

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° 5

Short Term Scientific Mission Report – Ontology based correspondences between modelling approaches

Anne-Françoise Cutting-Decelle (Ecole Centrale de Lille)

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* Date of the visit : April, 7th to 11th 2008

* Host : POLITECNICO DI MILANO, DiAP Department, Prof. G. Rabino

1- Purpose of the visit

**** Identification of the major modelling approaches met in building and construction engineering :**

- Building and construction engineering encompasses multiple facets : urbanism, planning and scheduling, architecture, project management, design, site management, FM, sustainable development, refurbishment, decommissioning, with multiple legal regulations : all of them corresponding to the multiple facets of the building life cycle ;
- Co-existence of several approaches of the construction process :
 - + technical approaches : structure, HVAC, design (overall and detailed), planning and scheduling, geotechnics, foundations, site management, ...
 - + environmental approaches : life cycle analysis (LCA), sustainable analysis
 - + quality based approaches
 - + urbanistic approaches :
 - * geography
 - * urban planning
 - * economics
 - * politics
 - * philosophy
 - + knowledge based approaches : ontologies
 - + information management and communication based approaches
- The objectives of the modelling process are also very different :
 - + modelling aimed at improving the communication process (e.g. the initial phase of the development and/or set-up of an information system)
 - + modelling aimed at simulation of situations of interest
 - + behaviour modelling
 - + modelling aimed at predicting future evolutions and/or situations of the system
 - + modelling for calculations
 - + modelling for improving the understanding of a system

**** To highlight the needs for ontologies : when those models have to be inter-connected**

**** To identify those ontologies and provide a representation of them**

2- Description of the work carried out during the visit

- Discussions with Prof. G. Rabino, about :

- needs for modelling, needs for models
- methodologies used in urban planning
- when we make a model : a model of what, to do what ?
- mathematical approach of the modelling concept : statistical approach, Harris & Wilson models
- urbanistic approach, links to geography
- role of computers in modelling
- need of more generic approaches : foundational bases of the modelling concept
- use of quantitative and/or qualitative information, quantitative and/or qualitative models
- role of the implicit and/or explicit information, knowledge
- systemic approach : city = spatial system
- complexity management in systems
- philosophy – epistemology
- analysis of the decision making process
- status of the knowledge related to a project : implicit, explicit
- urban and territorial dynamics (see notes of the S4 workshop in this report)
- spatial representation of the urban environment of the city
- role of agents : agent based approaches, multi-agent systems
- role of semantics : semantics of structures

- Lecture for the students of the Faculty of "Building Engineering" of the Politecnico di Milano, Lecco, 5th year :

- **Title** : *Information systems for construction management : modelling approaches and standards*
- **Schedule** : 2 hrs
- **Number of slides** : 139
- **Contents of the lecture** : *see below*
- *in italian*

INFORMATION SYSTEMS
for CONSTRUCTION MANAGEMENT :
MODELLING APPROACHES and STANDARDS

Anne-Françoise Cutting -Decelle
April 2008

11/04/2008 A.F. Cutting -Decelle 1

Contents

- ⌘ Introduction : information systems for construction management
- ⌘ Analysis and design with UML
- ⌘ Modelling methods
- ⌘ Process modelling
- ⌘ Product modelling and standardisation

11/04/2008 A.F. Cutting -Decelle 3

This presentation was focused on :

- data / information / knowledge / organisational approaches
- the importance of the concept of modelling

