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W096 Architectural Management

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Performance and Knowledge Management Joint CIB Conference

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Preface

There is a never-ending demand for performance improvement in the building industry internationally. This imposes the need for better construction professionals and effective innovation management. The busy practitioners take in and convert the information from contracts, plans, specifications, catalogues, research reports, websites etc. into knowledge when they are obliged – by contract or by law – to do so. The other way is to learn how the new practises make their life easier. Information and knowledge management is a prerequisite for performance improvements. We need to understand the current situation in order to propose better performance, and to convert effectively and efficiently information into knowledge in real building projects. The objectives of CIB2008 joint conference were to study:

- Knowledge based performance improvement
- Architectural design management and knowledge
- Communicating design
- Integral design and knowledge development
- Data and knowledge sharing in construction projects
- Role of client in the construction process
- Adaptation of KM in organizations
- How to build and maintain viable KM architectures and thriving communities of practice
- Networking with knowledge

This joint conference brings together two CIB working commissions: W096 and W102. CIB is the International Council for Research and Innovation in Building and Construction. The local organizers are the Association of Finnish Civil Engineers (RIL) and Vaasa University of Applied Sciences.

In 1992 the first conference on architectural management, initiated and organized by Paul Nicholson, was held at the University of Nottingham in the UK. During the same year CIB approved the formation of the working group W096 Architectural Management. Since this time the Commission has been active in the area, with regular conferences, meetings and published conference proceedings. The Architectural Management working group attempts to bring together researchers and practitioners worldwide, concerned with the whole life cycle of building and construction projects. Active working areas are; revaluing design, communicating design, inclusive design, design management, design integration, design management education and revaluing architectural practice – all with an underlying sustainable research agenda.

The first meeting of W102 was initiated and organized by Colin Davidson in Montreal, Canada in 1999. During the same year CIB officially accepted W 102, Information and knowledge management in building, to be its new working commission in the area of information and documentation. The working group explores for example, information and knowledge management processes to improve performance in construction supply chains; the challenges of global markets for professionals, firms and construction industry in different countries; the challenges of innovation, information and knowledge transfer to Small and Medium Enterprises; and how the exploitation of information and knowledge management could benefit construction education.

Thank you all authors around the world who provided excellent contributions to this book and related full paper proceeding. I would also like to express my gratitude to the scientific committee whose advice and reviewing has considerably helped in forming the book of extended abstracts and full paper proceeding. Special thanks to editors of these volumes.

In this full paper volume we have 37 accepted papers. In the extended abstract proceedings we have 43 papers.

Dr. Marja Naaranoja
Chair of Scientific Committee
CIB Helsinki 2008
Joint Conference of CIB W102 and CIB W096

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Integral Design and knowledge development

Semiotic based facetted classification to support browsing architectural contents in MACE

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Abstract

The research project MACE[1] presented in this paper aims at organizing already existing architectural and engineering digital archives stored in European repositories. The new settled interconnections will be driven both by usage and by structured-knowledge; moreover, contents and interconnections will be accessible in an intuitive and interactive way. The goal is to create an ensemble of findable, accessible and reusable information, hence forming the basis of a meaningful, extensible network of architectural information.

Keywords: semiotic, browsing, MACE, repository, architectural knowledge, architectural digital contents

1. Introduction

As we can experience when approaching digital repositories, the online data quantities to be scanned via search engines is enormous, and increasing. If on one hand this intuitively represents a big progress and advantage for the general knowledge, on the other one implies a greater effort to efficiently organize databases which otherwise risk to become labyrinthine and unsolvable tangles.

In this big and general effort, MACE aims at gathering architectural information, lying in many different and dissimilar repositories, and efficiently organizing them. The goal is to interface these repositories with heterogeneous kinds of users (e.g. students, designers, administrators,

[1] MACE (Metadata for Architectural Contents in Europe) is a project co-funded by the European Commission inside the eContentplus Programme, a multiannual Community programme to make digital content in Europe more accessible, usable and reusable.

technicians, etc.), each of one with particular interests and needs (architecture's theories, design references, normative aspects, etc.).

