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"E-LEARNING IN DIDACTIC WORKSHOPS. THE VIRTUAL ATELIER SYSTEM 'T-LABS': STORAGE, CONCEPTUAL METATAGGING AND SHARING OF THE ARCHITECTURAL DESIGN KNOWLEDGE"

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ABSTRACT

In the Faculty of Architecture of the University IUAV of Venice, the e-learning experimentation in architectural design teaching started in 1999. Since then, our research group developed a *virtual atelier* system based on prototypes called "TDraw" (Spigai et al. 2003) and "WITarch" (Spigai et al. 2004): informatics tools for the on-line revision and storage of students' design tasks. The didactic experimentation provided important information about the mechanisms of learning process and knowledge transmission in the *didactic atelier*: this kind of teaching methodology produce a large amount of notions, a rich information flux that can be factored in single *learning objects* and raised to a collective knowledge.

At present, our research group is improving and combining the previous instruments in a single tool: the new "T-Labs" system (Spigai et al. 2006); through this system, starting from the interrogatives that arise during the teacher-student relationship, each student can found possible design solutions, which would be exemplified by the students' design tasks annotated and commented by the teacher and stored in the system

The experience matured in these years acts an important role in the new MACE project; in fact, the analysis and the observation of the atelier activity brought about the definition and the validation of a series of conceptual categories through which is possible to map the architectural design generative process and the whole architectural design subject.

KEY WORDS

knowledge management, knowledge sharing, collaborative e-learning, e-workshop, metadata.

KNOWLEDGE RETRIEVAL IN ARCHITECTURAL DESIGN PROCESS TEACHING

Architectural discipline's learning is featured by a great number of practical exercises, implying a considerable production of graphic printouts, which also work as theoretical concepts carriers.

Being architecture mainly expressed through drawings, discussions held on graphic printouts are, in their turn, synthesized in sketches and graphic signs, more than in brief written texts and annotations. In this way, a big amount of evolving drawings and sketches is created, documenting the growth and the developing of a project through the continuous exchange of ideas and concepts.

In fact, the main learning method in architecture, which goes on for all an architect's lifetime and career, is based on the comparison with teachers, masters, expert architects or simply colleagues of the work team.

At a first glance, this middle-stage production may be considered as not important, but it would be a mistake. Actually, this production leads the making phases of a projects and it

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assumes an enormous importance: surely any architect would be enormously interested in examining and analyzing some sketches and correction made by a great architecture master on his students' boards and notebooks pages.

Nevertheless, the main part of this high knowledge's big amount does not exist anymore: in fact, the knowledge that grows every day in the Universities' halls during the courses of architectonic design is lost at the end of the day; it lives only in the students notebooks' pages featuring the teacher annotations and corrections and most of the times it is thrown away once the exercise is over.

In this way we see that on one hand the commented recording of a design process has a high didactic value, but yet the series of annotations constituting this record is often collected without any structure or organisation, on poor media, and it is destined to be lost once the project is ended.

Figure 1: A typical didactic workshop in architectonic design courses.

In short, we can state that the typical features of the architectural knowledge transmission in workgroups and didactic workshops, especially in Architecture Universities' design courses based on the *learn-by-doing* (Rogers 1969, Kolb 1984) activity, are:

- big amount of notions are created, shared and consumed in very short times;
- the greater part of skills and competences spent during workshops around a drawing table are scattered to mould a single student, or a very small group;
- very often there is no record of these notions, reflections, skills showing, opinion exchange; everything is quickly burned in the immediate connection between student and teacher, and in case these notion were recorded, they would be fragmentary and disjointed.

Such an exchange of knowledge could be easily recorded and translated into a unity of knowledge made up of excerpts of dialogue, notes, photographs, sketches, corrections, references, bibliographies, etc.

Thinking of these "unities of knowledge" as Learning Objects it is easy to comprehend how their computerization can represent an excellent solution to avoid an enormous waste of the teaching as yet described, which would seem to be a peculiar and irreversible characteristic of the lab activity (not only in architectural and engineering fields).

To achieve the objectives of rendering the growing amount of parcellized information significant and organized, the research group[3] has experimented on and developed a blended teaching methodology (Agosti et al. 2005), which adds a telematic system to the traditional classroom teaching activity. It has the following characteristics:

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3 University IUAV of Venice, Faculty of Architecture. At the research group leaded by prof. Vittorio Spigai, initially worked R. Grossa and C. Stefanelli and C. Palermo (1999-2004); currently are working: M. Condotta, E. Dalla Vecchia, M. Turrin, M. Domeneghetti with the contribution of G. Berti and P. Donà (software consultant, Archeometra s.r.l.)

