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Presentation of the COST Urban Civil Engineering Action C21 “TOWNTOLOGY”

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Introduction

1 Guarino (1998) defined an ontology as "an engineering artefact, constituted by a specific vocabulary used to describe a certain reality, plus a set of explicit assumptions regarding the intended meaning of the vocabulary words." Ontologies are usually enshrined in computer programs. They determine what can be represented and what can be said about a given domain through the use of information techniques. Accordingly "ontology designers have to make conscious and explicit choices of what they admit as referents in a particular system or language." (Kuhn, 2001) The way to make these choices is an important subject of research given their practical implications over the long-term. In the context of Urban Civil Engineering, explication of the kind of entities that are to be admitted in a language is not an easy task as it will shape the communication between different systems.

2 Current ontologies for information systems are mostly static, emphasising objects with attributes and relationships over operations. They tend to minimise possible controversies about concepts, or ambiguities about their exact meaning. This may be because the roots of Geographical Information Systems are static, map-based models of the world and because of the emphasis in object-oriented methods on attributes and relationships rather than on operations. One of the greatest ironies of information technology is that once conceptual structures are represented in software systems they become remarkably difficult to change, despite the inherent volatility of electronic media. In part this is because software systems are complex and require sophisticated skills and expensive resources to maintain them.

3 On the positive side, prescription can bring useful stability, but on the negative side it either imposes outdated conceptual schemes on reluctant users, thus stifling innovation, or ensures obsolescence for information systems, which occurs when the discrepancies between what users want to say about a domain and what a system will allow them to say become too great. The history of computer applications offers many illustrations of this problem. The EC-funded COMBINE project (Augenbroe, 1992), for example, tried to merge different definitions of building elements within a central data repository to support the informational needs of a range of computer applications designed to analyse the performance of buildings. Thus, different energy modelling programs would be able to access a single description of a building, the principal advantages being that users would only have to enter a building description once, and changes to a building design would always yield a consistent description, because there was only one. In practice, this proved impossible to achieve. Despite the fact that most of the computer programs were operating in the same general domain (energy modelling of buildings), the conceptual differences between them were too great to map with simple translations.

4 COMBINE sits within the ambitions of the STEP-AEC programme to provide comprehensive 'product models' of buildings, which can be instantiated by particular building designs, that will lead to greater interoperability between divergent computer systems in the construction industry. The lessons learned from the lack of success in this venture should inform the development of Urban Civil Engineering ontologies.

5 The results of COMBINE suggest that a more dynamic approach is crucial, to support real innovation and local instantiation of the system. Any serious attempt to construct urban ontologies must accommodate the evolution of concepts among different actors. Yet it has to be recognized that any major urban civil engineering project also requires some stability to develop: stability of the terms of reference, applicable rules and expected results. This implies that an ontology could not be substantially revised until better definitions had been found to stabilize some of its components. The difficulties experienced in COMBINE and other similarly ambitious integration projects also reminds us that the problems faced are not purely technical, but reflect conceptual differences that have been shaped by social processes, within different cultural and social groups. It is essential to recognise the inherently socio-technical character of ontologies in the methods used to understand meanings of concepts used by different groups. For instance, a street will be differently defined by different actors such as a cadastre officer, an engineering network responsible, a traffic officer. So, tools for managing urban ontologies will need to be capable of dealing with socially constructed meanings. Achieving this requires a close collaboration between different scientific fields and disciplines, including civil engineering, urban design and planning, spatial information techniques, artificial intelligence (Gandon, 2002), sociology of science (Kassel et al., 2000) and semiotics/language theory (Sowa, 1995).

6 The extension of an ontology to other languages raises challenging questions as soon as one attempts to develop a multilingual index. The notion of “urban design” does not have any straightforward translation in French for instance. It is close to the notions of “projet urbain” and “composition urbaine” without being synonymous with any of these terms. The “projet urbain” (urban project) is indeed usually considered as a socio-political construct. Its definition rather insists on the public nature of the urban realm while the “composition urbaine” (urban composition) tends to be more heavily focused on the formal and geometrical properties of the space, in terms of vistas, alignments. As a consequence, we only can assume the similarity of low level concepts, whereas we need to reorganise everything at top level through agreed high-level classes and proper hierarchical relationships.