The paper describes the considerations, the studies and the methodologies followed to develop the MACE system and its conceptual infrastructure, while moreover illustrates some potentialities of this classification that will allow students, engineers and architects to recognize, detect and link the contents through an interactive system, which reflects their typical logical behaviour [1]. The MACE system can be seen as knowledge organization system, which "serves as a bridge between the user's information need and the material in the collection. […] Whether through browsing or direct searching [...] [it] guides the user through a discovery process." [2]

2. Approaching the *knowledge organization system* in architecture, urban planning and construction management domain.

An architectural project constitutes a great syntheses effort, where different knowledge fields – may they be connected to the poetic-artistic side (ideas, cultural and social message of a project) or to the technical one (functionality, living wellness, building ease) – are called to simultaneously gather a project. To find a coherent strategy to approach the *knowledge organization system* of such a heterogeneous subject, the various and interconnected issues have been separated and re-ordered on the basis of two possible end users' point of view, which are:

- the researcher, interested in architecture's world, aiming to deepen descriptive aspects, documentation and technical knowledge, but without any design-applied goal (*Documentation activity*);

- the *designer*, may he be a professional or a student, active in sectors as architecture, city plan and civil engineering design (*Design Problem Solving activity*).

To develop classification and searching tools able to interface the enormous quantity of data with the needs of the users, it is necessary to analyze and understand the users' behaviors during these two kinds of activity.

2.1. Knowledge organization in the *Documentation Activity*: objective data.

The *Documentation activity* is a work that can be held both by students as well as other users using MACE to obtain information about history, geographical locations, typologies, techniques and general documentation in the world of architecture. To allow this kind of activity, part of the classification system needs to be based on *objective fields* that should cover all the *objective* aspects of the domain. With *objective fields* we mean all those aspects of architecture that refers to objective (non-interpretational) data and for this reason aren't influenced by architectural trends or by theoretical and personal concerns. The main challenge in this case is to develop a standardized and shared taxonomy, able to cover all the aspects of the discipline featured in the architectural and engineering domain.

2.2. Knowledge organization in the *Design Problem Solving*: personal and intuitive data.

It is, on the other side, more complicated to identify rules and structures founding such a system to support the *Design Problem Solving Activity*. This is because architectural design deals with complex shapes which represent, through the architect's personality and his conceptual filters, deeper messages. Therefore, architecture and the built environment is not only the technical production of concrete "facts" of various dimensions (from a city to a small object), but it is also a "sign" featuring a message. For this reason we can compare it to a text [3], as it is built through materially sensible signs (structures and building materials), while a written text is made of syntactic structures and graphic signs, perceptible through reading.

One of the bigger differences between architecture and language evidently lies in the nature of signs themselves: while we use elementary, cost-free and intellectual elements in writing, in architecture we deal with complicated signs, both from perceptive and economical points of view. Furthermore, "writing" and "language" moreover rely on defined and recognized code, while architecture, on the contrary, is presented by often ambiguous and hardly readable signs (even if in some cases for well-defined historical periods and cultural areas, architecture enjoyed indeed a universally well-known repertoire and language, e.g. in the Palladian style).

Comparing the architect to the author of a text, the architectural speech will express his meanings through perceptible signs. Therefore, conceiving a project is similar to the process of creating and communicating a message, at least for the conceptual aspects of the process which also are the most complex and ambiguous ones.

To classify and organize the knowledge related to these kinds of mental processes it is not wise to rely only on objective data (as in the *Documentation Activity*). Reading a visual text, except when it is a hyper codified system as a road sign (e.g. a Stop-sign) or a simple written text (e.g. "do not smoke"), always involve ambiguity and complexity (which are immanent in visual arts). The reading of a visual text therefore always requires a *personal and intuitive interpretation* which is both *individual*, when choosing among many ambiguity factors, and *partial,* when focusing on some complexity factors.

For this reason, the organization of the classification system needs to be based both on *objective* data and on *personal and intuitive* data, which will intercept the personal and intuitive interpretation peculiarity of the *Design Activity*.

At first glance, trying to classify non-objective data may seem to be an oxymoronic task. But if we consider modern and contemporary artistic production, we can see that often the oeuvre represents a true challenge sent by the author to the spectator, who is called to participate to the work's creation and to the research of a meaning through the lenses of his/her own personal history and personality[2]. Semiotics theory, notwithstanding its slow and sometimes contradicting evolution of the last half century, states the basis to help us perceiving and understanding messages in art.