- a – Shows the teacher-student collaboration through a virtual interactive table capable of sharing the learning experiences of a single student to all the other students in the classroom;
- b – Records and shares the knowledge learnt in the traditional course on the system;
- c – Creates links between the flux of knowledge "a" and "b" translating them into a unity of knowledge and recording them into the whole system.

As stated previously, all this was obtained by unifying the two computer instruments, T-Draw[4] and WITarch[5], in the new T-Labs[6], in order to make previous projects merge into an integrated system. Thank to it every student, teacher, or professional in the field of architecture and construction can search and investigate various possible solutions to their own problems in their projects.
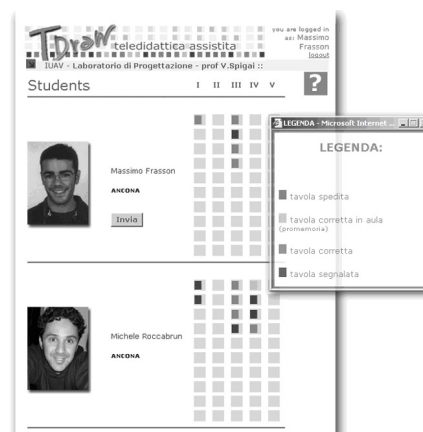

Figure 2: The virtual desk as displayed in the previous T-Draw system.

T-Draw was an informatics tool based on an asynchronous collaborative method organized as a virtual class (interface that has been improved in the new system) to which students and professors access on different levels and share graphic files that can be corrected and marked up by the teachers and can be visible to each student of the class. The system maintained a trace of all the communication-corrections that the student and instructor exchanged at the work table throughout the Course: the materials were organized by stages that corresponded to units in the course.

WITarch, was a dynamic archive of data, samples and case study, supporting the TDraw system, for the consultation and research through the concepts and key-words ordered according to the semantic-perceptive structure realized on a semantic base.

THE MULTIMEDIA T- LABS TOOL

UNDERSTANDING AND SHARING OF THE LEARNING EXPERIENCE

The experience and learning process occurs with the sharing of knowledge from an expert (teacher, professional) to a student and it is a continuous flux of ideas, abilities and comprehension. In applied studies, especially in architecture, as stated before, the medium through which the flux is possible is the physical, real and unique supports (i.e. the worksheet), being so because of the unique knowledge gained from observations of the

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4 TDraw, acronym of Telematic Drawing (e.g., Spigai et al. 2003).
5 WITarch, acronym of Web Interactive Archives of Architecture (e.g., Spigai et al. 2004).
6 T-Labs, acronym of Telematic Laboratories (e.g., Spigai et al. 2006)

teacher on a single student's work. It is due to this characteristic that refers to reality that the teaching and learning procedures of the architectonic design workshop need constant comparisons to case studies. In fact, the revision process of a student's graphic dissertations needs constant references to the previous projects of the student (including the progressive phases of the project and essay); as well as the projects of other students dealing with the same topic and issues.

Thus, in this direction the research activity is concentrated on the construction of an *e-learning* instrument based on the idea of a *virtual studio*, used as a virtual classroom and discussion forum between the student and teacher during the revisions of project exercises or other theoretical graphic dissertations (fig. 3).
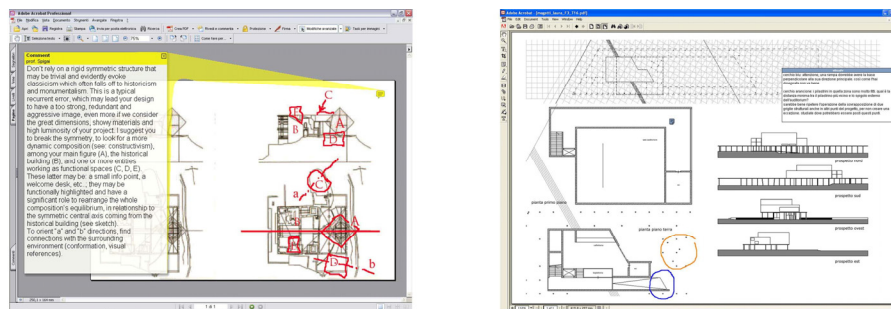

Figure 3: Example of a student's dissertations with teacher's notes as exchanged in the virtual classroom.

