

Subproject: *Supporting facilities*

Tema Informationsamverkan:

Conceptual Modeling - some thoughts¹

Version 0.8
(2004-05-05)

Stig Berild

(Santa Anna IT Research Institute AB)

¹ Rapporten är en bearbetning av en rapport som producerats inom Myndigheten för Skolutveckling.

Bearbetningen är gjord i samarbete mellan e-Society II-projektet (www.skriver.nu/esociety) vid Santa Anna IT Research Institute (www.santaanna.se) och Serviam-projektet (www.serviam.se) samt med stöd från Stiftelsen SISU och Vinnova.

1 Introduction

Conceptual Models are traditionally being used to capture the meaning and structure of the information to be managed in database applications. In this respect the Conceptual Model also acts as input for the generation of a specific database schema conformant to some chosen implementation technology. Increasingly, Conceptual Models are also being used to define the types of content to be accepted when exchanging information among independent Parties. The Web has in this respect been a driving force. Conceptual Models may also fill roles as semantic foundations to ensure or at least to increase the quality of information specification and interpretation within an organization.

No matter the use, a Conceptual Model fills, or at least ought to fill, a central role in expressing, searching, retrieving, managing and exchanging information. Its role will increase even further when the new information architectures currently being exploited and developed (Web Services, Semantic Web, ...) are put into place and gaining widespread use. The initial steps towards the so-called Information Society have just been taken.

Currently there seems to be a common trend in a number of business areas, a trend towards specification of an all encompassing Conceptual Model for the area, covering all of its needs. Most experiences show this approach to be a failure. Why? Because identification of a business area of interest is not an enough precondition to start conceptual modeling. Several important factors or aspects have to be taken into account. This document points at some of them.

Chapter 2 introduces a number of concepts that represent different aspects to take into account when performing conceptual modeling work. Chapter 3 makes some general comments on the role of a Conceptual Model. Chapter 4 discusses some additional aspects to keep in mind while doing conceptual modeling work.

This document approaches modeling from a general perspective and thus with no special consideration for Learning Objects. However, it is our strong belief that all of the content is applicable also to the area of Learning Objects. Chapter 5 includes more on the subject as well as the document 'Metadata – When, When, How, Why' (ISO/IEC JTC1 SC36 N0411).

2 Influencing aspects

2.1 Purpose

There is always a reason for information exchanges to take place. This Purpose has to be defined and expressed. Furthermore, it has to be part of and influencing every aspect of a supporting solution. The Purpose sets the feasible limits. It makes the solution tangible.



Purpose

Figure 1

2.2 Party

A **Party** is a participant in some information exchange within a specific Purpose. Behind the scene, the responsible entity for a Party could be any individual or organization. Over time, the concept of Party is expected to evolve to something more abstract and composite, to something with legal, moral, and other capabilities and responsibilities.

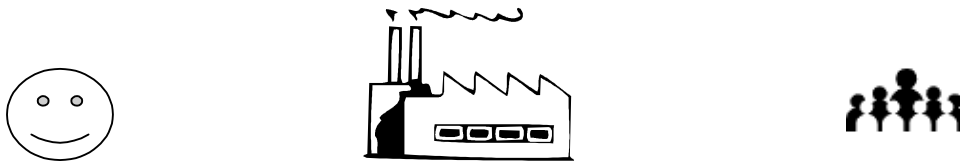


Figure 2

2.3 Participants

By Participants we understand those Parties that have the intention to share information based on a mutual understanding of a specific Purpose (which doesn't necessarily mean they all like it). Members of Participants could be a fixed group of Parties (figure 3 a) as well as an open number of Parties entering and leaving the Participants (figure 3 b).

