COST C21

Urban Ontologies for an improved communication in urban civil engineering projects

TOWNTOLOGY Project

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Objectives of the COST C21 Action

The main objective of the Action 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 (Groupware).
Definition of ontologies

From ontos (being) and logos (discourse/science) - theory of objects and their relations.

Ontologies determine what can be represented and what can be said about a given domain through the use of information techniques.

"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.." (Guarino, 1998)

"ontology designers have to make conscious and explicit choices of what they admit as referents in a particular system or language." (Kuhn)

The way to make these choices is an important subject of research given their practical implications over the long-term.
Main applications of ontologies

Knowledge sharing and reuse
A body of formally represented knowledge is based on a conceptualization: the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that hold among them (Genesereth & Nilsson, 1987)

Integration of data and system interoperability
"The ability of two or more systems or components to exchange information and to use the information that has been exchanged" (IEEE)

Revealing the logical structure of existing conceptualisations
"Conceptualizations are often tacit. They are often not thematized in any systematic way. But tools can be developed to specify and to clarify the concepts involved and to establish their logical structure, and thus to render explicit the underlying taxonomy." (Smith, 2003)
Ontologies in the urban domain

Improve the communication between Urban Information Systems
How can we share information/knowledge between different UIS? Raises issues of communication between domains (cadaster, population, planning, environment etc.), scales (nation, city, district), purposes and qualities (2D/2.5D/3D, topologically correct/incorrect, precision).

Improve the communication between experts and decision-makers
How can ontologies help us to build a common culture between experts, stakeholders and decision-makers? Argumentation, negotiation and conflict resolution require a common vocabulary, shared by the different partners.

Improve the communication between domain experts
How can ontologies help us to identify and describe elements of convergence/divergence between European urban planning systems? Neologisms and "planning revisions" have been flourishing throughout Europe to cope with the evolution of urban systems. Example of sprawl or planning gains.
Prospect for ontologies in the urban domain

What is an ontology and what are the goals of ontologies?
Description of ontologies for non expert of computer science
Ontologies of space and process (high-level)

Ontologies

Identify existing urban ontologies through various sources
Design and engineering of ontologies
Role of the stakeholders in the design process
Analyse align method of ontology to find example of different representation and emergence of conflict

Acrors / Domains

Activities

Case studies of ontologies "in action"
Categorisation of problems/ uses cases
How the context is treated in existing methods
## Relevant experiences (not ontologies...)

### Construction sector classification
- **Examples**: ISO 12006 - 2, ISO 12006 - 3, ISO 18629 - Process Specification Language
- **Main Purpose**: Standardisation, Entire life cycle
- **Leadership**: Normalisation bodies
- **Scale**: Focused on building entities (buildings, bridges) and construction complexes (motorways)
- **Formalism**: EXPRESS, bcXML taxonomy

### AEC Modelling
- **Examples**: IFC - Industry Foundation Classes, IFG - Industry Foundation Classes for GIS
- **Main Purpose**: Software Interoperability
- **Leadership**: Internation Alliance for Interoperability: AEC & software industry, Public bodies
- **Scale**: Buildings and Sites
- **Formalism**: EXPRESS, ifcXML

### GIS Ontologies
- **Examples**: Open GIS initiative, GML 3.0
- **Main Purpose**: Domain Interoperability
- **Leadership**: Research organisations, Private agencies
- **Scale**: Street networks to satellite img processing
- **Formalism**: XML, GML, OWL

### Urban knowledge bases
- **Examples**: EUKN - European Urban Knowledge Network, COST C20, URBANET, HEREIN
- **Main Purpose**: Exchange of experience, Cataloguing
- **Leadership**: European Networks, Public/Private bodies
- **Scale**: From public spaces to urban regions
- **Formalism**: Taxonomy, ISO 5964 (multilingual thesauri)
ISO 12006-2 and 12006-3

International Standardisation Organisation
Concepts for describing construction entities, their design, production, use and management, as well as people using and experiencing the built environment. Covers the entire life cycle of the building. Coordinate national and regional classification systems. Adopted in 2001 (Part I), 2002 (Part II). Follow-up of SfB, Swedish classification system (1950).

