Creating new ways of learning in architecture and building: MACE Project

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ABSTRACT: This paper presents the European MACE project (Metadata for Architectural Contents in Europe), a project that sets out to transform the ways of e-learning about architecture and building in Europe by integrating vast amount of content from diverse repositories created in several previous projects as well as from existing architectural design and building engineering communities. Moreover, an application scenario dealing with management aspects in construction engineering is presented in order to show new ways of learning through the use of online repositories such as MACE is.

1 INTRODUCTION

In Architecture and Construction sector a large amount of information is created in different types of media: written documents, images, photos, sketches, drawings…, which are in general hard to index and find. On the other hand, most of the times this information resides in the people related to this discipline and the transmission of this knowledge becomes informal rather than formal. This context makes more difficult the task of tracking, sharing and exchanging not only knowledge but also information. For these reasons, non-expert designers and students spend a lot of time searching large number of cases similar to their actual situation, to get cues and suggestions on how to proceed.

Currently there are a lot of projects concerning architecture, construction and e-learning. In addition to these projects, universities, companies and other parties have created databases for architectural and construction content which have, in some instances, started to enrich them with metadata in order to make easier its classification and search. Despite the shared domain, all these architectural and construction content repositories are only lightly connected to each other and the integrated access to their contents is not realized at present. This is due to the different approaches in knowledge structuring (no common methodology or standards are employed) as well as the different content languages used.

To solve these problems the MACE project (Metadata for Architectural Contents in Europe), co-funded by the European Commission inside the eContentplus Programme, sets out to transform the ways of e-learning in architecture and construction in Europe. It will integrate vast amounts of content from diverse repositories created in several large projects in the past and build a framework for providing community based services such as finding, acquiring, using and discussing about e-learning contents that were previously not reachable. Furthermore, MACE aims at providing innovative tools to search, create content and enrich it with new metadata, which can be used to support different kinds of learning scenarios in architecture and construction education. Several kinds of metadata are used in these tools to provide different perspectives on the learning content, and find new ways to combine them. For teachers, it will become easier to find and organise appropriate content based on the competence, context, and process metadata provided.

2 BACKGROUND

2.1 *Architecture and building online contents*

As aforementioned, different architecture and building focused web-portals have been developed. A possible classification by categories could be: e-learning platforms, visual collectors, software resources, vertical portals, projects databases, topical search engines and materials databases (UNIVPM, 2007). All of them have their own importance in the architecture and building sector bearing in mind that each portal provides different kind of information contained in different kinds of media (image, video, documents,…), as well.

On one hand, Visual collectors and Project databases are important in architecture and building sec-

tor because they own databases rich in images. However, they aren't usually very structured. While Visual Collectors take on the figurative, formal, perceptive and spatial dimension of architecture, the Project databases take on the spatial organization of dimension and typology.

On the other hand, Material Databases have interesting and useful documentation regarding products, building related materials and the latest technologies in the building field available. Therefore, Material databases bring the material and technological dimension of architecture and help professional designers and students to link products-materials-technologies to buildings in order to understand the materials and technological solutions adopted in their performance.

Software Resources orient the students, teachers or professionals in choosing which software is most suitable for his/her work or study's need. Moreover they also guarantee constant updating regarding the latest CAD and CAM photographic touch up, photo composition, rendering and video creation software products.

Besides possessing a rich image repertory, Vertical portals contain critical essays and document the development of the contemporary debate on architecture and building. This critical dimension/part complements the project and image repertories of Visual collectors and Project databases, which would otherwise remain mute.

2.2 *Searching information limitations*

Most of these already mentioned architecture and building focused web-portals use search tools to allow users to acquire, in an easier way, the information that he/she is interested in. However, as a consequence of the existing gaps in accessing information, not always this search solves the users' needs. Therefore, the search tools used in most of the web-portals present some limitations related to the access to the information, their structure and their operability (Giretti, A. et al., 2007).