Thanks to those studies and methodologies we can try to develop strategies to classify non-objective data. It's not our intention to summarize here a balance of the semiotics studies' results, even if limited to the visual arts field. Among the complex and variegated interpretative models offered by the current state of this discipline, we decided to rely on the Hjelmslev's interpretative model, to find the *personal and intuitive data,* used as reading keys to an architectural project. This model is based on the double opposition of *contents/expression* and *substance/form* [4] and on its following interpretation and adaptation held by A. J. Greimas [5] and his young pupils in Paris school during the 1970s. The model, initially evolved in urban analysis research, has then been first extrapolated and enlarged to a system of categories and levels devoted to the reading of any visual work[3], and then reduced and focused on architectural works[4] [8] [9].

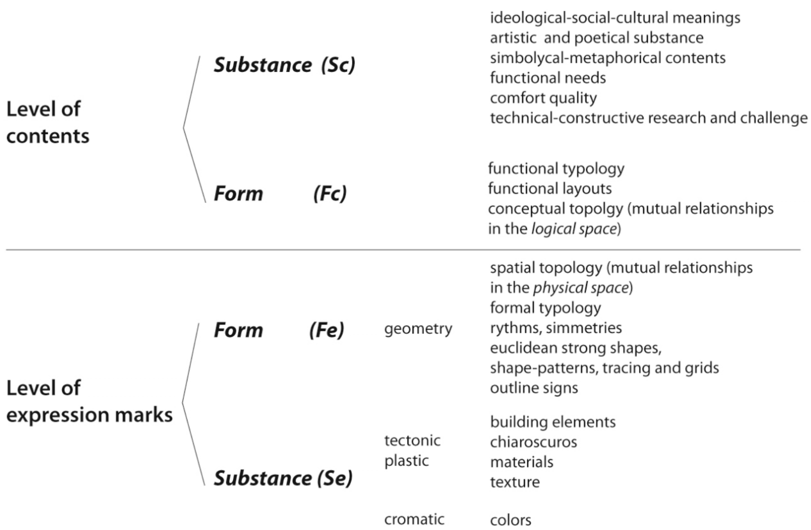

Figure 1: The Hjelmslev's interpretative semiotic model, based on the double opposition of contents/expression and substance/form, reduced and focused on architectural works [8]

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[2] Kandinsky, for example, in the introduction of his book "About spiritual in art" [6] give us some cues to understand and de-code artworks.

[3] Our choice is supported by similar addresses we find in some more recent studies: Thürlemann's work for painting, especially addressed to Klee's and Kandinsky's oeuvres [7]; Castiglioni's interpretative model focusing on urban design; models followed by Eco's and Calabresi's pupils at D.A.M.S. in Bologna during the 1980s.

[4] The sequence of concepts involved in the design activity has been thoroughly studied by IUAV of Venice (Prof. V. Spigai), in collaboration with UNIVPM in Ancona (Prof. M. De Grassi), during the period 1994 - 2004.

2.3. The knowledge organization system as aid in the *Documentation* and *Design Problem Solving* Activity.

The ways to deal with the designing activities are not the same all around the different architectural trends and schools in the world, and in particular among European universities; moreover they are influenced by the designer's personal convictions, artistic taste and poetical ideas.

For this reason, we are developing a knowledge organization system, based on the semiotic model displayed in figure 1 (built on the different levels of Contents and Expressions, Substance and Form), that aims to offer the possibility to answer to different needs of the various *Design Problem Solving* trends and approaches. An architect or a creative designer will need an approach based on personal and intuitive data and the keys may be about formal ideas, metaphors or intuitions chosen as starting point of the design speech (for example, a designer following the suggestion of transparency, could search through the system for design cases featuring a "transparent" *perceptive quality* to use as example to develop his own project; Fig 2). On the other hand, an engineer designer will need access to the system by objective data, and the keys may be about building elements, materials or technological performance.

