Workshop: Linked Data in Architecture and Construction
Wednesday 28 - Thursday 29 March, 2012
Organized by: SmartLab, Multimedia Lab
University of Ghent, Belgium

RESEARCH PROJECTS

Dr. Leandro Madrazo
ARC Enginyeria i Arquitectura La Salle
Universitat Ramon Llull
Barcelona, Spain

www.salleurl.edu/arc
ARC (Architecture Representation Computation) is a multidisciplinary research group integrated in the School of Engineering and Architecture La Salle founded in 1999.

Members of the group are architects, computer scientists, multimedia engineers and graphic designers.

It is dedicated to the design, development and application of information and communication technologies (ICTs) to architecture in different areas, including education, design and construction.
Research lines

**Architectural Design and Building**
Computer-based design and construction processes, building information modeling (BIM), building component catalogues, modular buildings and industrial construction.

**Pedagogy**
Environments to support collaborative learning, repositories of educational resources and learning systems.

**Information spaces**
Interactive interface design, information visualization, concept mapping and data mining.
ARC is a multidisciplinary group dedicated to the design, development and application of information technology and communication (ICT) architecture, in several areas: education, projects, and research. The group was founded in 1999 and in 2009 was officially recognized as research group by the Catalan Government. During this time, it has conducted numerous educational and research projects, whose results have been published in journals and at international conferences.

Currently, the lines of research of the group are:
- Design and construction: building information modeling (BIM), modular construction and manufacturing, simulation, design and construction processes, and product modeling.
- Pedagogy: collaborative environments, digital repositories, and learning models.

Among the projects funded by national research programs in Europe stand out: coordination of the project Barcode System Housing (Spanish National R+D+I plan); coordination of the project REPENER (Spanish National R+D+I plan); coordination of the European project OIKODOMOS (Life Long Learning Program), as well as the participation in the FP7 project Intube.

**Featured Projects**

- **VRML environment that allows users to set relationships between spatial units, building a 3d model collaboratively. Awarded first prize in the category “Interface design” in the international competition “ACADIA Digital Design Exhibition, 2002”...**

- **Web environment that allows a group of students to analyze texts by means of a semantic network.**

- **Web-based environment to visualize and send photographs and photomontages done in the theme IMAGE of the course ‘SDR, Sistemas de Representación’.**

- **Web pedagogic environment to promote collaboration between citizens and architecture students in the urban analysis and transformation.**

**Conferences**

- **ECAADE Conference 2011-10-10**
  The paper “OIKODOMOS Virtual Campus: Constructing learning processes in collaboration” was presented in the ECAADE conference, that took place September 26 to 28, in Ljubljana, Slovenia.

- **CIB Conference 2011-10-10**
  ARC will participate in the CIB W073-W102 conference with the paper “Integration of an infrared-based monitoring system with an EIP....” which presents some of the results obtained in the FP7 project INUBE. The conference, organized by CSTB, will take place in Sophia Antipolis, 26 to 28th October.

- **OIKODOMOS International Conference 2011-07-12**

- **CAAD Futures 2011 2011-07-12**
  A poster has been presented in the CAAD Futures conference, that took place in Liége, from the 4th to the 8th of July 2011, which summarizes the development of an integrated information platform to improve energy efficiency in the entire building lifecycle. The research work has been conducted in the project FP7 Intube and is continuing in the project REPENER, funded by the Spanish National RDIT plan.

**News**

- **Workshop on ontology modelling 2011-12-29**
  The ontology modelling workshop, held in our institution this week on 27-28/12/2011, joined people from different countries (Spain, Belgium, Germany) with the idea of sharing knowledge and common issues about ontology design methodologies, linked data, ontology matching, data mining with ontologies...
Research projects

**OIKODOMOS** (Long Life Learning Programme, 2007-2011)
A Virtual Campus to promote the study of dwelling in contemporary Europe

**REPENER** (Spanish National RDI plan, 2009-2012)
Control and improvement of buildings energy efficiency by means of repositories

**SEMANCO** (FP7 programme, 2011-2014)
Semantic Technologies for Carbon Reduction in Urban Planning

OIKODOMOS Virtual Campus is a space of collaboration where schools of architecture and urban planning collaborate in the design and implementation of learning activities to study housing in an interdisciplinary way.