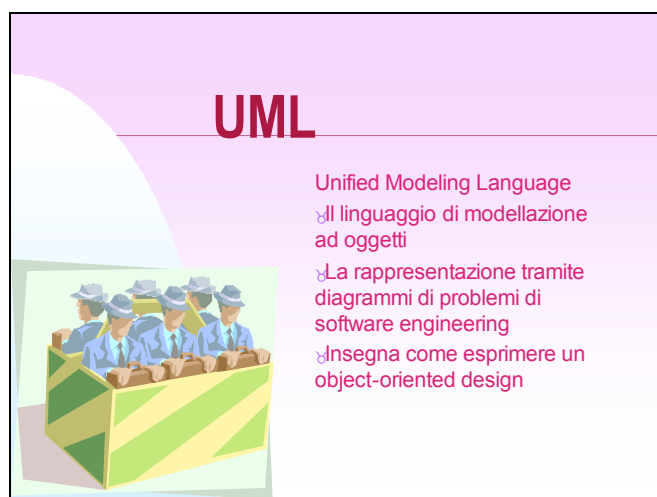
- the importance of standardisation of the information and the corresponding approaches at the international level : ISO 10303 STEP standard and IFCs

Main issues of the discussion :

- call for recruitment of a student for a joint research work between the two institutes (Polimi and EC Lille)
- possible questions sent by students for further information about modelling
- need of an initiation to modelling for those students

- Presentation of the UML modelling approach to students of the DiAP department at Polimi (4th year) and to Prof. G. Terna (Politecnico di Torino)

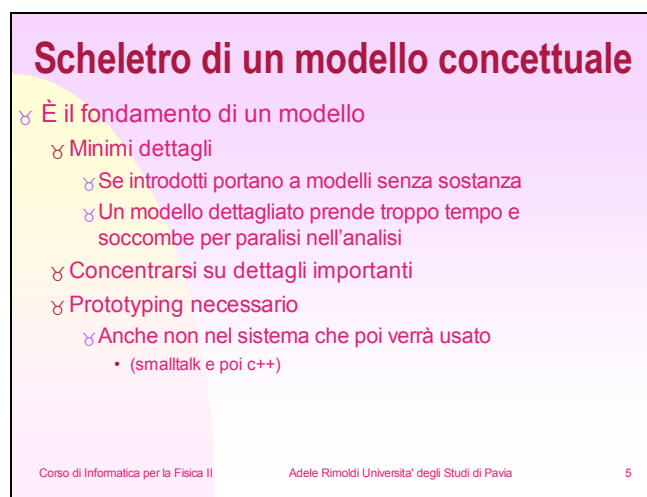
- **Schedule** : 2,5 hrs
- **Contents** : *see below*
- *in italian*



UML

Unified Modeling Language

- Il linguaggio di modellazione ad oggetti
- La rappresentazione tramite diagrammi di problemi di software engineering
- Insegna come esprimere un object-oriented design



Scheletro di un modello concettuale

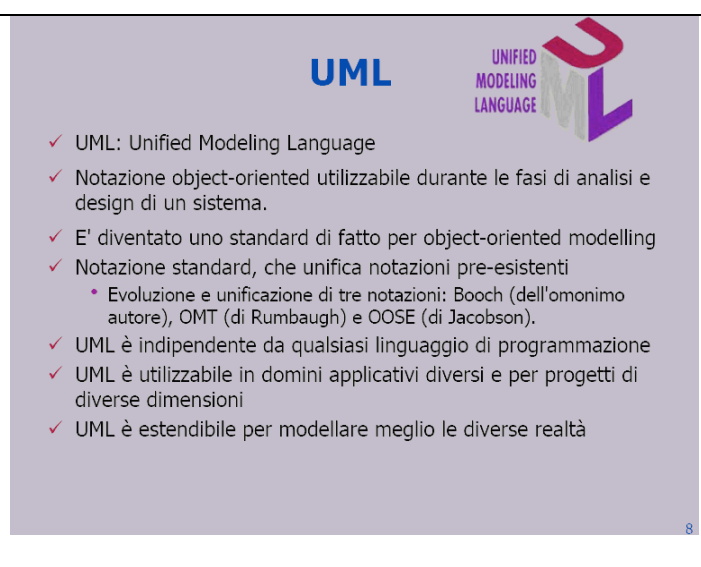
- È il fondamento di un modello
 - Minimi dettagli
 - Se introdotti portano a modelli senza sostanza
 - Un modello dettagliato prende troppo tempo e soccombe per paralisi nell'analisi
 - Concentrarsi su dettagli importanti
 - Prototyping necessario
 - Anche non nel sistema che poi verrà usato
 - (smalltalk e poi c++)