7 Still the establishment of a multilingual ontology can not correspond to the juxtaposition of N monolingual ontologies. It relies on the construction of a common instrument where all languages have equal status. Accordingly it is necessary to establish as many relationships as possible between the different languages, while, at the same time, respecting the specificities off each culture (in the domain of legal systems for instance). Experience gained from previous attempts to build a multi-lingual UCE glossaries informs us of the necessity to adopt a strict methodology during the work (Dupagne et al., 1996).

Objectives and benefits of the proposed COST action C21 TOWNTOLOGY

8 The main objective of the COST Urban Civil Engineering Action C21 is to increase the knowledge and promote the use of ontologies in the domain of Urban Civil Engineering projects, in the view of facilitating the communications between information systems, stakeholders and UCE specialists at a European level.

9 Secondary objectives of the Action are:

- producing a taxonomy of ontologies in the UCE field, contrasting existing design methodologies, techniques, glossaries and production standards;
- developing an urban civil engineering ontology both in textual and visual (graph) presentation and a visual editor to integrate and update concepts, definition, photos into the ontology (software tool);
- developing a set of guidelines for the construction of multi-lingual UCE ontologies, based on practical examples (cases);

- analysing the role of ontologies as a tool to foster an improved communication between UCE stakeholders.

10 Three working groups have been established in order to achieve these objectives.

11 The first working group will address methodologies for developing UCE ontologies. It is dedicated to the analysis of available ontology builders (KIF, IFF, Ontolingua, Loom, OIL) and approaches (semantic networks, ontologies, topic maps). The applicability of these techniques and approaches to the UCE domain is tested so as to provide guidance about their use.

12 The second working group (Construction of multi-lingual UCE ontologies) is dedicated to the definition and comparison of some key urban processes, objects and actions throughout Europe, possibly based on a specific field of UCE and cross-national analysis of some common case studies.

13 A third working group (Impact of ontologies upon communication between UCE actors) will concentrate on the social and cultural implications of using ontologies in the UCE context, in the view of developing a guidance for their best implementation in real-life contexts and their improved acceptance by different stakeholders.

Construction of an Urban Civil Engineering: the experience of street planning and mobility fields

14 A preliminary experiment to build an Urban Civil Engineering ontology started in 2002 with two French laboratories named LIRIS and EDU located in Lyon, France. The main objective of this experiment was to clarify and organize the terminology used by French experts in order to build an ontology about urban planning.

15 This experience aimed at the construction of a formalized vocabulary gathering, for the domain of urban management and planning, all the main concepts and their relations. From a practical point of view, the goals of the experiment were defined as follows:

- to identify terms and concepts used in different urban activities,
- to organize urban knowledge,
- to facilitate communication between various urban actors manipulating the same object types when achieving different goals,
- to gather urban data provided by heterogeneous sources.

Various ways of ontology engineering

16 The preliminary stage was to clarify the notion of concept and term. “A concept is a notion usually expressed by a term (or more generally by a sign), a concept represents a group of objects or beings sharing characteristics that enable us to recognise them as forming and belonging to this group” (Gandon, 2002). The link between concept and term is ambiguous because a term can express different notions depending of the context, and a concept can be characterized by several terms in different contexts. Wordings are interpretable, but nothing imposes that they must be interpretable in the same way (Bachimont, 2000).

17 Some researchers in artificial intelligence are specialised in knowledge modelling and ontology design (Gomez-Lopez et al 2004). Several methodologies have already been proposed at this purpose.

18 In particular in ontology design or engineering, three main approaches have been proposed (Gandon, 2002):

- bottom-up approach proposed in (Van Der Vet, 1998): starting from the most specific concepts and building the conceptual hierarchy by generalization; the ontology is built by determining first the most specific concepts and by generalizing them. This approach is prone to provide tailored and specific ontologies with fine granularity concepts.
- top-down approach recommended by Sowa (Sowa, 1995): starting from the most generic concept and building a structure by specialisation; the ontology is built by determining

first the top concepts and by specializing them. This approach is prone to the reuse of ontologies and inclusion of high level philosophical considerations which can be very interesting for consistency maintenance.