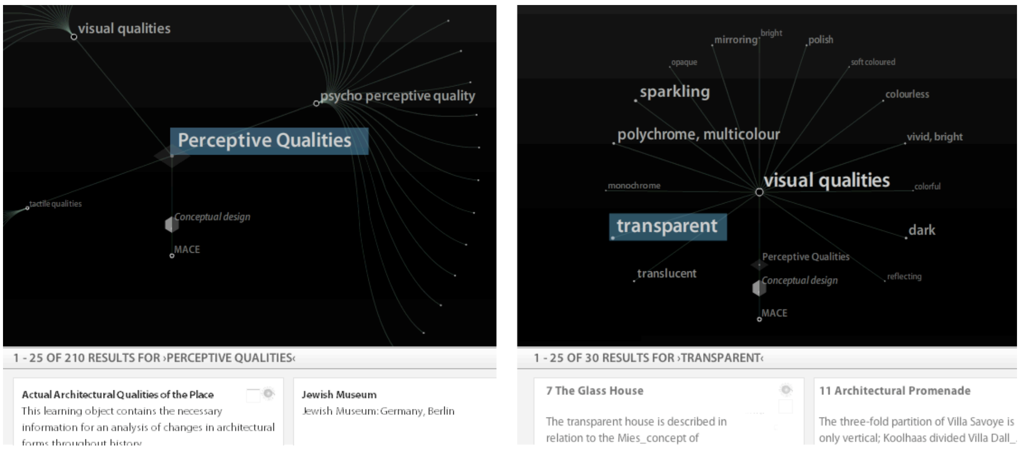

Figure 2: The user navigates through the taxonomy to the final term. The results are continually updated, enabling search refinement. He then can select one of the items for further inspection.

Moreover, this classification system allows the use of multiple, semiotically-interconnected search keys. This can be of great utility for a more focused search which, using the same number of filters of a normal search, will lead to fitting results faster and more effective. In other words, the system is set on a search for elements and suggestions characterized both by *content* and *expression* features; hence, the search is addressed to find "architectural texts, or fragments, where forms and signifies are possibly both present, and united" *[9]*.

Here two hypothetical examples, referring to well-known architectures, to clarify how the logic scheme of the semiotic model (Fig 1) is used to classify architectural features, principles that will be used in the MACE knowledge organization system.

We can imagine:

- A student who tries to find an example of a building expressing lightness. He can trigger a combined search with "aerial" (in a symbolic-metaphorical meaning, *substance of contents*) and "metallic structures" (*substance of expression / tectonic / building elements"*). These two search-keys may lead to the Eiffel Tower in Paris and to the Crystal palace of Joseph Paxton in London being both of them correspondent to an oeuvre expressing the combination of a *signifying* element (*"aerial"*) and a perceptible *significant* (*"metallic structures"*). If a further filter *"glass"* (*substance of expression / plastic / materials*) has been used, he would have found only the Paxton's building (a glass and steel architecture, expressing aerial lightness).

- A professional who wants to design a building expressing power, massiveness and classicality *(substance of contents*). He starts his search looking for "massive" elements, finding a lot of cases. By refining the search with "Euclidean shape" (*form of expression*) he reduces the results and among these he may get: the Neue Nationalgalerie by Mies Van Der Rohe in Berlin, Palazzo Pitti in Firenze and the Pentagon Headquarters U.S. Defense. He finally adds a feature about materials: "reinforced concrete" (*substance of expression / plastic / materials*) and the latter features allow him to isolate the case study of Pentagon headquarters. If he inserted alternative features as *substance of expression* entries, he would have found other results: e.g. the term "iron" would have led to the Neue Nationalgalerie; the term "masonry" to the monumental Palazzo Pitti. It can be noticed how this path can also be experienced in the other way round, e.g. starting from a search-key as "masonry", or from a middle step, as could be done if starting with "Euclidean shape".

The logical scheme of the semiotic model allows then a focused and aware search, devoted to the finding of *architectural texts* featured by their relationships between conceptual features (*contents*) and physical/constructive properties (*expressions*).

On a system like MACE, based on this model, the user is allowed to insert in his search those elements of *sense of a speech* that can go beyond the more banal aspects as typology-functions (e.g. the typological category "school"), historical-artistic trends (e.g. "Modernism", "Hans Scharoun") or geographic position (e.g. "Germany"). This possibility constitutes, we believe, an important feature of the browsing system of MACE.

3. Searching and browsing in architecture *Documentation* and *Design Problem Solving*

From the previous paragraphs it becomes evident that one of the most important phases in these activities is the information gathering, which is an important but not linear process. In some cases it is characterized by a *purposive information-seeking behavior*, when this is a conscious and focused activity; while when it is an instinctive almost involuntary action of drawing information from the most disparate repositories (an action sometimes disguised as creation or invention, but actually a work of referencing to them) we can speak of a *seemingly non-purposive information behavior* [10].