Corso di Informatica per la Fisica II Adele Rimoldi Università degli Studi di Pavia 5



Introduzione all'Analisi dei Requisiti e al Design Orientati agli oggetti

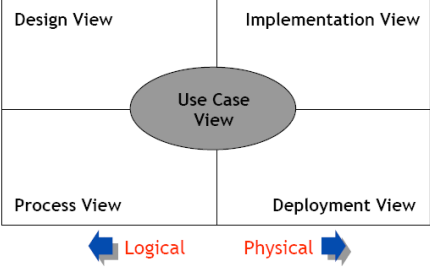
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UML UNIFIED MODELING LANGUAGE

- ✓ UML: Unified Modeling Language
- ✓ Notazione object-oriented utilizzabile durante le fasi di analisi e design di un sistema.
- ✓ E' diventato uno standard di fatto per object-oriented modelling
- ✓ Notazione standard, che unifica notazioni pre-esistenti
 - Evoluzione e unificazione di tre notazioni: Booch (dell'omonimo autore), OMT (di Rumbaugh) e OOSE (di Jacobson).
- ✓ UML è indipendente da qualsiasi linguaggio di programmazione
- ✓ UML è utilizzabile in domini applicativi diversi e per progetti di diverse dimensioni
- ✓ UML è estendibile per modellare meglio le diverse realtà

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4+1 Views	Diagrammi UML
 <p>P. Kruchten, "The 4+1 View Model of Software Architecture". IEEE Software 12 (6), pages 42-50, november 1995</p> <p style="text-align: right;">11</p>	<h3 style="text-align: center;">Diagrammi UML</h3> <ul style="list-style-type: none"> ✓ Viste statiche <ul style="list-style-type: none"> • Use Case Diagram • Class Diagram • Component Diagram • Deployment Diagram ✓ Viste Dinamiche <ul style="list-style-type: none"> • State Diagram • Activity Diagram • Collaboration Diagram <ul style="list-style-type: none"> • Interaction Diagram • Sequence Diagram <p style="text-align: right;">12</p>

- Introduction to the different diagrams provided by UML, use of these diagrams
- focus on : use cases, sequence and class diagrams, communication diagrams

* Issues, discussion :

- for Prof. Terna : use of sequence diagrams in simulation
- for the students : use of UML for the modelling part of their 2-month project

- Participation in the S4-European Modelling Tour workshop (2 days) : Exploring Urban Dynamics

See the programme of the workshop in the Annex to this report.

*** Presentation of the S4 European Research Group :

* **Objective of S4 :** <http://www.spatial-modelling.info/European-Research-Group-S4-Spatial>
<http://s4.parisgeo.cnrs.fr>

European Research Group S4: Spatial Simulation for Social Sciences

European Research Groups are research networks, with no legal identity, made of public or private European laboratories, working on the same scientific theme.

The *European Research Group S4* proposes to **develop spatial dynamic modelling as an integrative tool for understanding, discussing and helping to manage the evolution of our complex societies**. We shall **focus on comparing models' performances and enhancing their complementarities** for the simulation of spatial evolution at different scales and for a variety of applications.