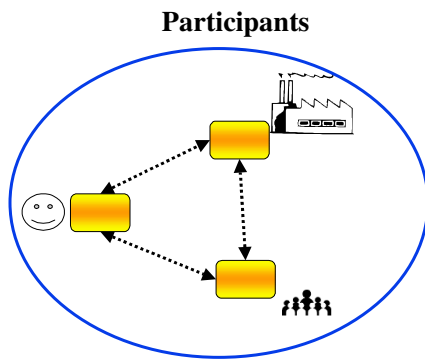


Figure 3 a

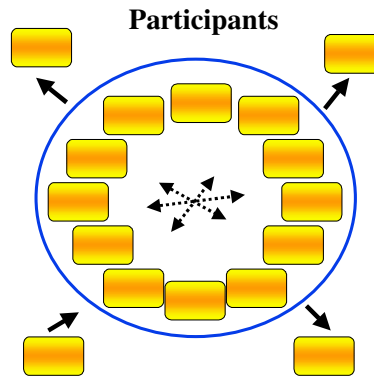


Figure 3 b

2.4 Charter

Normally each Party in Participants is expected, in some form or the other, to accept the articulated understanding of, as well as each party's role in and responsibility for the Purpose, in some type of general **Charter**. The Charter explains who, what and why and may be drawn up in writing, oral or in any other way the members of Participants feel is suitable. For some Purpose the Participants may choose to act without any Charter.

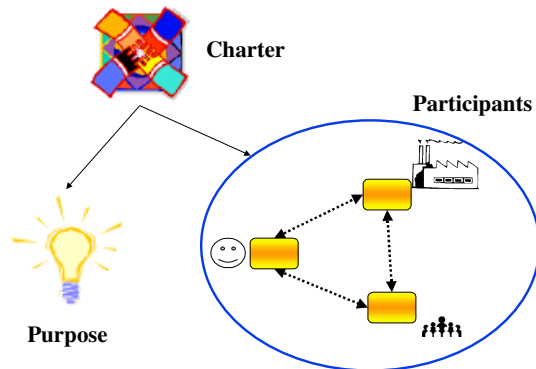


Figure 4

2.5 Universe of Discourse

Universe of Discourse – UoD represents something real or imaginary that the Participants have identified as being of interest to exchange information about in the context of the defined Purpose.

The ‘something of interest’ is called the **Scope**.



Scope



Scope

Figure 5 a

Figure 5 b

The Purpose also sets the **Context** for the type of information of interest.

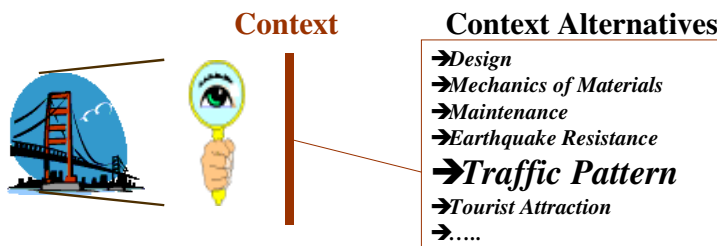


Figure 6

UoD is about a Scope, given a specific Context as identified by Participants.

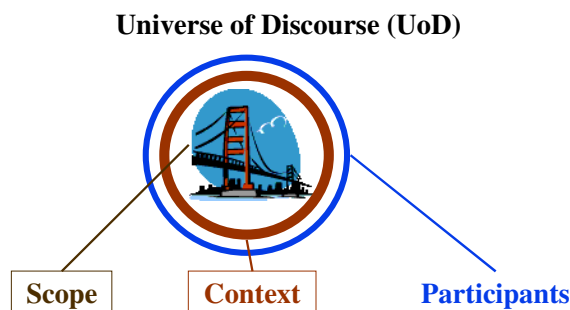


Figure 7

The same understanding of the UoD is essential for successful, meaningful communication among the Parties. Also, changing any of the three perspectives in some way creates a new UoD.

Purpose has a somewhat more flexible connection to a UoD to allow for different levels of detail in its specification. One specific Purpose may also deal with information based on more

than one UoD. Bridges may for instance be of interest both from a traffic pattern point of view and a road surface condition point of view if the Purpose is Accident Prevention.

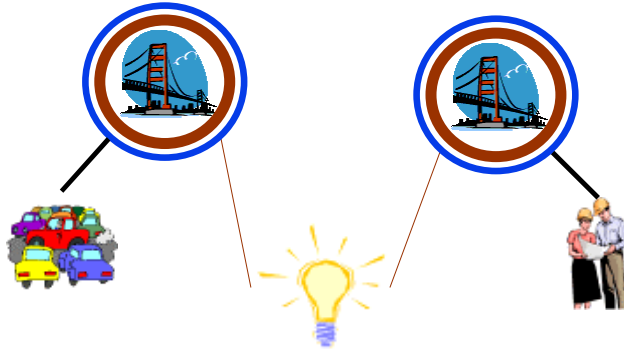


Figure 8

Also, the same UoD may in some cases be of interest for several different Purposes. Purpose may for instance differ depending on the way the Participants choose to approach it or different levels of detail chosen in different phases of a project.



