

COST Technical Committee "Transport and Urban Development"

COST Action C21

"Urban Ontologies for an improved communication in urban civil engineering projects" - TOWNTOLOGY Project

<http://www.towntology.net/>

Technical report n° 6

Short Term Scientific Mission Report - Using ontologies for 3D city model semantic enrichment

Claudine Métral (University of Geneva)

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Date of the visit : June, 2nd to 6th 2008

Host : University of Liège (Belgium), Faculty of Sciences, Department of Geography, Geomatics Unit, Pr R. Billen

1 Purpose of the visit

A large number of 3D city models have recently been created or are currently under development, in relation to the development of geographic information systems (GIS) since they are usually associated to spatial databases. If 3D modelling has traditionally focused on graphical representations, there is a trend and a real need to add rich semantics to current 3D city models so that they can effectively deal with urban issues. The use of urban ontologies as developed within Action COST C21 is a robust and effective way to perform this task.

The purpose of the visit is to explore the use of ontologies to enrich the semantics of current 3D city models and more specifically:

- to present the projects related to 3D urban data and knowledge and the projects related to urban ontologies currently under development at University of Liège and at University of Geneva;
- to identify the common centers of interests, the expertise, the complementarities of the different teams;
- to identify specific applications and domains that will gain in value with enriched 3D city models and whose development will be coordinated between University of Liège and University of Geneva;
- to identify the possible ways to strengthen the collaboration (currently within COST C21) between University of Liège and University of Geneva relatively to these aspects.

2 Description of the work carried out during the visit

2.1 Presentations of research works

Research performed at the University of Geneva

Presentation to the Geomatics Unit of “**Ontologies for the Integration of Air Quality Models and 3D City Models**” explaining how 3D city models and urban ontologies can be used for the integration or the interconnection of various urban models in order to have a more general view of the impacts of decision-makings at the urban scale.

This approach raised a great interest from the members of the Geomatics Unit and gave rise to a very fruitful discussion, in particular about which 3D geometry and which semantics are mandatory to perform such model interconnections.

Research performed at the University of Liège

Presentation by **Dr François Laplanche** (geomatician, Geomatics Unit) of “**Gestion intégrée de l’information spatiale 3D urbaine**” related to the integrated management of 3D urban spatial information. This 2-year project is funded by the University of Liège and will begin in September 2008. It aims to develop, in an Open Source environment, an integrated 3D urban spatial information management system. This system is conceptually built on a geomatic-based generic urban space model, which follows current geographical information standards. The system will offer several modules, especially a 3D spatial database-modelling interface.

Geomatics Unit – Unité de géomatique : <http://www.dept-geo.ulg.ac.be/unites/geomatique.php>

Presentation by Mrs **Muriel Van Ruymbeke** (archaeologist, European Center in Archeometry) of “**Development and use of a 4D GIS to support the conservation of the Calakmul site (Mexico)**”. This is a 2 year project renewable, within the framework of UNESCO, financed by Belspo, started on March 1, 2008. This project is related to the archaeological site of Calakmul, which was a Maya capital (and consequently an urban centre) and which is now located in a biosphere with many other smaller sites.

The main deliverables of the project are:

- a cartography of the archeological sites in the biosphere for, if required, accomodating tourists;

- an archaeological inventory of urban type (function of the buildings);
- an infrastructure of geospatial information usable by the Mexican archaeologists.

The research performed at University of Liège is the part of the global project using satellite imagery. It is linked to the project "Gestion intégrée de l'information spatiale 3D urbaine" as it will be the first application of this project. As spatio-temporal aspects must be taken in account, a paleo-urban ontology will be developed.

The main issues of the discussion following the presentation are:

- problems of this archaeological site are similar to that of a current urban centre in a perspective of a sustainable development. Indeed, in spite of the roughness of the area, during 5-600 years, the city lived in symbiosis with the environment. Then, a demographic increase, a less good management and perhaps a major event unbalanced the system, with consequence that, in 30-50 years, all the area was emptied out of its human occupants;
- archaeological interpretations often differ e.g. for Calakmul between the Maya archaeologists William J. Folan and Ramón Carrasco, thus the utility of ontologies to represent different points of view;
- given the complexity, there is a real need for a preliminary stage of conceptual modelling.

European Center in Archeometry - Centre européen en archéométrie : <http://www.ceaarcheo.ulg.ac.be/>

Presentation by **Prof. Pierre Leclerc** and his colleagues of the main projects of the **LUCID** (Lab for User Cognition & Innovative Design) group. The Lucid Group is a research laboratory which brings together complementary fields (design engineering, human machine interaction, artificial intelligence, signal processing and cognitive ergonomics) to develop new methods and tools supporting creative design. The laboratory is funded by the marketing of some projects. There is a multidisciplinary team of 15 persons (engineer-architects, mechanical engineers, computer scientists, computer graphics experts, ergonomists) and a person for the marketing development of the results.

The scientific projects can be classified into three main categories:

- sketch interface croquis with electronic pencil and sketcha software (sketcha for sketching);
- human-computer interaction;
- architectural or urban modelling.

Let's mention especially a virtual desktop to efficiently assist designers, a free hand design environment for architects (EsQUISE), an interactive system dedicated to visual and acoustic simulations, a system for performing energy calculations from architectural 2D plans.

The main issues of these presentations are:

- a multidisciplinary approach is mandatory to perform such projects;
- 3D is here only a vision of the model, as the model is richer.