When talking about Access limitations we refer to Integration of information, Polysemy in keywords, Information overload and Non optimal ranking aspects. Integration of information aspect refers to the fact that search engines are general purpose, therefore they present results in a loosely arranged listing without arranging results in a structured and well integrated manner. On the other hand, Polysemy aspect is related to the problem caused by the many keywords in architecture that are shared with other fields, and that a traditional search engine is unable to distinguish. Information overload aspect refers to the long lists of irrelevant items related to a topic that hides the few interesting ones. And finally the Non optimal ranking aspect, related to the lack of ranking or description regarding to the type of content provided.

On the other hand, Structure limitation is classified in two aspects: Categorical search and extended search limitation. Categorical search limitation refers to the impossibility to include subcategories of a topic in a single search and Extended search limitation is related to the impossibility to extend the search topic to related subjects in order to provide further cues for improving comprehension.

And finally, Operability limitation is differentiated between Context awareness and Language aspects. Context awareness refers to the fact that searching is usually performed without any information relative to the user's operative context, what implies poor ranking and displaying. And Language aspect is used to state that despite the fact that current search engines provide support for multilanguage search, in architecture there are many idiomatic words that require specialized thesauri.

3 THE MACE PROJECT

3.1 *MACE overview*

Metadata for Architectural Contents in Europe (MACE) is a project co-funded by the European Commission inside the eContentplus Programme, a multiannual Community programmed to make digital content in Europe more accessible, usable and reusable. The MACE project sets out to transform the ways of e-learning about architecture in Europe. It is integrating a considerable amount of contents from diverse repositories created in several large projects in the past as well as from existing architectural design communities.

The MACE consortium consists of ten partners from academia and industry. It builds on several successful projects including WINDS project (Web based INtelligent Design tutoring System, an EU-funded e-learning platform containing 21 courses spread over Europe), ARIADNE Foundation, in the ICONDA (Fraunhofer IRB, hosting 650.000 references and referencing 300 journals monthly), DYNAMO (K.U.Leuven, complemented with 5000 learning objects from many different universities worldwide through ARIADNE and the GLOBE network of learning object repositories), MONUDOC (hosting 15000 facts and literature reference covering preservation of monuments and historic buildings) and BAUFO (containing 13000 descriptions of building research projects) (Stefaner, M. et al., 2008)

MACE provides a framework for community based services such as finding, acquiring, using and discussing about e-learning contents that were previously only reachable to small user groups.

Furthermore, MACE aims at providing innovative tools to search, create content and enrich it with new metadata, which can be used to support the learning scenario described in this paper (Barth, H., 2007; Stefaner, M., 2007). Several kinds of metadata are used in these tools to provide different perspectives on the learning content, and find new ways to combine them. For teachers, it will become easier to find and organise appropriate content based on the competence, context, and process metadata provided.

3.2 *MACE metadata*

The project develops and uses different types of metadata for tagging contents. These metadata fields allow an intuitive navigation system to search thought the concepts and a collaborative educational/learning platform.

Therefore, the MACE metadata is classified as content and domain metadata, contextual metadata, competence metadata and usage and social metadata.

Content and domain metadata contains information about the learning object and its content: domain of the learning object, what the content is about and the technical properties of the object. A MACE taxonomy related to architectural and construction domain has been developed based on controlled vocabulary (standards, glossaries, and thesaurus) in the architecture and building domain: CI/SfB, UNICLASS, Getty Thesaurus, as example. In particular, the definition of the terms related to all the aspects of the construction and management domain is based on the UNICLASS thesaurus (Table C-C5/C9 Management of construction activities / project management) and the standard ISO 12006 (Building construction - Organization of information about construction works). The developed MACE taxonomy contains more than 2700 terms classified in 25 categories: Building Element, Construction Form, Material, Functional Typology, Technical Performance, Intervention Type, Urban Context, Geographic Context, Project Cues, Project Actions, Relation with Context, Form characteristics, Perceptive Qualities, Form Typology, Structural Profile, Technological Profile, Systems and Equipments, Maintenance and Conservation, Construction Phases, Construction Activity, Machinery and Equipments, Construction Management, Theoretical concepts, Styles, Periods and Trends. This taxonomy is available in different languages: English, Italian, Spanish, German and Dutch. All the contents accessible from MACE are tagged with terms coming from the MACE taxonomy.