- middle-out approach of Uschold and Gruninger (Uschold et al., 1996): identifying core concepts in each domain identified and then generalized and specialized them to complete the ontology. This approach is prone to encourage emergence of thematic fields and to enhance modularity and stability of the result.

19 Other approaches which are not really different from those referred to above use existing resources to identify the concepts:

- from existing vocabularies approach (Aussenac-Gilles N, 2003): in this approach, the starting point is an already existing textual dictionary or glossary. The problem is transforming this text into a semantic graph by selecting the more appropriate concepts and relations, like in the middle-out approach.
- from existing database conceptual models: in this approach the starting point is a data base conceptual model, typically specified with the Entity-Relationship (ER) model or UML. In this case the E-R models of different databases are integrated into a unique ontology. A transformation of databases relations into ontologies is feasible as ontology of each theme can be defined to allow for shareability and exchange of information. When one uses a schema of database, one handles objects with the very fine granularity as in the bottom-up approach.

20 After having analyzed the existing approaches, and knowing that urban planning is an extensive domain with several sectors, it was preferred to concentrate on a limited set of topics. Thus, to start the engineering of our ontology, we chose to work on concrete topics such as street planning and mobility. We used the middle-out approach from existing vocabularies to identify the more important concepts of the domain.

Engineering of Street Planning Ontology

21 As our goal was to produce a first draft and not to be exhaustive in our terms list or definitions list, we started by identifying the technical objects of street planning, while using the book of Chantal Berdier: *The dictionary of the Street planning* (Berdier, 1998). We chose this entry point because it appeared to us to be most accessible to start our work. Indeed, while being interested in the objects and not in the complex notions of the domain, we were sure to remain on concrete things and to avoid too complex terms. This first work on technical objects enabled us to start on sound and understandable bases. After we determined a certain number of relations between the terms which appeared simplest to us. Then we integrated the set of terms from the street planning dictionary, except for those which seemed too far away from the domain of the street planning (arboreal terms, data-processing terms).

22 After this stage we dealt with the analysis of more complicated terms, such as “public space”, “mixity”. Indeed these concepts are often prone to semantic drifts because they are more difficult, sometimes impossible, to identify and define clearly. The people give them often with the same term for different meanings, even contradictory. It is thus necessary that work is continued in this domain, in order to reach the first goal of an ontology which is *"to mitigate the semantic drifts of comprehension between the interlocutors"*.

23 More than 800 terms have thereby been defined, which means that there are more than 800 concepts (French language) in the ontology. Due to the fact that a term can have several definitions, each definition needs to be categorized by its specialization and its activity field to clarify the underlying concept. In addition we need some relations to explain the semantics of the concepts.Twenty one main relation types between concepts were determined. These relation types are used to build several hundreds relations between our 800 concepts. To specify these relations, we represented them visually by a semantic network indicating the name of the relation which links the two concepts.

Engineering of Mobility and Travel Ontology

24 Further experiment was interested in the field of mobility and travel. The objective was then the integration of concepts concerning this field with the existing street planning ontology. That was done in three phases:

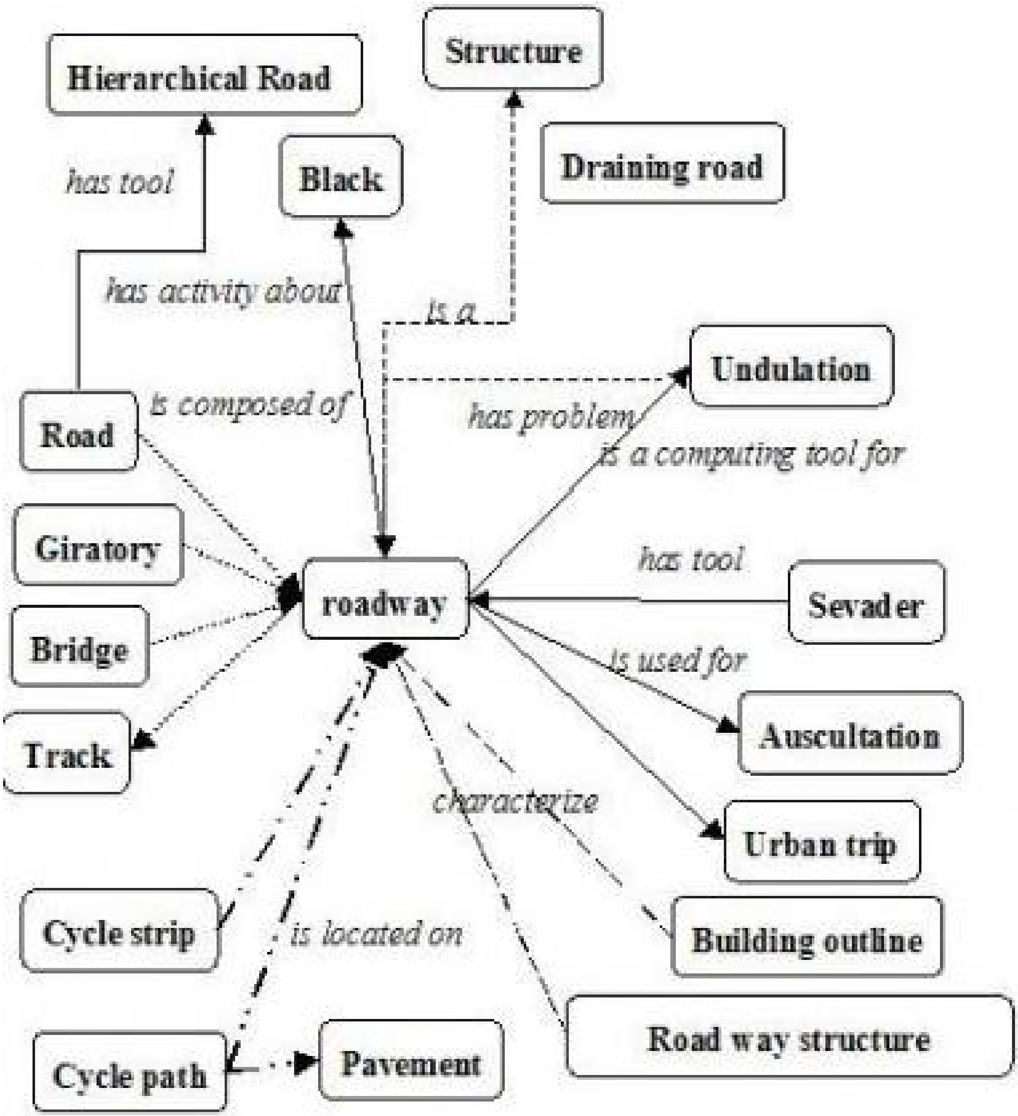
- construction of a sample of concepts,
- search of the set of associated definitions,
- implementation of the semantic networks.

25 To obtain a sample of concepts concerning the field, various alternatives were possible. Our choice was carried on a lot of concepts by questionnaire to experts of the domain, in order to identify the concepts interesting the users (given by experts), to allow to facilitate thereafter the future tests of the base, but also to increase the interest carried out with this tool. This method enabled us to collect around fifty concepts in the field of mobility and travels.

26 The second phase consisted in gathering a set of definitions concerning all the new listed concepts. Some of the concepts had, from the start, several definitions whereas others on the contrary missed precise details. It was thus necessary to carry out a work of selection and complementation. Then, each one of these definitions, was organized according to the existing structuring of the base, i.e. classified according to its specialization and its activity field.

27 From sample of concepts and definitions, organization in semantic networks began while supporting on the relations defined in the existing base. It was necessary to simplify the use of the existing relations in the semantic network. At the same time by classifying them to try to remove ambiguities, but also by generalizing them, to facilitate their re-use and to avoid their multiplications. In order to integrate this field into the existing model, it was necessary to choose a certain number of footbridging concepts, i.e. making it possible to connect the new semantic network to that existing.