It is a network of learners (teachers, students, adult learners) and activities, as opposed to an organization of schools with shared curriculum.

A digital platform has been specifically developed and implemented for the Oikodomos Virtual Campus to support a blended-learning pedagogic model. It consists of two environments: Workspaces and Case Repository.
OIKODOMOS digital platform

OIKODOMOS ICT PLATFORM

WORKSPACES

Searching for relevant examples

Document generated to be used as deliverable

CASE REPOSITORY

Project-based learning: Design/implementation of learning activities, tasks, deliverables, evaluation

Case-based learning: repository of cases, knowledge elicitation, collaborative analysis

www.oikodomos.org
OIKODOMOS: WORKSPACES

Workspace: Proximity

Data Start: 16 February 2011 Data End: 17 July 2011

This workspace is dedicated to analyse and rethink the status and design of the contemporary domestic in densification processes in European multilayer landscapes. Besides existing theories and practices of the field, the open call is a way to pose the visual landscape, dense energy, consumption and social cohesion. Many other shows a concerning practice of ten doma landscapes containing an efficient and sustainable furnishing of urban systems. A Joint Workshop dedicated to this theme will take place in the Istanbul Technical University, from May 2nd to 6th 2011.

Institutions participating in this workshop:
ITB, Sint-Lucia, RIS, FA, STU, ESL, Gebze Institute of Technology, URL - La Salle, Other, SUSUM, Escuela Técnica Superior de Arquitectura de Valencia, USB

Workspace: Winter Semester 2010-11

Data Start: 31 October 2010 Data End: 22 February 2011

Learning Workspaces for the shared learning activities in the Winter Semester

Institutions participating in this workspace:
RIS, Sint-Lucia, URL - La Salle, EHU, FA, STU, USB

Workspace: The FINAL WORKSHOP

Data Start: 09 November 2010 Data End: 13 December 2010

OIKODOMOS is an agenda research project funded by the Lifelong Learning programme (2007-2013) carried out by higher education institutions and research centres from Belgium, France, Hungary, Netherlands, Spain, Switzerland and the United Kingdom. The goal of the project is to create a virtual campus to promote the study of dwelling in a European setting. The OIKODOMOS campus is developed interactive online workspaces, which have been inspired from the diverse architecture of European institutions. In parallel to this, a virtual campus has been created in a 3D environment aiming at the reconfiguration of different urban studies and research practices. A final exhibition at the OIKODOMOS campus will be held in the 3D environment.
WORKSPACES

A learning environment where teachers can design learning activities in collaboration

Students develop the tasks both in the digital environment in the classes

www.oikodomos.org
WORKSPACES

Learning tasks are organized in sequences.

Each task can be carried out by a different group of students, in one or several institutions.
CASE REPOSITORY

It contains over 350 cases of housing projects and buildings, documented and analyzed by students from different schools.

It is more than a digital library: it is a learning resource to support collaborative learning.
Flexibility and Variability

Housing flexibility and housing variability can be defined as the design of dwelling structures with an understanding of the prospective development of the site as well as life and social scenarios, and with the possibility of making appropriate changes in the living environment. Flexibility and variability enable one to change the living environment according to the new requirements in the course of their existence. It can be applied to urban and architectural design related to the actual and future needs of the people living there.

In the urban context it applies mainly to the structure of amenities of a city and community in order to design specific areas for shops, services, offices, leisure and culture. The variable, flexible structure of amenities of a community within a city offers an attractive mixture of different functions, which can be linked in a variety of ways with multifunctional, point-concentrated units, i.e. shopping malls, multipurpose complexes, courthouses and greenery. Public spaces play significant role and create a connecting framework for the combination of individual amenities. Public spaces may offer a number of variable, flexible elements that increase their attractiveness of use and may also change their functions. The final outcome in the context of a variable, flexible urban structure improves the quality of housing through its relationship to such structures.

