determine the organizational strategies. Consequently, the traditional information system methodologies are not able to bridge a communication gap among business experts and IT-system designers. Various interpretations of semantic relations in conceptual modeling approaches make the system analysis and design process more art than science. It creates difficulties to formulate comprehensible principles of decomposition and separation of concerns. Unambiguous definition of aggregation and generalization is necessary for breaking down information system functionality into coherent non-overlapping components. This article concentrates on conceptual modeling enhancements, which help to avoid semantic integrity problems in conceptualizations on various levels of abstraction. The presented conceptual modeling approach is based on a single type of diagram, which can be used for reasoning on semantic integrity between business process and data across organizational and technical system boundaries.

Keywords: Active Concepts, Composition, Inheritance, Integrity of Static and Dynamic Aspects, Semantic Dependencies

INTRODUCTION

Information systems can be conceptualized by using graphical constructs of semantic modeling

languages. Such conceptualizations are intrinsically complex engineering products. They are typically represented and visualized across disparate modeling dimensions (Zachman, 1996). Conceptual representations are built fragment by fragment on different levels of abstraction.

DOI: 10.4018/jismd.2010092304

Unfortunately, system designers still do not have effective methods for detecting semantic inconsistency, incompleteness and ambiguity of specification fragments. One of the difficulties resides in the information system analysis and design tradition to conceptualize separately organizational (business and service) architecture, data architecture, application architecture and deployment architecture. Semantic integrity of different diagram types is a fundamental problem in the traditional information system analysis and design methodologies. Verification of integrity between business process and business data is especially difficult. It is recognized that the Unified Modeling Language (UML) support for such task is quite vague, because integration principles of different diagram types are still lacking (Harel and Rumpe, 2004).

Conceptualizations cannot be interpreted by stakeholders in two different ways. Disambiguation of design should be regarded as driving force in conceptual modeling. More abstract conceptual representations must be suitable for inspection by business managers who have no technical background. Conceptual modeling methods should also help to verify semantic inconsistency and incompleteness of representations on various levels of abstraction. Current conceptual modeling practices are not quite ready for the achievement of such goals. Typically, conceptual representations help system developers (Kung & Solvberg, 1986):

1. To increase understanding of domain,
2. To serve as a common basis for design,
3. To facilitate communication between system analysts and designers,
4. To serve as specification of system requirements.

Even if the listed advantages are taken into account, it is recognized that good quality of conceptual modeling (Burton-Jones & Meso, 2006) is very difficult to attain. This situation makes information system analysis and design more art than science. The semantic integrity problems of conceptual representations create

difficulties in communicating the semantic details of application domain among stakeholders. Conceptual specifications are often ambiguous, incomplete and inconsistent. They fail to serve as a basis for reaching consensus among system designers. The consequence is a communication gap between business analysis experts and system designers.

There are many concrete recommendations given by theoreticians for improving the existing conceptual modeling methods (Wand et al., 2000) and practices (Evermann & Wand, 2005). Typically, such improvements are either misunderstood or ignored by practitioners, because they are dealing with the partial solutions of semantic integrity problems. The consequence is that conceptual representations are still very difficult to use in information system analysis and design. There are many reasons why conceptual modeling fundamentals fail to provide a strong foundation of information system development. Conceptual modeling is still an emerging discipline. In this article we analyze several theoretical enhancements to achieve semantic integrity of conceptualizations. The proposed solutions are illustrated by using our enterprise modeling (EM) approach (Gustas & Gustiene, 2008). It helps us to theoretically investigate the semantic power of various diagram types. This article makes an attempt to discuss the following difficult questions:

1. Similarities and differences of objects can be manifested by their properties. But what is a property? According to Wand, Storey and Weber (Wand et al., 2000), not having a property is not a property, 'null values' have no meaning. In the object-oriented approaches, properties can be represented either by attribute values or by references to other objects. The deductive power of conceptual modeling approach, which is presented in this article, is based on the fundamental understanding of property. Properties are introduced by using a restricted set of totally applicable dependencies with the nameless association ends. To simplify

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