Competence metadata is used to specify the competences that education should aim at and to tag contents in order to make them reusable and retrievable for educational purposes. Therefore competence metadata describes the abilities that the student could acquire after analyzing the content of the learning object. Two different domains of competences have been defined in MACE: architectural competences domain and engineering competences domain (based on the results of the EUCEET II - European Civil Engineering Education and Training II project that is part of the Tuning project (Tuning project 2005-2006). Moreover, a competence administration tool has been developed to administrate the competences and to create new domains of competences, depending on the academics. Both already defined competences and new domain of competences (defined by academics) are used to tag all MACE contents.

Contextual metadata is used to define the context related aspects of the overall taxonomy to be used in MACE. Contextual metadata will provide a categorization of entities with respect to similarities in their context metadata and enable more advanced search than traditional keyword search can offer. Even though the MACE system will deal with the digital contents describing real world objects and not the objects themselves, it makes sense to distinguish between two categories because they have different metadata associated with them. Currently, position context metadata tool is being developed. This new widget will enable the user to browse contents by their real location in a map, finding out other objects located nearby. In reference to the construction and management domain, the contextual metadata can be used to understand which is the best constructive solution to choose bearing in mind the location of the building and the weather of that area. On the other hand, and in reference to the management aspects, the contextual metadata can inform of the regulation to apply depending on the city, area or country where the building is located.

And finally, the *Usage and social metadata* describes how, by whom and in which context a learning resource is used (Usage metadata) and allows the users to annotate, rate, tag and store contents (Social metadata). Students' annotations, discussions, and metadata together with social recommendation techniques will improve individualized learning and allow for open learning corpus integration (MACE project 2009).

3.3 *MACE tools*

For all these different metadata types or end users functionalities a dedicated widget, that are small thematic applications aimed at visualizing and structuring information according to the requirements of specific tasks, have been developed and implemented in MACE portal (See Figure 1).

They are used to allow basic user management and navigation tasks (Basic widgets), to display search results or a single result information (Content presentation widget), and finally, to visualize metadata values, edit metadata and filter searches (Metadata widgets) (See Figures 2, 3 and 4).

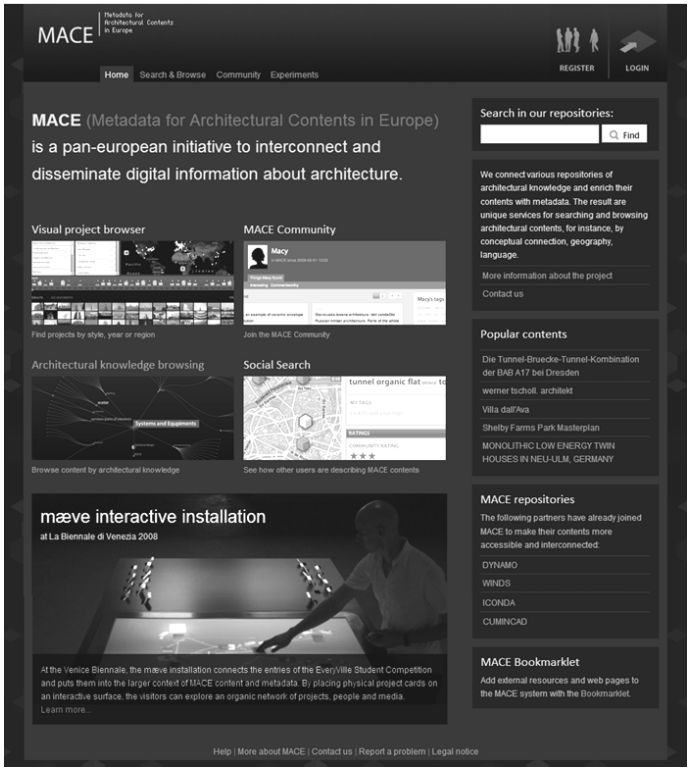

Figure 1. MACE portal (www.mace-project.eu)

MACE tools allow the user to search in different ways:

Filtered search, the user can search contents using a keyword search, filtering afterwards the results in terms of repository, language, media type, classification terms and competencies. This filter is dynamic, so it adapts both the filters and the results along the user search process (See Figure 2).