Figure 9

3 Conceptual models

A conceptual model is an abstraction of a UoD expressed as a number of concepts representing types of entities and their identified relationships in the UoD. We regularly use abstractions as part of our learning, to be able to grasp something complex more easily and to help express more meaning to what we communicate.

In order to communicate a given abstraction or concept we need to express it as one or more interpretable symbols in some language where each symbol represents a concept. For instance, a concept is represented by a text symbol (term) when written or spoken languages are used. Consequently, natural language grammars include expressions where these terms fit in. Graphical languages offer graphical symbols. Available symbols for a concept is also part of the Conceptual Model. Refer to Ogden's well-known triangle of meaning (figure 10) applied to our terminology.

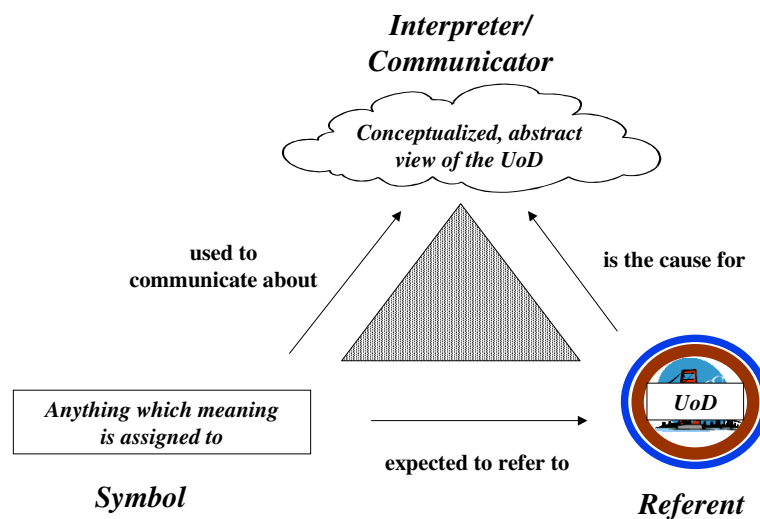


Figure 10

Basically, each concept represents a conception of some real or imagined entities similar enough to be classified as being of the same type. In the simple sentence 'Person Smith works at Company Anderson and Sons' the words 'Person' and 'Company' are both terms for concepts representing abstractions of entities. Perhaps our UoD is just about where people work. The concepts referred to by the terms Person and Company help us create a generic view of that UoD. But these two concepts, representing two types of entities, are not enough.

Of interest is also a specific type of relationship, i.e. a 'works at' relationship. The concept referred to by the term 'works at' is also part of the abstraction. Among other things we need to define the meaning or role of 'works at' which in this case is that a Person 'works at' a Company. Also a number of other details and semantic clarifications might be of interest to include in the view.

An accepted and among the members of Participants mutually understood UoD is essential for communication. However, we can hardly expect that common understanding to exist by

default to begin with, even if Scope and Context both are defined and agreed upon by the Participants. Each Party still has its own conceptualization or view of this UoD. Do we include the same meaning – do we refer to the same concept – when we use the term Person? Is ‘works at’ used by Party A referring to the same concept as ‘employed by’ used by Party B? If not, are the concepts partly related? And so forth.

Each party’s understanding of the UoD

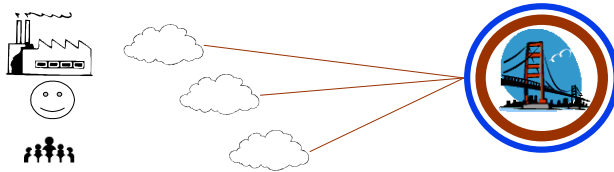


Figure 11

Not only is a common view of the UoD essential for communication, we also need a way to state that common view and to be able to reference that view in the information we are exchanging about the UoD. This common view helps to explain and to avoid misunderstandings – for unambiguous and meaningful interpretation. The common view is expressed as a **Conceptual Model**. Ontology and Vocabulary are other terms with a similar interpretation. The Conceptual Model is by no means a proof that the Parties really have the same view. But it is the best we can do. The Conceptual Model is at least something concrete to base the Party negotiations on.