THE VIRTUAL CLASS

T-Labs is an asynchronous multi-media instrument made for the virtual revisions of project dissertations, which the students make during the courses of architectonic design and technique.

The system, like in the previous version T-Draw, is structured as a virtual class where students, teachers and tutors, share graphic files: student exercises annotated by the teacher. These files memorized in the system can be consulted at any moment by any student as well.

The main idea behind this didactic method is the transfer of the real classroom to the *virtual classroom,* and this is one of the distinguishing characteristic of this instrument compared to the other e-learning systems. In this virtual environment the corrected dissertation in the T-Labs system, which is the most important form of communication of knowledge between the student and the teacher, is transported from the physical paper to a virtual display within the system.

The drawings of the students, their compositions and any other type of dissertation containing images, drawings or texts etc. are converted into electronic dissertations in which the students can assemble and create sketches, texts, images, photographs, cad designs, renders and every other type of marking translated beforehand into an electronic format.

At the same time, the teacher's activity is transferred from paper to virtual space; he may correct directly onto the electronically formatted dissertations using adept programs in order to make markings very similar to those made written by hand.

In the experiment at the IUAV, the *.pdf* format was chosen for the conversion of notes and corrections because it is a flexible and versatile standard format, and it allows the student to use a compositive technique desired given the many graphic programs, CAD, and text files that can be made in *.pdf* format.

The original dissertations of the students along with the corrected ones of the teacher are mailed, posted and exchanged in the virtual classroom via web (fig.4).

In this environment, all the students in the course have their own box, each with their various dissertations indicated by colored icons. The different colors indicate whether the exercise has been already viewed and corrected by the teacher or whether a new file has yet to be corrected or whether a corrected exercise has a particular didactic value and is suggested to be studied by the other students.

Figure 4: Example of a page of the "virtual classroom"

From the virtual class page (fig.4), the student may access his personal page and then to a page of a single exercise (fig.5). In this section, the student or teacher can upload and download files (dissertations) and may view following corrections of the file. The teacher is therefore always able to keep a close eye on the work and progress of a student and at the same time gains a better response and input from the entire class as a whole. On the other hand, the student is able to view his work corrected by the teacher or tutors and the whole progress and growth of a dissertation.
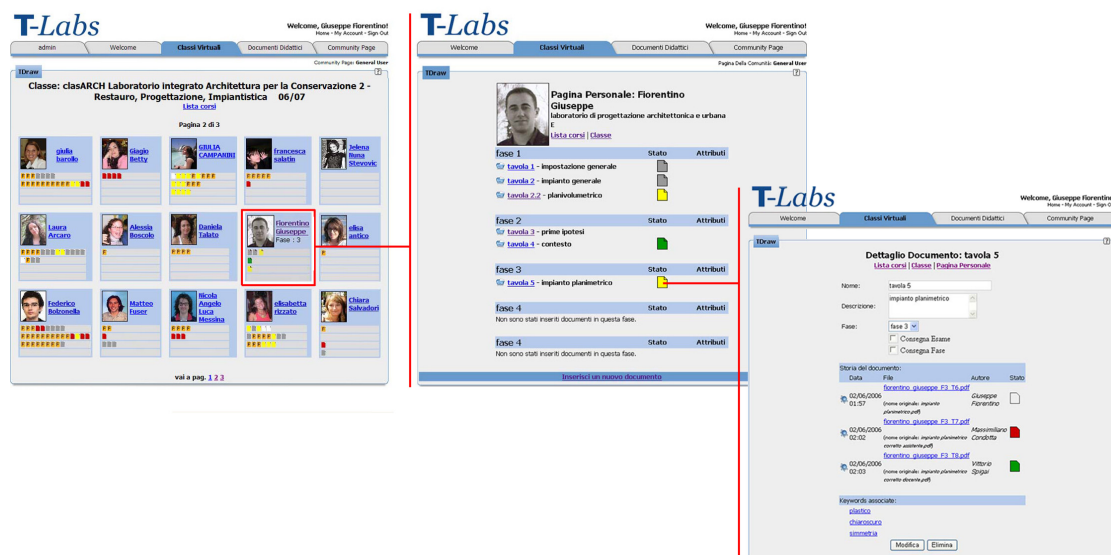

Figure 5: From left to right: examples of "virtual classroom page", "student's personal page", "exercise page" as recorded and visualized in the T-Labs system. Red linking lines show a possible path through the system's various sections.