Browse by classification search, the user can search contents in a more conceptual way through the classification map where all the terms related to the domain of architecture and building are represented. This search tool opens new perspectives to the knowledge acquisition process of the user and motivates him to explore new related contents (See Figure 3).

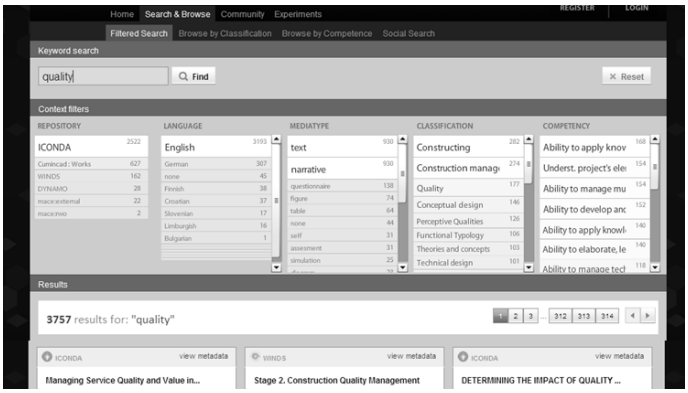

Figure 2. Filtered search

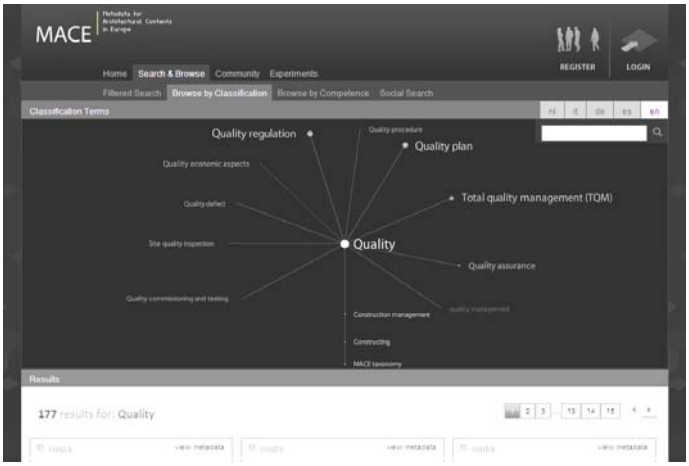

Figure 3. Browse by classification search

Browse by competences, the user can search the contents from an educational point of view, bearing in mind the abilities he would like to acquire after analyzing the contents. This search tool is based on a matrix made up of the engineering and architecture competences domains, the level of EQF and the number of contents that have been tagged with these competences in a specific EQF level. Academics can use this tool to prepare their teaching material and guide the students along their knowledge acquisition process (See Figure 3).

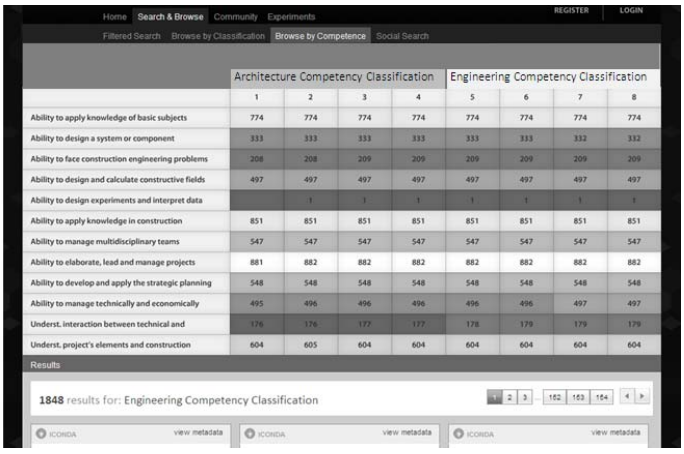

Figure 3. Browse by competences search

Social search, the user can browse the contents that have been previously tagged by other users, with the aim of sharing these interesting contents or to have them stored in their personal space for following uses. The contents that can be browsed throw this Social search are those that have been previously tagged with terms related to the content domain, its media kind or its possible usage context, among others. The final propose of this search is to enable the users to share contents with all the MACE community (See Figure 4).