The rest of this report will use the symbol in figure 12 for any Conceptual Model.

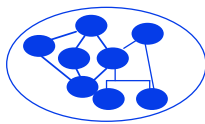


Figure 12

By the way, ‘Employee’ would probably be a more accurate term than ‘Person’ to reflect the concept representing employment perspectives within the given UoD. This indicates the need to choose terms that properly associate the semantics of the concept at hand for the involved participants.

In fact, Employee is just one of a number of roles that a human may play in different situations - in different UoDs. Just think of the roles behind the terms Wife, Husband, Homeowner, Traveler, Accused, Union Member, Goal Keeper, Frequent Flier, Farmer, Ticket Holder, Driver, Customer,

Let’s continue with Customer. It may in turn be specialized into Car Buyer (at a Ford dealer), Preferred Customer (at a food store chain), Guest (at a hotel), Borrower (at a bank),

Continuing with a bank environment a human may play a number of different roles except being a Borrower: Account holder (maybe further specialized into Check ... and Savings ...), Safe Deposit Box user, Traveler Checks Buyer, Investment Advice Receiver, Trust Department Customer,



What about former Customers? Should they also be included? And those being approached to become new Customers? Perhaps only Account Holders having more than 5000 dollars on deposit are to be called Account Holders (for some promotion application)? And so forth.

Obviously each UoD has its own view of the role of a human. That role has to be properly reflected as a concept in the Conceptual Model and given a name reference that the Participants like and are capable of interpreting.

No doubt we need to take Purpose, Scope, Context, Participants into account when creating a Conceptual Model.

4 Some additional influencing factors

Some additional factors influencing the outcome of conceptual modeling are briefly discussed in this chapter. They all add to the complexity of the modeling work. Still, they need to be taken into account in a proper way.

4.1 *Conceptual Modeling Language*

Each Conceptual Modeling Language has its own constructs for expressing the components of a Conceptual Model. Some languages are simple and easy to learn and use. On the other hand they may lack some expressive power of interest for some specific semantics specifications. A richer language obviously allow for a richer and more precise specification of the Conceptual Model but only under the condition that the Participants are good enough in understanding and using the more expressive power of the language. If not, more confusion will result instead. A richer language may also require a more complex user interface.

The choice should be made based on the expected need for expressive power plus the Participants' general modeling skill in combination with their knowledge of the language to be used.

4.2 *Conceptual Model usages*

A Conceptual Model may be used for a number of different purposes.

It may be used as a foundation for unifying the understanding of a specific UoD within an organization or department. The semantically precise specification of concepts and terms facilitate communication when discussing the UoD orally or in writing.

Alternatively, a Conceptual Model may be used as a semantic contract between Participants when exchanging information on a formal basis, for instance in Business-to-Business applications.

Traditionally, Conceptual Models have been used in the analysis and design phases of database application development as implementation independent representations of the types of information to be managed. This Conceptual Model is usually later on transformed into a Storage Model (most often expressed in a Relational Modeling Language) for the actual database management of the information.

Nothing really prevents a Conceptual Model from also being used as a Storage Model. Trends in that direction already exist. The document 'A Binary Modeling Language' discusses an alternative that for a number of years has been used in a number of operational applications.

Suppose for some reason that no UoD has been specified (and thus no Conceptual Model exists) but that a number of Parties still choose to exchange information, i.e. without any guidance from a Conceptual Model. This is very similar to a situation where people come together at a dinner party and start talking about almost anything. Misunderstandings probably

occur to begin with, especially when there are new acquaintances. Stepwise each person is capable of generating a successively better interpretation of the received information by learning what the other person is talking about (that person's UoD). The terms and language constructs used in combination with noticed repeated patterns of expressions plus other observations add to a successive refinement of some sort of temporary Conceptual Model in the head of the listener.