KNOWLEDGE MANAGEMENT FOR COOPERATIVE LEARNING: UNDERSTANDING AND SHARING OF THE VIRTUAL CLASSROOM ACTIVITIES

DESIGN ACTIVITY'S CONCEPTUAL METATAGGING

As hinted before in the abstract, eight years of experimentation and the use of the system has brought about various phases of development of the technical computer apparatus (T-Labs) as well as constant refinements of the theoretical foundation on which the system of analysis and organization of knowledge is based.

The new instrument is built upon a scientific base with the objective to index the contents of the all the media stored in the system according to an approach founded on not just the contextual characteristics of the media, but its contents and concepts as well.

The approach used to define the categories involved in the design processes refers to the semiotic models of A.J. Greimas of the school of Paris and his French, Swiss, and Italian students during the early 1970's. A whole dissertation would be too long and complex for this article[7], however, it is important to understand that these categories dismantle the *generative path* of the project, thus rendering the principal aspects and actions of such *path* "classifiable" and traceable (Hjelmslev 1943, Greimas et al. 1979).

Furthermore, years of design task corrections provided a rich case study used to set and fix the metadata categories and related thesaurus.

Currently, the taxonomy used in our courses is sub-divided into three different domains:

- The *references*, meaning the contextual and referential aspects with which the architectural project communicates, the physical and socio-cultural environment of the project;
- The *planning requirements*, that includes the different ingredients and components of the project, thus the conceptual aspects of the project, its aesthetic value, etc;
- The *abilities*, meaning the planning and design processes that define the project, combining the data of the first two domains and reworking them in the way in which the previous ingredients are assembled to build the project.

The subsets of the three domains are:

References:
- Theoretical concepts (land-art, zoning, morphology, environment, urban planning, ...)
- Cultural, scholastic, author references (Cubism, Brunnelleschi, Futurism, ...)
- Historic-Philosophical references (Hellenism, neo-Platonism, modern style, ...)
- Historic-Geographical references (French gothic, Italian Renaissance, ...)
- Geomorphologic and climatic references (hilly region, Mediterranean climate, ...)
- Context (historical cities, country-sides, industrial area, ...)
- Location (Rome, Germany, Asia, ...)

Planning Requirements:
- Conception, internal sense, metaphoric significance, project cue (austerity, ambiguity, lightness, ...; ethereal, protective, welcoming, ...; forest, cloud, ...)
- Functional typologies (church, school, villa, airport, ...)
- Formal typologies (tower, spiral, square court, ...)

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7 To deepen: Spigai, V., Condotta, M., Stefanelli, C., (2006), Collaborative e-learning in engineering and architecture: intelligent systems for knowledge sharing in on-line design laboratories. In: "Joint International Conference on Computing and Decision Making in Civil and Building Engineering", Conference Proceedings, Editors: H. Rivard, E. Miresco, H. Melhem; June 14-16, 2006, Montreal, Canada. (Pages. 1082-1091)

- Constructive typologies (column, vault, pillar, netlike beam, …)
- Formal characteristics (proportion, linear, fluid, straight, spherical, …)
- Perceptive qualities (transparency, shine, multi-color, roughness, …)

Abilities:
- Planning (overlap, intersect, extrude, deform, …)
- Design techniques (plan, detail, section, …)
- Errors and recurring advice (scissor alignment, acute angle, wrong details, sharp and convex angles, …)
- Good solutions of typical and peculiar problems.

METATAGGING ACTIVITY, AND KNOWLEDGE REUSE

The conceptual categories described previously are inserted into the T-Labs system, where every conceptual category corresponds to a *keyword* category, inside which is a thesaurus predefined by the administrator of the program or head of the course, modifiable at any moment.