* **Coordinating person:** [Denise PUMAIN](#), Fax: +33/1 40 46 40 09

* **Participants of the European Research Group S4 :**

- [Centre National de la Recherche Scientifique \(CNRS\)](#) (France)
- Univ. Paris VII/CNRS - [RIATE \(Réseau interdisciplinaire pour l'aménagement du territoire européen\)](#) UMS 2414 (France)
- Univ. Paris 7 Denis Diderot/CNRS - [Géographie-cités](#) UMR 8504 (France)
- Univ. Franche-Comté et Bourgogne/CNRS - [ThéMA \(Théoriser et Modéliser pour Aménager\)](#) UMR 6049 (France)
- Université Paul Verlaine, Metz - [CEGUM \(Centre d'Etudes Géographiques de l'Université de Metz\)](#) (France)

- Ecole d'Architecture de Nantes/CNRS - [CERMA \(Centre de recherche méthodologique d'architecture\)](#) UMR 1563 (France)
- Université de Toulouse 2 Le Mirail/CNRS - [CIRUS-CIEU \(Centre Interdisciplinaire d'Etudes Urbaines\)](#) UMR 5193 (France)
- Ecole Polytechnique de l'Université de Tours/Département Aménagement (CESA)/CNRS - [CITERES \(Cité, Territoire, Environnement et Société\)](#) UMR 6173 (France)
- Université de Haute-Alsace, Mulhouse - [CRESAT \(Centre de Recherche sur les Sciences, les Arts et les Techniques\)](#) (France)
- Université d'Avignon et des Pays de Vaucluse, Université de Provence Aix-Marseille 1, Université de Nice Sophia-Antipolis, Université Paul Valéry Montpellier 3, CNRS - [ESPACE \(Etude des Structures, des Processus d'Adaptation et des Changements de l'Espace\)](#) UMR 6012 (France)
- Universités de Caen, du Havre et de Rouen/CNRS - [IDEES \(Identité et différenciation des espaces, de l'environnement et des sociétés\)](#) FRE 2795 (France)
- Université Louis Pasteur Strasbourg I/CNRS - [Image et Ville](#) UMR 7011 (France)
- [RIKS \(Research Institute for Knowledge Systems\)](#) (Netherlands)
- Cranfield University - [Complex Systems Management Centre](#) (United Kingdom)
- Ecole Nationale des Ponts et Chaussées - [LVMT \(Laboratoire Ville, Mobilité, Transports\)](#) (France)
- University College London - [CASA \(Centre for Advanced Spatial Analysis\)](#) (United Kingdom)
- University of Pisa - [LISTA \(Laboratorio di Ingegneria dei Sistemi Territoriali e Ambientali\)](#) (Italia)
- Politecnico di Milano (POLIMI) - [Department of Architecture and Planning](#) (Italia)
- [STASA \(Steinbeis-Transferzentrum Angewandte Systemanalyse\)](#) (Germany)
- Université Catholique de Louvain (UCL) - [Département de géographie](#) (Belgium)
- [OSI \(Austrian Institute of East and Southeast European Studies\)](#) (Austria)
- Istituto Di Studi Politici Economici E Sociali [EURISPES](#) (Italia)
- [Istituto di Ricerche Economico Sociali del Piemonte](#) - *LabSIMQ-IREs* (Laboratorio di Sperimentazioni Innovative di Metodologie Quantitative) (Italia)
- Università della Svizzera Italiana (USI) - [Institute for Contemporary Urban Project of the Department of Mathematics](#) (Switzerland)
- UNIFI (Università Degli Studi Di Firenze) - [CSCD \(Dipartimento di Urbanistica e pianificazione del territorio\)](#) (Italia)
- New University of Lisbon - [CIGA \(Applied Geosciences Research Centre\)](#) (Portugal)
- Université de Lausanne - [Institut de géographie IGUL](#) (Switzerland)

* Objectives of the European research group S4

-> **As places are both revealing and integrating a wide range of sources of social change, from global trends to local daily interactions, space is a very important dimension for an information society.**

Many challenges facing European society are intimately related to the issues of spatial structure and its transformation over time as a result of a whole range of interacting decisions, policies and technological innovation. Some act at the European scale, such as the multiple changes that result from enlargement policies. Others are perceptible at more local scales, for example, the problems of availability of affordable housing near to jobs, the development of areas of social exclusion and of dislocation, the mismatch between supply and demand of public services, or the differential accessibility of cultural, leisure and educational infrastructures for different groups.