These two basic figures (mentioned in chapter 2) are characterized by different approaches to the information sources. It is possible to distinguish "between *analytical strategies for information seeking*, based on planning, use of query terms, and iterative adaptations of the query based on evaluation of intermediate results" (an approach this, typical of the documentation activity), and *browsing strategies for information seeking*, heuristic, opportunistic, associated with recognizing relevant information" [11]. This second approach is widely used in architecture and in other visual disciplines. This is in fact the typical architects' behavior when visiting for the first time the physical environment and context hosting their "spatial problem solving". As Arthur and Passini write, this is an activity "based on a process of scanning and glancing. When moving through a complex setting, the eye scans the visual field. This preattentive perception serves to identify objects or message of interest" In this context, "the notion of browsing is examined in its broadest sense as a scanning process (usually visual) and has been related to environmental perception and cognition" [12]. This is also the situation that architecture students face while looking for useful case studies in university libraries, often adopting a very time-spending browsing strategy, which consists in checking all the somehow promising books, one by one. Probably, if architecture students only could, they would spread around all the pages from architecture books, like the tesserae of a muddle up mosaic of images, drawings, sketches, graphic schemes and they would walk through them ready to catch out the corner of their eyes the contents that can solve the problem [1].

In MACE we try to bring such a visionary scenario to reality, by breaking down the original and often restricted content repositories into single Learning Objects (LO) to be reorganized in the MACE infrastructure. In this scenario, in order to help architects to find the information they are seeking for, it is fundamental to reproduce seeking strategies they are accustomed to. To obtain a close affinity between the before-described seeking strategies and the MACE system usage possibilities were also one of the guidelines while developing specific browsing tools.

For example, a student searches information and examples to solve a design problem related to covering a big space following the metaphor of the sky vault. He queries the system with the keywords "roof" and "glass" and starts studying one of the projects displayed (Fig. 3 in the next page). However, the system offers to the user also other related contents, and one of this (a picture of a dome designed by Nervi) captures the attention of the student who recognizes it as relevant information. Thus, he is able to refine his research, based on an unexpected but fitting example found by serendipitous browsing.