In the architectural context, the flexibility and variability provide specific conditions to create spaces that are designed to change their functional use. They are the spatial expression of the activities created by a rapidly changing way of life. Architects and planners must be able to translate the needs and resources of society into plans and express the ideals of the time.

Related Cases

Variability of dwelling unit (student work)
A variable apartment is a dwelling without changing the total area and inexpensive modifications to the floor plan.

Flexibility of dwelling unit (student work)
A flexible apartment is a type of flexible but uncomplicated and sliding walls and a variety of furniture elements are changed. Such an apartment can be a variety of functions.
Containt remains hidden in the repositories, it is difficult for new users to find “decontextualized” information.

Potential relationships among databases are not visible.
- Flexibility and Variability is a tag attached to case Les Nids in Case Repository.
- Flexibility and Variability is a Keyword attached to learning activity Reflections on Housing in Workspaces.
- Urban theoretical concepts is a task added to learning activity Reflections on Housing that has attached Flexibility and Variability keyword in Workspaces.
- Today’s apartment architecture is a reference attached to concept Flexibility and Variability in Oikopedia.

GOALS
To transform the interface in a space of interaction, with certain “depth”
The interface helps the user to construct knowledge; it is more than a search tool.
Spanish National RDI Plan, 2009-2012

The purpose is to create an energy information system based on the model proposed by the initiative Linked Open Data.

The energy model embraces two kinds of energy information:

- building information (building systems, consumption,...),
- contextual data (economics, climate,...)

The data sources are of two types: proprietary and open. Both types of data sources have been interlinked by means of ontologies.
To build-up the **energy model**, the knowledge of experts in building energy domain was formulated in terms of categories. These categories provide the starting point for the creation of a generic **data structure**.
Use cases have been used to reduce the number of parameters (potentially an immense list!) included in the energy model data structure. Energy parameters have been analyzed and classified and relationships between them have been identified. Based on this study, an open and flexible data structure has been created jointly by energy experts and ontology engineers.
The core of the information system is the energy model which contains descriptions of terms, relations, types and units which are present in all of the data sources.

The energy model is implemented as a global ontology which is the union of the sets of terms from all data sources.
• Local ontologies have been designed for each data source using the OWL.

• An ETL process has been applied to translate relational databases into RDF.

• D2RQ mapping language has been used to obtain RDF dumps which have been uploaded to a RDF server (Virtuoso server).
Welcome to REPENER!
Introduce yourself and REPENER can bring you the information you need

I’m a
- building user
- building owner
- architect
- engineer
- facility manager
- public administrator
- researcher

I’m involved in a
- project of a new building
- project of building retrofit
- feasibility study
- energy certification
- research

I’d like to know
- typical solutions
- building examples
- typical performances

[type other]
see more
REPENER - Control and improvement of energy efficiency in buildings through the use of repositories

<table>
<thead>
<tr>
<th>building location</th>
<th>Cerdanyola del Valles</th>
</tr>
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<tbody>
<tr>
<td>Main building utilisation</td>
<td>residential</td>
</tr>
<tr>
<td>Passive Systems</td>
<td>[mark items √ ]</td>
</tr>
<tr>
<td>orientation</td>
<td>☐</td>
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<tr>
<td>insulation</td>
<td>☐</td>
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<tr>
<td>envelope</td>
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<tr>
<td>solar control</td>
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<tr>
<td>inertia</td>
<td>☐</td>
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<tr>
<td>natural ventilation</td>
<td>☐</td>
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<tr>
<td>Active Systems</td>
<td>[mark items √ ]</td>
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<tr>
<td>heating</td>
<td>☑</td>
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<tr>
<td>Energy Carrier</td>
<td>☐</td>
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<tr>
<td>gas</td>
<td>☐</td>
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<td>oil</td>
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<tr>
<td>biomass</td>
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<tr>
<td>electricity</td>
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<tr>
<td>renewable</td>
<td>☐</td>
</tr>
<tr>
<td>Degree of centralisation</td>
<td>☐</td>
</tr>
<tr>
<td>district heating</td>
<td>☐</td>
</tr>
<tr>
<td>central system for building</td>
<td>☐</td>
</tr>
<tr>
<td>system for apartment</td>
<td>☐</td>
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<tr>
<td>other</td>
<td>☐</td>
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</tbody>
</table>

See the 137 building examples found!
CO₂ emissions reduction is a systemic problem that must be addressed at multiple geographical, social and economic scales. This approach to carbon reduction in urban environments can be fostered by exploiting ICTs and the application of semantic energy data modeling.