Without the underlying ability to take into account the spatial implications of multiple policies, decisions and technological changes, our societies will experience considerable unnecessary stresses, tensions and costs.

The objective of the Network S4 would be to help provide a dynamic, multi-scalar, spatial modelling capacity that could be used to anticipate the changing patterns of opportunity, stress and need that would result from emerging private and public initiatives concerning economic, residential, and infrastructural developments.

-> **Spatial simulation models are a way of linking together a variety of interacting social and physical processes**

Very complex socio-spatial dynamics can be presented on simple maps through different scenarios. We want to help public institutions to gain a much better knowledge of the objectives, preferences, trade-offs of the citizens (the "users" of the territory), and their decision-making processes, which determine spatial self-organisation and the reactions of the spatial system to plans and intervention. This will enable them to reliably compare sound and transparent scenarios of evolution, and to debate and make choices on the basis of well founded and structured knowledge.

*** Work done

- discussions with participants
- possibility of building collaborations with other research labs
- role of computer based approaches in geography : MAS (multi-agent systems), cellular automata, genetic algorithms, ontologies, ...
- many elements common to the two communities of people : geography and urban planning people
- multi-disciplinary teams : geography, modelling, computer science specialists
- role / importance of approaches based on modelling
- role of human aspects in urbanism

- Meeting with Prof. G. Turchini, Dean of the Faculty of Architecture - Building Engineering, Politecnico di Milano

- Exchanges of students between our institutes : already exist
- Need to develop research collaborations and exchanges
- Aim : to improve the international scope of the italian research through the development of international collaborations
- set-up a research network through :
 - + common research programs
 - + common research publications
- set-up collaborations between our institutes through relations between professional associations of the construction sector between the two countries : enabling the development of projects of a greater importance
- investigations to be made about the possibility of projects funded by the two countries (France and Italy).

- Investigations about the use of ontologies through discussions with the research team at Polimi

Informal discussions about ontologies with members of the team.

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. G. Rabino :**

- proposal of a book about modelling with facets related to epistemology and modelling, nature of the modelling problem, modelling tools

*** Results issued from the discussion with Presid. G. Turchini :**

- possibility of joint papers EC Lille / Polimi in Journals : both Italian and English languages (architecture Journals)
- other research collaborations : to be investigated : *see section 4*

*** Results following the presentation about UML :**

- follow-up of a student project of the DiAP Department, particularly for the system modelling
- collaboration with Prof. Terna : benefits of the use of UML representation for simulation

*** Investigations to be made about the possibility of a joint supervising of a PhD student : EC Lille / Polimi**

*** Need to make further investigations about the use of ontologies in the urbanistic approach of the construction project : see S4 workshop (section 2).**

4- Future collaboration with host institution

Several types of collaborations can be envisioned between the two institutes :

- Direct exchanges of researchers : funding to be found (possibly through research projects already worked out by the institutions)
- Collaborations through publications :
 - + on Journals : Italian, French, international
 - + through joint participations in international workshops
- Collaborations through research projects :
 - + 7th Framework Programme,
 - + COST,
 - + others ...
- Collaboration through specific actions : to be investigated further such as : Partenariats Hubert Curien (PHC) : EGIDE : see the URL : <http://www.egide.asso.fr/fr/programmes/pai/general/>
- More industrial collaborations : to be developed through contacts with professional associations active in Italy and France :
 - see if there already exists relationships in between them : set-up collaborations between the two academic institutions through professional networks across the two countries.

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

- See section 4 : book about modelling is planned as one of the main issues of this STSM
- The description of the mission and of its main results will be the subject of a presentation at the next COST C21 TOWNTODOLOGY project meeting to be held in Oslo on the 21st and 22nd of April 2008.
- A paper on the major modelling approaches related to the management of the different data / information / knowledge / organisations met in building and construction engineering and their mutual interoperability, the way of managing this interoperability through the use of ontologies is also planned as a joint work of the two research structures.