Content of the standard
Provides a framework and a set of recommended table titles supported by definitions, but not the detailed content. ISO 12006-2 not expressed in a formal definition language. ISO 12006-3 defined in EXPRESS (object oriented, construction domain independent). Tables that adhere to the principles laid out in the standard are assumed to be similar and possible to translate between. Supports multilingual taxonomies.

Main Challenge: Integrate different "views" in the same schema
Construction Entities defined by main construction method (girder bridge, arch bridge, or truss bridge), or by function-or-user activity (railroad bridge, motor vehicle bridge or pedestrian bridge). Similar subdivision possible for “Space” (kind of enclosure vs. living room or kitchen).

Respect the design process (defining design objects, representing building parts by geometry, and incrementally determines technical solution). Allow multiple applications (cost calculations, visualisation).
ISO 12006-2 and 12006-3

(ABS) Construction Resource

(ABS) Construction Object

(ABS) Construction Process

(ABS) Construction Result

Construction Product
Construction Aid
Construction Agent
Construction Information

(ABS) Space

Space by Encl
Space by Func
Construction Complex by Function
Construction Entity by Function
Construction Entity by Form
Element
WorkResult

Designed Space

Designed Construction Entity

Designed Element

1

is used in

will result in

has

also has

composed of

part of

subclassed by

subdivided by

determined by
Industry Foundation Classes (IFC)

Interoperability between AEC software

Content of the standard
IFC Classes not defined in an explicit model (no ontology). Not sure that selection is complete and classes are mutually exclusive. Formalised in EXPRESS then in ifcXML. Common kernel + open extensions. Based on three main classes: objects, relations and properties. Objects includes tangibles (walls, beams, etc.), intangibles (processes, controls, ressources and actors) and conceptual (grids, ...).

Main Challenge: Interoperability vs. "Capacity to evolve"
Two releases since 1995, third release on its way. From IFC 2x release (October 2000), part of the model has been protected against change (ISO PAS 16739). Evolution, extensibility and customisation. Object-oriented approach though some heritage of ER (EXPRESS). Strong interaction with "Software Implementers".
Industry Foundation Classes (IFC)
Industry Foundation Classes (IFC)
Ontologies for GIS

Interoperability between GIS and application software

Content of the ontology
Ontology for street planning and mobility. Dynamic tool for developing semantic networks. Description based on an extension of XML. 800 terms (more concepts as several definitions for a given term). Available on http://lisi.insa-lyon.fr/~townto/

Main Challenge: Bottom-up approach
No ontology engineer. Ontology developed by end-users in collaboration with computer scientists. Started from a glossary of street planning, extended with analysis of more complex terms (e.g. public space). Identification of both concepts and relation types ("is a", "is made of", "is located in", "is used for", "is a subset of").
Ontologies for GIS
Ontologies for GIS

Ensemble constitué par une ville et ses banlieues.

Jusqu'à la fin du XVIIIe siècle, les villes occidentales différaient par leur taille, mais toutes présentaient les mêmes caractères morphologiques généraux : elles étaient articulées autour d'un centre, proclitique par des faubourgs, une banlieue urbaine, marquée, de tours et de ruelles étroites de l'axe des grandes voies principales qui débordaient l'un de l'autre par une rue, une route, une avenue, un canal, une promenade, une voie de chemins de fer ou des remparts.

L'apartheid, dans la nomenclature urbaine, du terme d'agglomération traduit les transformations profondes qui sont liées à l'urbanisation généralisée, au développement des transports modernes et à l'apparition de centres commerciaux ou de centres directs dans la périphérie des villes les plus importantes. Le terme convient bien pour saisir une réalité où les formes sont moins clairement ordonnées que par le passé. Il traitait la généralisation d'espaces urbains, souvent désordonnés et dégradés, et il est utilisé de manière dans les projets de planification et de gestion des espaces à prendre en compte.