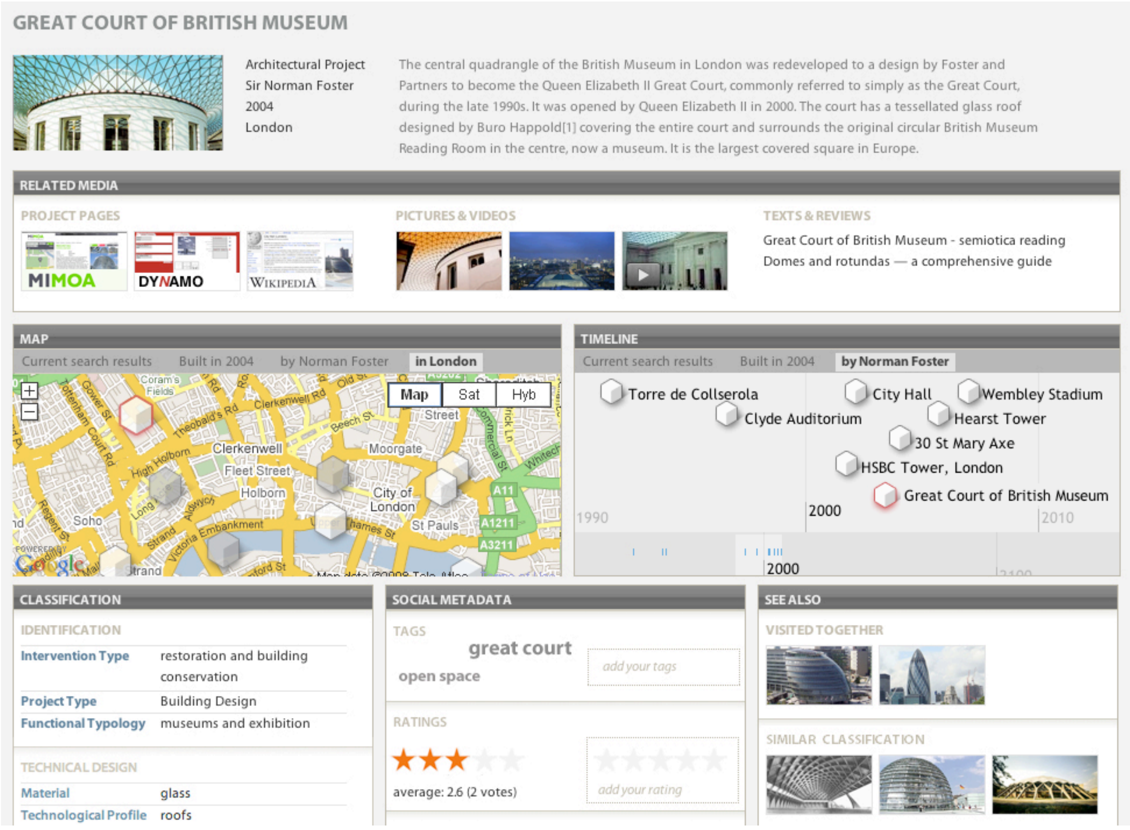

Figure 3: A detailed view of a learning object as displayed in MACE. Related media, locations in proximity (shown on a map), contents belonging to same period (shown on a timeline), the classification terms, social metadata, and related contents are shown on this page.

4. The MACE knowledge organization system

To allow these kinds of navigation by interpretative or objective data, as well as by purposive or non-purposive seeking behaviour, we developed the *MACE Application Profile* containing a taxonomy, which categories are motivated and supported by the studies and the semiotic model previously explained. The application profile is the base for the *metatagging* of all the contents harvested by MACE and is fundamental for the searching and browsing tools.

This profile enables to harmonise metadata descriptions of architectural contents. The application profile is based on the Learning Object Metadata standard (LOM) with adaptations and extensions optimised for architecture and engineering[5]. The LOM standard organizes metadata about learning objects in categories (e.g. identification, lifecycle, or classification), through which it is possible to express both media features and content features. Moreover, in the classification category we included additional attributes from architectural taxonomies and classification systems.

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[5] In LOM the metadata describing the learning objects are stored. Additionally, other metadata such as contextual, competency, and usage metadata is stored in special databases. See [13] for a more detailed description.

In order to obtain such a knowledge system, contents from the various joining repositories have to be described by metadata according to the MACE application profile. Existing contents metadata are transferred into a central metadata storage, where they are enriched and classified by a group of experts on basis of its actual content. Note that only the metadata are transferred; the learning objects themselves, actually lying in various repositories, stay in their original location. MACE here acts as a catalogue referring to all the contents, extended by the interconnections among these emerging from the metadata and classification terms. This classification activity, started by a group of experts and operated by a community in the long run, had to be built upon a common, agreed-on basis, constituted by a hierarchical classification of terms in a controlled vocabulary. Trough this taxonomy (see Table 1), featuring categories related both to *objective data* (e.g. Materials, Structural Profile) and to *personal and intuitive data* (e.g. Perceptive Qualities, Project Cue), it is possible to classify and find all the LOs according to the principle described in the previous paragraphs.

Table 1: *The categories featured in the MACE taxonomy are grouped in five facets referring to objective data and one facet (conceptual design) referring to personal and intuitive data.*

Identification	Intervention type, Project type, Functional typology, Form typology
Context	Location, Geographic context, Urban context
Technical design	Materials, Construction form, Building element, Technological profile, Structure profile, Systems and equipments, Technical performance, Maintenance and conservation
Constructing	Construction management, Construction phase, Construction activity, Machinery and equipments
Theories and concepts	Styles, periods and trends, Theoretical concepts
Conceptual design	Project cues, Project actions, Form characteristics, Perceptive qualities, Relation with the context

An important part of the work to build this taxonomy was to scan, check and gather already existing architectural thesauri[6]. The need to rely on pre-existent and known thesauri follows from various reasons; besides mandatory quality protocols which in any case would require an official validation for an application profile, architecture is a quite complicated discipline when facing specific glossary definitions. In fact, while for a range of basic concepts there are widely shared and agreed-on definitions (e.g. "Renaissance" and "Gothic art", but also "pillar" or "inner court"), for others, a sure definite and unique meaning is still missing. Moreover, not only same concepts have been named differently during the centuries and by different architectural critic's schools, but even on some main issues, especially about theoretical and conceptual critical analysis, an agreement among different schools is not in sight.