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

On behalf of the host Institute, the Politecnico di Milano, Department of Architecture and Planning (DiAP), I (prof. Giovanni Rabino, member of DiAP involved in the COST C21 Action and national delegate in this COST action) confirm the successful execution of the STSM by prof. Anne-Francoise Cutting-Decelle (professor of Ecole Centrale de Lille and COST C21 Member).

This report prepared by prof. Cutting-Decelle shows that:

- all the activities done in Milan (meetings, discussions, lectures, etc.) develop in an effective and efficient way the research ideas at the basis of the STSM proposal;
- the results of these activities are very useful advancements primarily for the COST Action, but also for the Ecole Centrale de Lille and the Politecnico di Milano.

Here I like only to add two short notations to such a complete report,:

- on one hand, a better understanding of relationships among models, metamodels and ontologies (such as gained in this Cost Action, with a great contribution from this STSM) can consistently help to the (semantic and operational) interoperability of urban models, a requirement of the new participatory planning practices, new cognitive modelling approaches and new multi-agent model typology;
- on the other hand, these new planning and modelling styles, all rooted in the “science of complexity” (auto-organization of systems, emergent properties, irreversibility ...) raise new interesting “ontological” questions; and this STSM helped in discovering these new frontiers of study for the current C21 Cost Action and potentially for new Cost Actions.

Milan, april 29th, 2008

Signed: prof. Giovanni Rabino

7- Other comments – conclusion – perspectives

As a matter of conclusion, this week spent at Politecnico di Milano provided a very good opportunity of discussing with many people coming from various backgrounds and horizons, and to confront opinions about the overall environment of building.

This week was also very rich in terms of the knowledge gained from the discussions with people whose background was different, even opposite to mine.

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

- Building and construction is still today a major research domain, numerous disciplines can be identified under this generic denomination.
- Numerous research communities are working in this field.
- Most of the time, those communities are working separately – however intersections begin to emerge !
- Some of those communities share a more scientific and technical approach of the construction process, mainly focused on product, material, process based approaches.
- Organisational approaches are recent, there are most of the time borrowed from other industrial sectors that have had to face re-engineering problems, quality management situations.
- Human centered approaches are the subject of several researches : the building is thus considered through its integration in human focused entities : city, region and country.
- Relations between those different communities, within the same country (same language, same culture), or across countries (with different languages, same or different culture(s)) are not obvious : there are not frequent whence the importance of workshops such as AESOP (URL : <http://www.aesop-planning.com/>) or S4 (URL : <http://www.spatial-modelling.info/European-Research-Group-S4-Spatial>).
- Whatever the community, whatever the approach followed within the research community, all of them share common needs in terms of modelling :
 - ** Need of strong modelling methodologies, built on well-founded and sound theories
 - ** Need of methods to express and formalise information and knowledge about a system, then to formally represent this information and knowledge
 - ** capability to assess and to check the robustness of a model

** possibility to make those models interoperate once implemented on computer based systems (most of the time leading to important interoperability problems) : those problems often become critical due to the increasing number of models and methods used

==> needs of approaches such MDA (Model Driven based Approaches) providing the theoretical bases necessary to make the models interoperable

==> need of ontologies to provide the common interpretation of the knowledge underpinned in the models processed according to the MDA approaches

** The use of ontologies is not yet considered as a common, usual way of reasoning and working within these research communities – However, given the discussions held during the meeting, the situation is evolving :

- To date, very often the knowledge that could be embedded within ontologies is scattered amongst the actors of the teams

** Most of the time, the need for ontologies emerges from, or comes out from the need to make models cooperate. When the models are developed for a stand-alone use, ontology development is not considered as crucial.

The building and construction sector can be seen as a crossroad between scientific and technical sciences, and social sciences, as such, it is a very rich study domain.