SEMANCO’s purpose is to provide semantic tools to different stakeholders involved in urban planning (architects, engineers, building managers, local administrators, citizens and policy makers) to help them make informed decisions about how to reduce CO₂ emissions in cities.
SEMANTIC ENERGY INFORMATION FRAMEWORK (SEIF)

Application domains
- Building stock energy modelling tool
- Advanced energy information analysis tools
- Energy simulation and trade-off tool
- Interactive design tool

Stakeholders
- Policy Makers
- Planners
- Designers/Engineers
- Building Managers
- Citizens

Technological Platform
- Building repositories
- Energy data
- Environmental data
- Economic data

Enabling scenarios for stakeholders
- Regulations
- Planning strategies
- Urban Developments
- Building Operations

CO₂ emissions reduction!

WP2
WP3
WP4
WP5
WP6
WP8
SEIF: Semantic Energy Information Framework

TOOLS: (visualization, analysis, simulation)

ACCESS TO SEMANTICALLY MODELLED ENERGY DATA

OUTCOMES FROM TOOLS IMPROVE ENERGY MODEL

ENERGY PROFILES ASSOCIATED TO BUILDINGS TYPES CALCULATED BY TOOLS

RETRIEVING DATA ACROSS DIFFERENT GEOGRAPHIC SCALES

Interfaces with external tools

Mapping tool

Exploration interfaces

Ontology Repository

Energy Model

Off-line data

Building repositories

Monitoring data

Open Linked Data

Environmental data

Economic data

Energy data

DATA: Distributed repositories of energy related information

TOOL: SEIF - Semantic Energy Information Framework

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DATA: Distributed repositories of energy related information
www.salleurl.edu/arc
Spanish National RDI plan, 2005-2009

2002-2005, development of a stand-alone prototype system

2005-2009, development of an environment which supports the design and construction of housing blocks with flexible dwellings, using industrial components and assembled according to the principles of open prefabrication.

It is an open, participatory, modular system that facilitates the interaction of the different actors (architects, builders, manufacturers, occupants, facilities managers) involved in the design, construction and use of housing.
In this project we have built our own data model, it is not using BIM. Because of this, we could integrate a building model with a product catalogue; we could define assembly rules for spaces as well as for building components. This integration of the different environments worked because we had control on the whole environment. To achieve such level of integration using BIM software we would need to use of semantic technologies.
A graph represents the spatial structure of a housing unit in terms of relations between cells.
These are the floor-plans generated by the rule-base system
These are examples of the kind of housing blocks that can be generated by assembling the housing units. The...
These are examples of the kind of housing blocks that can be generated by assembling the housing units. The
The architectural attributes extracted in the last stage of the generative process are used to cluster housing units. The architect seeks in the system the most appropriate housing units for a specific program requirements. The search is done with clustering techniques.
The housing units retrieved in the previous interface are used to generate the block. In the process to create a housing block, the housing units (infill) and support structure (e.g. the rules governing the position of building systems, structure, ...) need to conform to each other. The final block is the solution of the interaction between both systems, infill and support.
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Support and infill: The underlying support structure which holds a variable combination of housing units

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The building model is thought of a system made up of four subsystems. Each subsystem is made up of the components defined at the lowest level. The relationship between levels is in both directions, from top down and from bottom up. Thus, the selection of a particular component for structure might determine the spatial composition (bottom up), while the selection of a particular subsystem (e.g., steel structure) determines the lower level components.
The collaborative process of design and construction is structured in different environments. Different actors can intervene at different stages. The diagram shows the flow of activities leading to the generation of a housing block.
PRODUCT’S CATALOGUE

Building components are selected from the catalogue

This is a product catalogue open to external providers but only used by the BCHS model. A research topic could be to developed product catalogues using semantic technologies which can interoperate with