Les agglomérations ont un statut à travers la loi Vornot du 25 juin 1989 qui a prévu que les établissements publics de coopération intercommunale des agglomérations de plus de 50 000 habitants comportant au moins une ville-centre de plus de 15 000 habitants établissent un projet d'agglomération qui détermine les orientations de l'agglomération et les mesures nécessaires en matière de développement économique et de cohésion sociale, d'aménagement et d'urbanisme, de transport et de logement, de politique de l'eau, de politique d'environnement et de gestion des ressources. Dans le même temps, la loi Chavanné du 12 juillet 1992 encourageait la création d'établissements publics de coopération intercommunale, notamment pour les agglomérations en créant, à côté des communautés de communes et des communautés urbaines, des communautés d'agglomération réservées à celles qui atteignent les seuils de population ci-dessus. Enfin, dans la cadre de la quatrième génération de contrats de plan (2009-2009), les agglomérations ont constitué une cellule communautaire pour signer un contrat d'agglomération avec l'Etat et la région.
European Urban Knowledge Network

Intergovernmental initiative.

Content of the e-library.
Four types of entries: research, networks, practices and policies. Templates defined for each type of entry. 1500 entries at the moment. Expected to reach 5,000 at the end of 2006. Taxonomy established for classification purposes (604 nodes). Six main entries: 1) urban environment, 2) housing, 3) transport and infrastructures, 4) economy, 5) knowledge and employment, integration and social cohesion, 6) security and crime prevention. Opportunity to further specify by keywords.

Main Challenge: Validation of Knowledge.
Performed by National Focal Points (NFPs). According to common model (largely formal until now).
European Urban Knowledge Network

EUKN – European Urban Knowledge Network

http://www.eukn.org/eukn/themes/index.html

Home > E-library

Urban Policy

<table>
<thead>
<tr>
<th>Economic knowledge &amp; employment</th>
<th>Security &amp; crime prevention</th>
<th>Transport and Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital services</td>
<td>Anti-crime policy</td>
<td>Public transport</td>
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<tr>
<td>Internet access</td>
<td>Anti-social behaviour &amp; vandalism</td>
<td>Community transport</td>
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<tr>
<td>Broadband</td>
<td>Burglary &amp; theft</td>
<td>Train services</td>
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<tr>
<td>Research &amp; innovation</td>
<td>Cross-border crime</td>
<td>Trans &amp; light rail</td>
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<tr>
<td>Implementation &amp; production</td>
<td>Drug crime</td>
<td>Roads and road transport</td>
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<tr>
<td>Knowledge &amp; technology transfer</td>
<td>Extremism</td>
<td>Cycle routes</td>
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<tr>
<td>Universities &amp; spin-offs</td>
<td>Gender &amp; domestic violence</td>
<td>Parking</td>
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<tr>
<td>Support for spin-offs</td>
<td>Race crime &amp; harassment</td>
<td>Pavements</td>
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<tr>
<td>University research environment</td>
<td>Riots</td>
<td>Road charging</td>
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<tr>
<td>Training</td>
<td>Transport &amp; vehicle crime</td>
<td>Road safety</td>
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<tr>
<td>Coaching</td>
<td>Youth crime</td>
<td>Traffic management</td>
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<td>Lifelong learning</td>
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<td>Training for new professions</td>
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<td>Vocational training</td>
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<td>Urban economy</td>
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<td>Business support</td>
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<td>Business advice</td>
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<td>Business parks</td>
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<td>Economic opportunity zones</td>
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<td>Encouraging entrepreneurship</td>
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<td>EU-Funding</td>
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<td>Environment education</td>
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<td>Sense of insecurity</td>
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<td>Risk management</td>
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<tr>
<td>Civil disorder</td>
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<tr>
<td>Industrial disasters</td>
<td></td>
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<tr>
<td>Natural disasters</td>
<td></td>
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<tr>
<td>Terrorist attacks</td>
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</tbody>
</table>

Advanced search

Topics in alphabetical order
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
Language and institutional differences

EuroWordNet experience
Multilingual database with wordnets for several European languages (Dutch, Italian, Spanish, German, French, Czech and Estonian). Based on WordNet synsets (166 000 words, 90 000 senses). Completed in 1999.