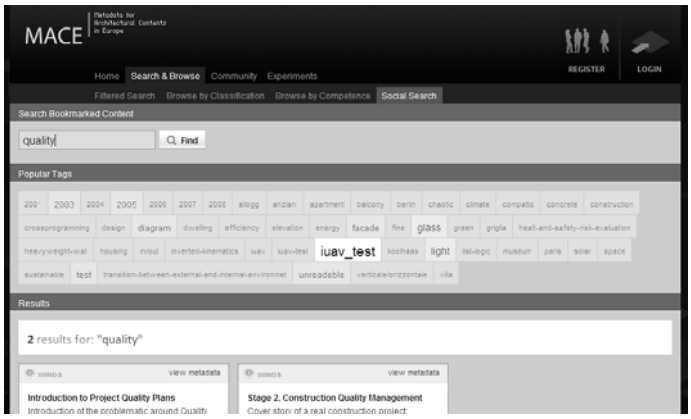

Figure 4. Social search

Figure 5. MACE tools. a) Map widget (Contextual metadata), b) Classification widget (Content and Domain metadata), c) Tags widget (for the Social search), d) Competence widget (Competence metadata), e) Rating widget and f) Comment widget (Usage and social metadata)

Besides the search tools, the MACE users can enrich the contents using different tools or widgets to give their opinion with comments, to rate the quality of the contents, to tag them or to enrich them with competence metadata. On the other hand, all this information and enriched contents can be saved in personal portfolios. These services enable MACE users to actively share and discuss learning resources and thus, learning communities of practice are created. See Figure 5 and 6.

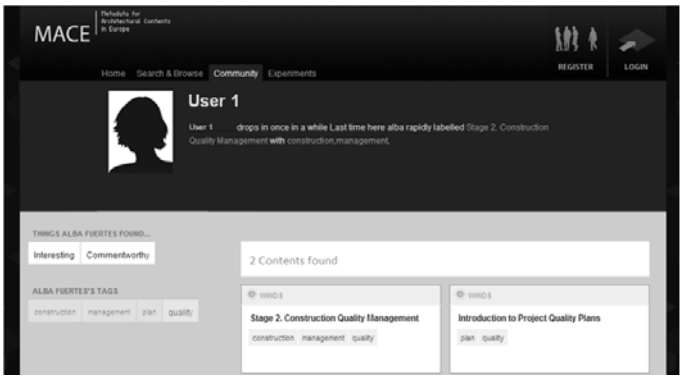

Figure 6. Personal Portfolio

4 MACE APPLICATION SCENARIO

4.1 *Introduction*

In the construction sector, especially when using general contracting, it is clearly visible the separation of responsibility for designing from the responsibility for construction. However, the designer has always supervised the construction of the work. In practical terms, this has come to signify that design and management are two sides of the same coin. Therefore, the knowledge of different management aspects becomes also necessary along the learning phase of an architect student. For this reason, MACE not only provides knowledge related to the architectural design and technological design but also to knowledge related to construction.

Health and Safety management contents, quality management contents, environment management aspects, time management techniques, as well as costs and logistics on site aspects can be found in some of the repositories included inside MACE. All these MACE contents are expected to be used in educational scenarios, providing instructors new, more structured and specific digital information to prepare their courses, as well as real cases, examples and tests to facilitate the students the development of their works and their personal evaluation.

In this paper an application scenario related to learning construction management concepts using the MACE system is exposed. Thus, the work asked to the student is described as well as the possible tools used to accomplish the learning process. This scenario will be used to evaluate the system from an educational point of view. In this evaluation, a group of university students of the Industrial Engineering

master's degree will be ask to develop an academic activity based on the application scenario.

4.2 *Application scenario: Development of a Construction Project Quality Plan*

This application scenario is concerned with the application of e-learning solutions in a Construction project management course, which is part of an Industrial Engineering master's degree.