[6] The main thesauri and classifications we relied on are: the "Art & Architecture Thesaurus Online" of the Getty Research Institute (http://www.getty.edu); the Ci/SfB classification (http://www.ascinfo.co.uk); the UniClass classification (http://www.connet.org/uk) and the ISO12006 (http://www.iso.org).

The aim while composing this taxonomy was therefore two-fold: first of all it was important to collect as many concepts' keywords, definitions and names as possible to keep a balanced and neutral position, and to allow the expression of any point of view. Moreover, not less important was to collect a glossary of already defined and approved terms, to efficiently re-ordering and organizing them in synonyms groups. The combined use of already defined terms and of their grouping by synonymity should bring to express even debated theoretical concepts with an affordable optimisation, obtaining to limit the risk of information losses.

Our taxonomy consists of facets; each of them could be seen as an independent axis along which documents can be classified, and "addresses a conceptual dimension or feature type relevant to the collection" [14]. A facet contains a number of hierarchical categories, which again contain a number of terms (compare fig. 2). To give an example, in the facet "Technical design" there is the hierarchical category "Material: wood" with the containing term "timber". Through this structure and the resulting associative relationships between concepts (e.g. by looking at the parent of a term) a semantic map becomes visible for searchers as well as indexers, helping to create a mental image of the overall topic, and to select the most appropriate term. Moreover, because "documents classified with a facet classification [...] may be assigned multiple facet nodes" [15] multiple views on the same content are possible. Hence, in MACE contents can be classified in segregate conceptual dimensions, such as "Management" or "Theories and concepts".

A lot of the values are composed by a number of synonym terms. These are automatically assigned to a LO, once one of the terms a user has been chosen during manual tagging. In this way, finding content is simpler for the user, since he can rely on an architectural language as similar as possible to the one he is accustomed to.

Furthermore, users are able to add a keyword to a specific LOM, even if it does not exist in the application profile, yet. Such keyword is stored in a freeform text field not only to be included for search and other usages, but also for later reviewing by experts. If the keyword is commonly used and approved by experts, it is added to the classification vocabulary. This hybrid of a pre-defined top-down hierarchy and a bottom-up folksonomy allows us to utilize the wisdom of the crowds in a controlled manner to profit from existing personal knowledge. In this quality assured way, our taxonomy can be extended and improved over time, thus having the flexibility to adapt to emerging changes and arising innovations.

5. Conclusions and Outlook

The conceptual and technical infrastructure and the user interfaces of MACE, developed by a consortium of European universities and research centers, will allow students, architects and engineers – independently from their scientific background, school trend or poetic orientation – to carry out their information seeking activity on several different repositories using searching and browsing tools that give them several navigation possibilities through the contents. These can be referred principally to:

- an end user orientation behavior; that is accessing the system with *personal and intuitive* or *objective* searching keys referring to all the disciplines affirmable to the architectural domain;
- *a seeking strategy behavior; that is accessing the system using analytical strategies for information seeking or browsing strategies for information seeking.*

Moreover, the users are enabled to enrich the contents they stumble upon while browsing with terms from the MACE taxonomy, thus increasing the potential of the system.

The MACE system is currently under development. A simple search is available, which incorporates LOs from repositories already integrated. Also, first tools and user interfaces are openly accessible [7]. Content partners are manually enriching a number of LOs to set the core of MACE knowledge organization system, while technology partners are developing and testing approaches to automatically and semi-automatically add metadata to existing LOs. In this phase we concentrate on the classification taxonomy, and geo-positioning contents. MACE is open to other repositories, databases and websites, and encourages them to connect their contents to our system (manuals have been written and can be send out on request). For these repositories we provide different ways to plug into our system: connection to technical interfaces (APIs) for e.g. harvesting metadata, or querying similar and related contents, as well as user interface facilities such as embeddable widgets. These methods support utilizing MACE functionality in own applications, learning environments, and websites, and allow both users and data owners to benefit from the interconnections.

To further enhance the capability of MACE we are also working on an innovative approach to those LOs describing architectural works. The idea is to create a specific kind of entity (a non-information LO stored in the MACE database that represent the real building) to which LOs describing that specific building connect to. In this way we make a clear distinction between the content (the real world object) and the media expressing or describing it. Additionally, this strategy will allow us to increase the amount and quality of metadata, as the LOs referring to the same real object share their classification metadata.

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