Limitations of WordNet from Falquet (2006)
In Wordnet, a concept cannot exist without an english term to denote it. Ex. FR:Fleuve (large rivers that flows into a see or ocean). No difference between instanciation and heritage. Directed acyclic graph (not a tree). Meronymy holds for "part of" and "made of" relations

Applications to urban planning
No interest for direct synonyms but for differences in meaning and "institutional value" of proximate concepts. Exploratory work of Ventura and Calderón for Italian and Spanish planning systems (very proximate and dynamic).
### Urban glossaries from Ventura and Calderón

<table>
<thead>
<tr>
<th>1st Level</th>
<th>2nd Level</th>
<th>3rd Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquinamento ambientale</td>
<td>Impatto ambientale</td>
<td>Piano regolare generale (P.R.G. o P.R.G.C.)</td>
</tr>
</tbody>
</table>

Inquinamento ambientale:
Degrado che subisce un dato ambiente per l’azione di uno o più elementi inquinanti. Può essere acustico per i rumori prodotto dal traffico o da lavorazioni industriali; fisico per l’accumulo di rifiuti; atmosferico per la dispersione nell’aria di sostanze nocive; o anche visuale per l’inserimento di elementi di disturbo quantitativo o qualitativo nel panorama dell’insediamento.

Contaminación Ambiental:
Degradação que soporta el ambiente por la acción de uno o más elementos contaminantes. Puede ser contaminación acústica (tráfico, industria, etc.), contaminación física (acumulación de basuras, etc.), contaminación atmosférica (dispersión en el aire de sustancias nocivas) o contaminación visual (por la presencia de elementos que distan珊瑚 cualitativa o cuantitativamente el paisaje).

Impatto ambientale:
Insieme degli effetti che un'opera edilizia o urbanistica, produce sul territorio circostante, provocando alterazioni o perturbazioni dell'ambiente.

Impacto Ambiental:
Efecto que una determinada acción produce en los elementos del medio o en las unidades ambientales; efecto que puede ser beneficioso, es decir, positivo, o perjudicial, esto es, negativo.

Piano regolare generale (P.R.G. o P.R.G.C.):
Il piano regolare generale (P.R.G.) è costituito dal complesso degli atti di pianificazione territoriale con i quali il Comune disciplina l’utilizzazione e la trasformazione del territorio comunale e delle relative risorse. Il P.R.G. è composto dal piano strutturale, dal regolamento urbanistico, dal programma integrato di intervento.

Plan General de Ordenación Urbana:
El Plan General, si bien con matización en las denominaciones, es el principal instrumento de planeamiento urbanístico municipal. Es un instrumento de ordenación integral del término municipal completo. Establece los elementos fundamentales de la estructura general del territorio (sistemas generales de comunicaciones, espacios libres y equipamiento comunitario); la clasificación del suelo y la calificación del suelo.
Ontologies vs. Folksonomies

Existing classification systems

Folksonomies or ethnoclassification (Tweed, 2006)
User-generated metadata in the form of tags or keywords. Tags exist in a flat namespace with no hierarchy. It is a bottom-up as opposed to a top-down approach. A folksonomy is more about categorisation than classification.

Limitations of Folksonomies
The same tag may be used in different ways. Different tags may be used for the same concept. Acronyms not differentiated from actual words, e.g. ANT. Lack of controlled vocabularies allows great inaccuracies. Lack of structure creates possibility of chaos.
Ontologies vs. Folksonomies
Ontologies of visual artifacts

Significant part of urban knowledge conveyed through graphics
Maps, plans, conceptual schemes, aerial/site photographs (observatories). Urban representations designed for both information and action. Computer representations often miss the semantics of drawings. Images are non-sequential and ambiguous by nature.

Ontologies of "non textual" artifacts
Classification based on annotations of graphics (example Flickr): user based tagging of photographs. Ontologies of urban representations addressing mereological and heritage relations. Spatial relations for instance. Chain of documents from design ideas to legally binding-plans.
Conclusions and Future Developments

Ontologies are key to knowledge management
Various experiments in different domains. Important efforts in the construction sector (interoperability, costs and risk management). Urban ontologies hardly formalised. Largely based on taxonomies.

Common issues to different ontologies.
Stakeholder's views. Issues of scale and versatility. Design, engineering and validation of ontologies.

Urban domain raise specific questions
Various domains characterized by a variety of approaches (security, urban tourism, urban civil engineering, etc.). Validation of knowledge. Public participation. Urban decision-making and policies. Role of visual artifacts. More during the conference...

Next Steps in the COST C21 Action