LUCID group : <http://www.arch.ulg.ac.be/Lucid/>

2.2 Meetings

With Prof. Roland Billen from the University of Liège and Prof. Anne-Françoise Cutting-Decelle from the Ecole centrale de Lille (one full day discussion)

The main objective of the discussion is to find out axes for future research collaboration between to the 3 institutions (University of Liège, Ecole centrale de Lille and University of Geneva).

The main issues of the discussion are:

- identification of a common interest : creation of a meta-model including 3D and urban ontologies;
- possible application fields with urban geography, archaeology, etc.;
- possible resources from master students, research funding still to be got;
- possible structures : direct agreements institution-institution, partenariats Hubert Curien, COST Actions, etc. ;
- writing of a joint paper that will be submitted to the CEUS journal (Computers, Environment and Urban Systems);

To start the collaboration between the 3 institutions, it is decided that University of Geneva and Ecole centrale de Lille are associated as experts to the project "Gestion intégrée de l'information spatiale 3D urbaine" from University of Liège.

With Prof. Jacques Teller from the University of Liège and Prof. Anne-Françoise Cutting-Decelle

The main topic of the discussion is to find out axes for a possible continuation of the COST Action C21 Townology. The main axis investigated is the possibility of a Eureka project. This implies:

- finding industrial partners (that can be services companies);
- giving place to a marketable product.

A possible application of urban ontologies is the building field with aspects such as: quality, management of building sites, environmental aspects (links between a building and its environment).

As main issue of the discussion it was decided that Prof. Anne-Françoise Cutting-Decelle will contact Eureka in Brussels.

3 Description of the main results obtained

The main results obtained are directly related to the work carried out and described in the previous sections.

Results issued from the discussions with Prof. Roland Billen and Prof. Anne-Françoise Cutting-Decelle

- identification of a common center of interest, the creation of a generic model for the urban space, that will lead to a common research;
- investigation of possible resources and ways to perform this research (see section 4);
- proposal of submitting a joint paper to the journal CEUS – Computers, Environment and Urban Systems http://www.elsevier.com/wps/find/journaldescription.cws_home/304/description;
- as a first step, University of Geneva and Ecole centrale de Lille associated as experts to the project "Gestion intégrée de l'information spatiale 3D urbaine" from University of Liège;

Results issued from the discussions with Mrs Muriel Van Ruymbeke

- identification of archaeology as a possible application field of current urban tools and methods : Geographic Information Systems, 3D models and meta-models, ontologies. Ontologies are particularly suited to represent the different possible interpretations related to an archaeological site or object;
- need for using the tools and methods quoted above in an interdisciplinary way: for example, archaeologists, geomaticians and computer scientists.

Results issued from the discussions with Prof. Jacques Teller and Prof. Anne-Françoise Cutting-Decelle

- investigations to be made about the possibility of a possible continuation of the COST Action C21 Townology, e.g. in the Eureka framework;
- contacts with Eureka in Brussels to be made by Prof. Anne-Françoise Cutting-Decelle.

4 Future collaboration with host institution

Several types of collaborations can be envisioned between the two universities (University of Liège and University of Geneva) and also with Ecole centrale de Lille:

- direct exchanges of researchers : funding to be found (possibly through research projects already worked out by the institutions);
- collaborations through publications : on international journals or through joint participations in international workshops;
- collaborations through specific actions such as Partenariats Hubert Curien (PHC) : to be investigated further;

- collaborations through research projects : COST Actions, Interreg, 7th Framework Programme, others.

As a first step, it was decided that University of Geneva and Ecole centrale de Lille are associated as experts to the project on "Gestion intégrée de l'information spatiale 3D urbaine" from the University of Liège.

5 Projected publications / articles resulting or to result from the STSM

The description of the mission and of its main results will be the subject of a presentation at the next COST C21 TOWNTOLOGY Action meeting to be held in Zaragoza on 21th of October 2008.

A paper on a generic urban model including 3D and enriched with ontologies is also planned as a joint work of the two research structures (University of Liège and University of Geneva) with Ecole centrale de Lille.

6 Confirmation by the host institute of the successful execution of the mission

On behalf of the host Institute, University of Liège, Department of Geography, Geomatics Unit, I (prof. Roland Billen national delegate in this COST action) confirm the successful execution of the STSM by Dr Claudine Metral (professor at University of Geneva and COST C21 Member).

This report prepared by Dr Claudine Metral shows that:

- all the activities done in Liège (meetings, discussions, etc.) develop in an effective and efficient way the research ideas at the basis of the STSM proposal;
- these research ideas present a real added-value to the current COST action C21 and also to potential new collaborations (notably between the University of Geneva and the University of Liege).

It has appeared that we share common ideas about urban information definition and management as well as common ideas about the use of ontologies to create generic urban data models. Dr Metral's lecture has been very well perceived by geomaticians colleagues; she has very clearly shown the necessary use of ontologies for the integration of models (in this case 3D urban model and air quality model). As a result of our discussions, the benefit of using ontologies in diverse domains such as air quality analysis or archaeology becomes even more obvious. I strongly believe that this STSM is the starting point of future fruitful collaborations (e.g. within current C21 Cost Action and potentially for new Cost Actions), the first one being the external expert role played by Dr Claudine Metral and prof. Anne-Françoise Cutting-Decelle for our project on "integrated management of 3D urban spatial information".

Liège, July 3rd, 2008

Signed: prof. Roland Billen

7 Other comments - conclusion - perspectives

As a matter of conclusion, this week spent at the University of Liège was very rich in terms of the knowledge gained from the discussions with people coming from various disciplines and with various backgrounds.

As a matter of perspectives for future work, it is possible to say that :

- various disciplines would gain in value to use 3D models enriched with ontologies;
- a multidisciplinary approach is mandatory to perform such models.