More formally the same approach may be applied when a listener (perhaps a computer program) receives electronic information from another party. By successive refinements of a formal Conceptual Model the listener not only is capable of understanding more and more but furthermore, at some proper time, to enter into a conversation about the comprehended UoD.

And so on.

The intended use expressed as part of the Purpose obviously indirectly influences the choice of Modeling Language and the creation and content of the Conceptual Model.

4.3 Constraining or guiding?

A Conceptual Model is a more or less precise specification of some UoD. It includes a limited set of concepts and relationships as well as different types of conditional rules. As an add-on to 4.2 above, the Purpose should also include information on the rules for using the model. Is all information exchange between Participants always to be expressed only within the limits of the Conceptual Model? Are extensions allowed, and if so, how are these extensions to be managed? Or, is the intent of the model just to propose a set of concepts and terms for those interested, as a recommendation in an effort to avoid misunderstandings?

Again, the answers to these questions certainly influence the choice of Modeling Language as well as the content of the Conceptual Model.

4.4 Concept - Symbol

Figure 10 above makes a clear and important distinction between symbol/term and concept. The same concept may be referenced by a number of different terms by different parties. These terms are synonyms. The only way recognize equivalence is by negotiation in combination with gained experience from usage. But proof is in reality an impossible task. Still, in many situations a number of synonym terms for the same concept have to be supported. Internationalization support (Parties using different natural languages) is in this respect a driving force. But also other requirements have to be supported, for instance a need to use both a graphical symbol and a term for the same concept or support for different dialects or cultural traditions. However, working with several synonyms is not the hard problem.

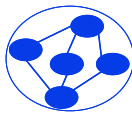
The problem occurs when the parties find that symbols/terms reference *almost* the same thing but probably not fully. Specialization expressions in the modeling language may help if the difference is known and possible to specify in the Conceptual Model. Sometimes there is just a vague suspicion of some slight difference in meaning. Negotiation among the Participants has to be worked out, preferably by the active use of Conceptual Models.

An even bigger risk may exist when parties use the same symbol but for different concepts (homonyms). How to find out that the semantics are somewhat different when a first and natural starting-point is to consider them as representing the same concept? Again, instead of just arguing orally, the use of conceptual modeling hopefully points at different meanings through differences in the way the Parties choose to model the underlying concept.

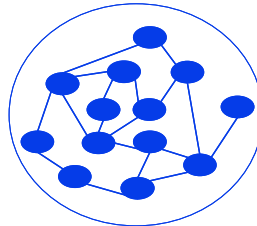
In any case, the difference between symbol and concept should always be in the minds of the modelers and managed appropriately. This difference in combination with a UoD based reasoning has also to be taken into account when taxonomies and vocabularies are being defined. Today, mostly neglected (or not fully understood ...).

4.5 Coverage

It is easy to note that Purpose, Scope and Context are active ingredients in defining a UoD. But how to balance simplicity (figure 13 a) and complexity (figure 13 b) with usefulness?



Figur 13 a



Figur 13 b

Suppose, for some reason, that an extensive UoD would be preferable. A complex Conceptual Model has to be created. The more complex the more skill has to be put in to give it the right precision. A complex model is certainly also harder to negotiate. At the same time, a more limited UoD and accompanied model is less useful. Where is the balance?

An alternative may be to keep the extensive UoD but to focus only on the main parts to begin with and let further additions be part of some later development step.

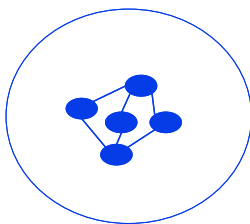


Figure 14

Sounds practical, but how to find and delimit a natural and effective kernel? How to keep preparedness for the full coverage while only working on the kernel? Or, if no preparedness should be allowed to influence the work on the kernel, why not just limit the UoD to the problem at hand?

4.6 Participant influence

At least two different “playing fields” may exist when doing conceptual modeling. In the first case the members of Participants need to reach a compromise in their understanding of the UoD. A lot of work is probably required before each member’s initial private view can be replaced with a mutually accepted common Conceptual Model, at least when communicating information about the UoD.