28 Below we show an excerpt of our ontology in the form of semantic graph. It contains at the same time concepts of the street planning and mobility. A relation has a direction of reading: the relation "is located on" between the concepts “Cycle path” and “Pavement” is read as an Cycle path “is located on” the Pavement.



http://www.cybergeo.eu/docannexe/image/8322/img-1.jpg

Figure 1 : Excerpt of ontology

Language description

29 Ontologies must be expressed with a concrete notation. An ontology language is a formal language in which an ontology is built with. There have been a number of data languages for ontologies, both proprietary and standard-based. In this section we analyse the existing ontology specification languages and describe the tool which was most adapted for our system.

30 Several frame-based languages called "traditional" ontology specification languages were proposed such as: Ontolingua (based on KIF), OKBC, LOOM, OCML, and Flogic.

31 The interchange of ontologies across the World Wide Web (WWW) and the cooperation among heterogeneous agents placed on it is the main reason for the development of a new set of ontology specification languages, based on new web standards such as XML or RDF. These languages (XOL, RDF(S), OIL, DAML+OIL, OWL), aim at representing the knowledge contained in an ontology in a simple and human-readable way, as well as allow for the interchange of ontologies across the web.

32 Information in comparison table is filled using “+” to indicate that it is supported feature in the language, “-“ for non supported features, “+/-“ for non supported features but could manage to support it by doing something additional.

	RDF(S)	OIL	DAML+ OIL	OWL	XOL
XML-based	+	+	+	+	+
Hypertextual definitions	+	+	+	+	-
Allowing several definitions	-	-	+/-	+	-
Multimedia attributes	+	-	+	+	-
Metadata inclusion (to describe the context of use)	+/-	+	+	+	-
Trackability of modification	-	-	-	-	-

http://www.cybergeo.eu/docannexe/image/8322/img-2.png

Table 1 : Comparison table

33 This comparison highlights that none of the formalisms referred to above are really appropriate to the Towntology project. Actually we do not have an existing, ready to use ontology. At this stage identifying and defining the vocabulary is more important than the syntax as we are in a process of construction and reorganization of the ontology. We thus proposed a simple model to allow non-data processing specialists or logicians to validate the concepts and other elements of ontology. We are not building a language of representation of ontologies. For example, OWL is a language of representation of a built ontology. In our case there are several definitions for one concept and we are in a process of selection and characterization of these definitions. Do they represent the same concept, a different concept? The challenges of consistency and stability are to be raised in future work.

34 The standard XML was thus chosen for storing our ontology, because of all these reasons referred to above but also this language offers us the means of reaching the assigned goals, i.e. the visual representation of the ontology and, in the long term, the interoperability. XML allows also an user-friendly and adapted use with the JAVA programming language, which we use for our prototype.

Visual Browser and Editor interfaces

35 Afteranalysing the existing ontology design systems, we developed a software package to engineer ontologies. The system is a portal to access the ontology.The way to enter the system is via a visual portal which includes three possibilities of accessing , as shown in the Figure 2: a list of terms, some photographs representing some urban views with active zones, the visual (graphic) representing of the ontology.

http://www.cybergeo.eu/docannexe/image/8322/img-3.jpg

Figure 2 : The Towntology visual portal.

36 The graphical browser interface is divided into three parts. The main part is the visual browser (a GraphPanel) which displays the ontology as a semantic graph. It makes it possible to navigate in the ontology and query it. The second part is a scrollable list showing all the terms used in the graph, and the third contains two buttons for navigating between the main portal (Portal) and the information frame.

37 The information frame displays all the information about the select term: several definitions and images describing the selected term and all the relations linking the selected term with an other term. The editor interface is intended to store and give access to the ontology. Four elements are stored: the relation types, the domain, the concepts (definitions) and the terms (String).

38 The XML specification describing the ontology content is divided in two parts head and body. The head part contains general information about the ontology. The body part contains relation type definitions, domain definitions, concept definitions and the list of relations between concepts. The XML data are the storage structure used by our application.