The aim of this course is to provide basic knowledge of all the aspects related to management in construction projects, such as health and safety management, quality management, environment management and resources management. Therefore, the course provides the know-how that will enable the future construction project managers to analyse and identify all the key aspects that influence in the accomplishment of the objectives proposed in the construction project (most of the times reduced to time-cost-quality).

By now, this course is based on face-to-face classes where all the theoretical contents are taught. All the contents are verbally conveyed by the instructor, who acts as the expert on the subject matter. Most of the times, these contents are enriched and complemented with images, schemas, and sometimes even videos, which are used as examples of real situations in construction sites.

The application scenario is centred in improving the concepts learnt about structures typologies and choosing one them. On the other hand, students will improve the concepts learnt about quality plans in construction projects to secondly develop the part of a construction project quality plan related to the structure typology selected. To this, the student should define all the operations, measures and controls necessary to assure that the chosen structure is well executed.

In this case the student, who is already registered to MACE system, logs into the MACE portal (See Figure 1).

To accomplish the first objective identified, which is based on selecting one of the structural typologies, the student decides to start their search browsing through the classification map. This tool allows the student to identify all the different structure typologies and their classification. The student chooses the concrete frame construction. The results of the search are centred in information related to the elements that constitute this structure typology, images of existing concrete structures, constructive details,..., thus basic knowledge about concrete structures. All the interesting results are tagged by the student, making easier their future search or use. All these tagged contents are automatically stored in the student's personal portfolio.

Now that the structure typology is selected, the student decides to improve their knowledge about quality plans. He tries a simple search through the keyword "quality plan". He chooses the second result and inspects the information/metadata related (See Figure 5). He finds that the content could be interesting and decides to open it and inspect the wider course which the content is part (See Figure 7). Browsing from content to content the student gets all the needed knowledge related to the quality plans in construction projects. Again, the student tags all the interesting contents for future uses.

The last step of the activity proposed to the student is to develop the part of the quality plan that is related to the structure of the building: operations, measures and controls necessary to assure that the chosen structure is well executed. To do so, the student needs more information about the construction process of a concrete structure and tries again the simple search.

Figure 7. Result detail view

Now the results of the keyword search don't fit exactly with the expected information; probably the keyword isn't included in the MACE content and domain metadata. For this reason the student decides to use the browse by classification search where all the defined keywords appear. And again, the student tags all the interesting contents for future uses.

On the other hand, and in a parallel way, the student can navigate through the net searching for other architecture and building portals. The MACE system allows the users to tag external contents in order to be found later through the MACE search tools or stored in the users' personal portfolios. In this case the student itself becomes a content provider of the MACE system and contributes to the improvement and update of the information.

At the end of the information acquisition process, the student can check all the contents that he has

tagged (internal or external to MACE system) because of its interest or useful information related to the work asked by the teacher. On the other hand, the student can shear and discuss these contents with other users, thus learning communities of practice are created.

5 CONCLUSIONS

In this paper the existing problems related to the search and connection of architectural and building related contents is exposed. Moreover, the European MACE project is presented as a solution to make digital content in Europe more accessible, usable and reusable, and the MACE portal becomes a single access point or interface that contribute enormously to the learning experience. The system offers a group of different widgets or tools that enables the users not only to search and consult all kinds of architecture and building related contents, but also to share, comment, discuss, contribute and store contents. By this way a new learning community of practice is created. On the other hand, the contents accessible through MACE system are enriched and related to each other with different kinds of metadata, what allow the users to freely navigate from content to content improving and discovering new concepts.

And finally, an application scenario is described with the aim to show the potentialities that MACE offers to the students, and especially those from a construction management course. In order to evaluate the potential, effectiveness, and the advantages of the available MACE tools for construction education, an experiment that has the application example as a guideline will be carried out. A group of students involved a Construction project management course, which is part of an Industrial Engineering Master's degree, will participate in this experiment. The idea is to compare the learning process by using all kind of search tools and portals, with the learning process carried out through the use of MACE system.

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