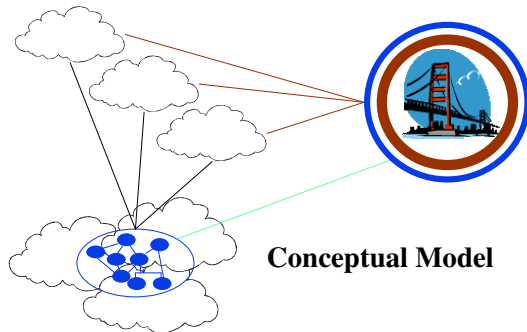


Figure 15

In the other case there is one dominating information-delivering Party. That Party specifies the Conceptual Model it is willing to accept in sharing information to the external world. We still have a common Conceptual Model even if no compromises have been involved. The other Participants have to adjust to the circumstances at hand in one way or the other.

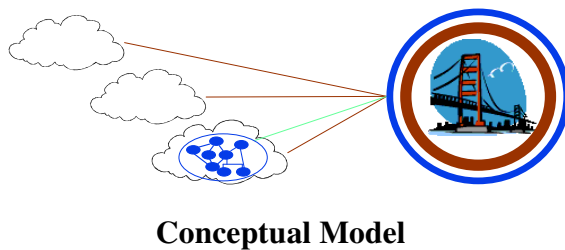


Figure 16

Probably more work will be needed for each party in harmonization between the own internal model and the common model. Also, as no negotiation has taken place, the parties have had no chance to get to know each other. Then, even more work has to be put on the dictated conceptual model for it to be expressed in a way so that the semantics of each concept is clearly interpretable. What otherwise to hope for?

4.7 Participant population

A Conceptual Model may be of interest for a large or a small population of parties depending on the actual Purpose. The larger population, the harder to get to a consensus on the contents of the Conceptual Model or even the UoD to start from. On the other hand, if all parties of a large population accept a Conceptual Model, a solid basis for broad information exchange is established. If the acceptance level for some reason is low or has a lowering trend a

fragmentation into a number of modified Conceptual Models, negotiated within subgroups of the total population, will come into existence over time.

The balance between a broad acceptance and a large Population may be a delicate one. Perhaps a combination with the Coverage discussion above (section 4.5) would be aim at a broad acceptance in the large Population but only for the kernel concepts of the Conceptual Model. Allow for nuances in other parts of the Conceptual Model as expressed by those subgroups of parties sharing the same values, interest or concern.

4.8 Life Cycle

An agreed upon Conceptual Model is in itself an achievement and a cornerstone for information management and exchange. However, this is just a first step in the full life cycle of this Conceptual Model. The agreement is a decision made by the Participants based on a comprehension among them that the model has an enough quality and stability to be put into “production”. In reality this by no means indicate that it has reached any long-term stability. Errors, adjustments, missing pieces all need to be taken care of in order to reach an ever more useful Conceptual Model given the identified UoD.

After some initial adjustments the model is found to be a feasible abstraction of some UoD. Now to the next problem. The UoD is in the general case not at all static. Purpose, Scope, Context, and Participants may all change over time. These changes have to be reflected in the model no matter if they are small or extensive. Even a revised opinion of just one of the Participants has to be dealt with.

No doubt the Conceptual Model will come to exist in a number of versions during its life. How do we manage the different versions and their relationships?

Perhaps the Participants at some time decide to use another modeling language to express the model. The reason could be a need for more semantic precision, a correlation to used storage models, an adaptation to new general trends and standards in conceptual modeling, or something else. What will be the consequences for the work on correlating different versions expressed in different languages? What will be the consequences for mapping rules between a Party’s own internal models and the common model? And – referring to section 4.1 above - will the Participants be good enough in using the more expressive power of the new language or will more confusion result? If a less powerful language is chosen, what will be the effects of the missing semantics in the new model?

The life cycle perspective is probably not the first aspect to come into the minds of conceptual modelers. However, after the initial phases, it certainly will.

4.9 Ownership

Closely connected to the Life-Cycle perspective is the management perspective. Management in turn is closely related to ownership of a Conceptual Model. A responsible and accredited ownership is a necessity for managing the “life” of the model.



Even (initial) negotiations among the Participants have to be managed in a way that effectively leads to the envisioned goal.

The management perspective is probably another of the less spectacular aspects to take into consideration but undoubtedly still very essential for the long-term outcome of a modeling project.