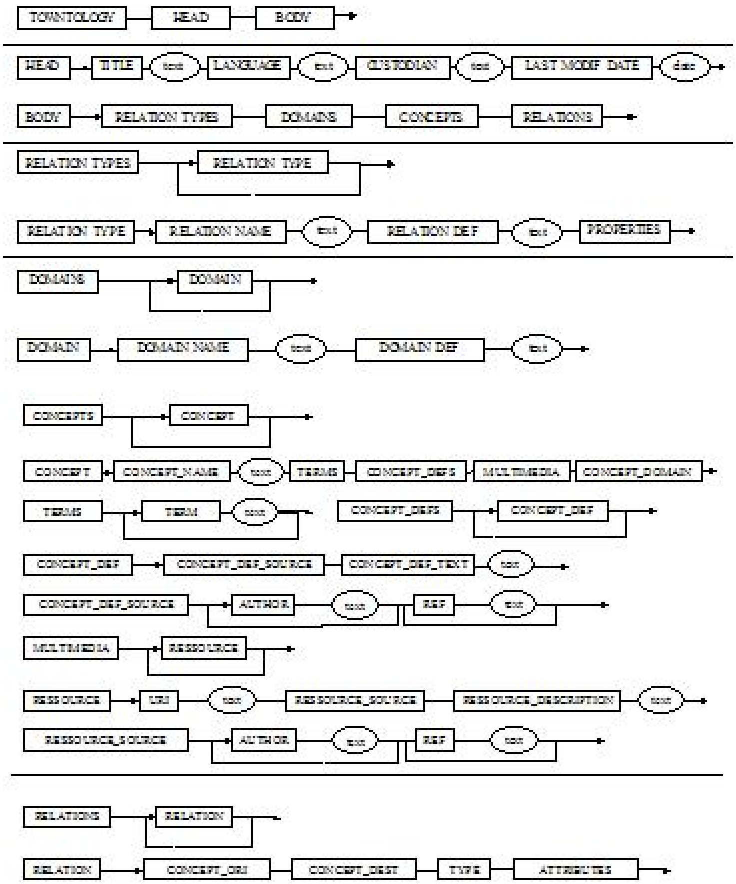


Figure 3 : The XML specification.

Conclusion

39 In this paper, we presented the Towntology project whose objective is to design an ontology in the urban field. This project is divided into several stages. Concerning the prime main objective of the Towntology project, i.e. to build an ontology for urban planning by integrating all urban objects with their descriptions and relations, we began to deal with some fields, such as street planning and mobility. To reach the second main goal, by using ontology for interoperability and groupware, we developed a software tool making it possible to urban planners to work on the structuring of a semantic network. Thus we built a visual browser and an ontology editor. An extension of XML is designed and used for the description of the ontology.

40 Our future work will concern the analysis of other domains in the urban field in order to integrate them into our base. We must also improve our prototype from a navigability point of view, for example to be able to navigate through the concepts and not only through the terms. And especially to solve the cases of inconsistencies, to reach at our final objective which is the implementation of a formal ontology.

41 At international level, the participants of the Towntology project have decided to launch a European project COST to build a complete urban ontology including the terms in several languages.

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Droits d'auteur

Résumé / Abstract

Les ontologies urbaines: pour une amélioration de la communication dans les projets d'urbanisme

Dans cet article, nous avons présenté le projet Towntology dont l'objectif est de concevoir une ontologie dans le domaine de l'urbanisme. Ainsi grâce à cette ontologie, les différents systèmes d'information utilisés dans l'urbanisme pourront coopérer entre eux. L'objectif principal du projet est de décrire les objets urbains et de les mettre en relation les uns avec les autres. Tout d'abord, nous avons commencé par nous intéresser aux domaines de la voirie et de la mobilité. Dans le cadre de ce projet, nous avons développé une série d' outils logiciels permettant aux urbanistes de développer un réseau sémantique. Ainsi nous avons construit un navigateur et un éditeur d'ontologie, tout deux basés sur un modèle XML propre à notre domaine.
Mots clés : intéropérabilité, urbanisme, conception d'ontologie, système d'information, XML, modélisation conceptuelle

In this paper, we presented the Towntology project whose objective is to design an ontology in the urban field. This project is divided into several stages. Concerning the prime main objective of the Towntology project, i.e. to build an ontology for urban planning by integrating all urban objects with their descriptions and relations, we began to deal with some fields, such as street planning and mobility. We also developed a software tool making it possible to urban planners to work on a semantic network. Thus we built a visual browser and an ontology editor. An extension of XML is designed and used for the description of the ontology.
Keywords : modelling, ontology design, urban planning, interoperability, information system, XML