In the T-Labs system, the tagging operation is arranged simultaneously with the online corrections of the dissertations. The system is predisposed to allow the teacher to easily insert *keywords* of the conceptual categories through an implementation window; a progressive indexing procedure, where the indexing is simultaneous to the creation and recording of the data. This helps the teacher in his duty to select and elaborate the capacities gradually acquired during the academic year into the system, such as the drawings made with the virtual design table during corrections.
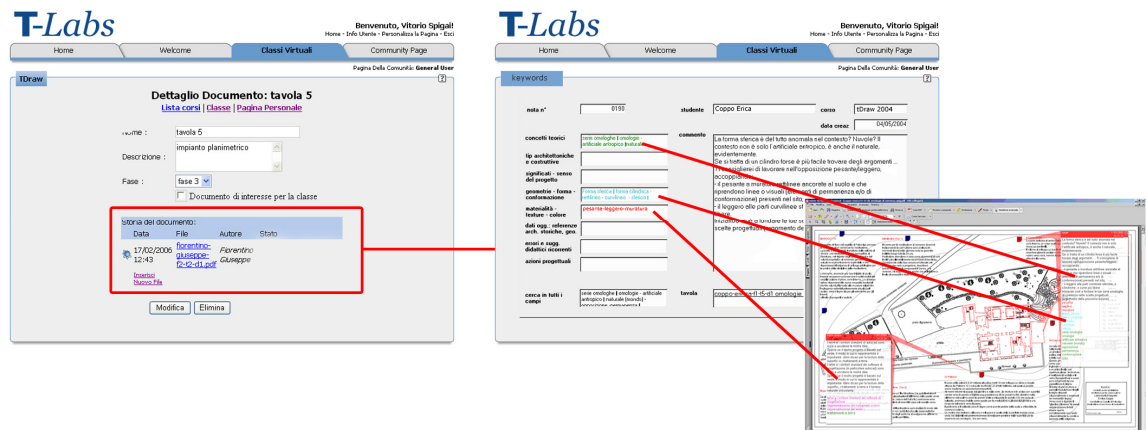

Figure 6: The indexing system as integrated in T-Labs.

For every dissertation, the student can therefore find an assigned series of *keywords* (managed by the teacher) to his own work (e.g. figure 6), (for example, they could be related to theoretical concepts, or a typical error, or a good solution to the present dissertation).

Thanks to an explicit indexation, the users of the system are capable on one hand to have conceptual references for their work, on the other hand, they have the possibility to search through the database with the keywords analogous to ones found in their dissertation to research other students' documents with the same keywords and concepts. In this way, it is possible to explore the base of knowledge searching for the dissertations with similar problems to the ones one is working on (Spigai 1994).

In summary, the added value of this learning platform focuses on the possibility of reproducing in a digital environment the activity of a real workshop, and on the capacity of registering and making sharable the knowledge produced in this activity. Nowadays, the

original paper notebooks are naturally replaced with their digital homonyms (the portable PC) making the use of this telematic system more natural and easy.

Therefore, the constant and diffused use of similar tutoring systems could bring about the creation of a database containing a great number of indexed notions of this kind, a unit of knowledge with indubitable value not only for education, but professional activity as well. The value of these notions grows if they are inserted in a managing system of digital repositories like MACE.[8]

CONTRIBUTION TO THE MACE PROJECT

These studies, focusing on the decomposition of the architectural design activity, and eight years of experimentation results, in the first semester of 2007 contributed to the MACE project analysis framework. This analysis work is aimed at setting the frame which will support the project specifications and strategic decisions. The purpose is to fix the *Domain Metadata Taxonomy*. This taxonomy concerns the content of the digital object, mainly related to the description of the architectural object (e.g. the building, the urban area, etc.) in terms of the basic information and of the processes that are involved with design tasks, or construction competences, normative aspects, and so on (UNIVPM, 2007).

In the following figures we can see the complexity of the MACE analysis requirements activity carried out to fix all the concepts which will be useful to decompose and classify the whole aspects of the architectural domain. The domain has been subdivided into 9 categories, and each category features a hierarchical structured taxonomy (how is possible to realize from the detail in fig 8). This figures, that are a graphical representation of the Domain Metadata Taxonomy in the MACE Project, and the taxonomy itself, are the result of the first six months of analysis carried out by the Content Partners inside the MACE project[9].
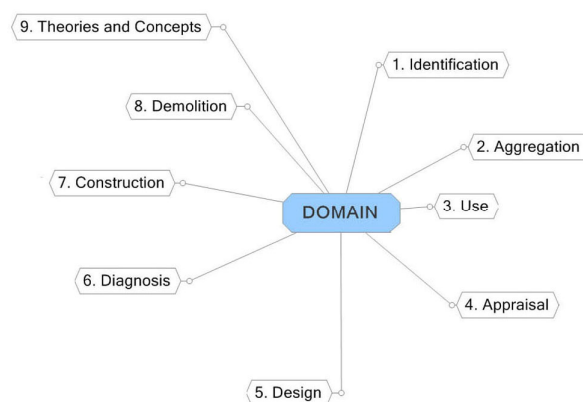

Figure 7: The Mind Map Taxonomy: decomposition and classification of the architectural domain.

The specific sectors in which the taxonomy presented in this paper has been applied into the whole MACE taxonomy are obviously related with the architectural design activities and

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8 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 (www.mace-project.eu).

9 This analysis work was coordinated by the research group of UNIVPM (Università Politecnica delle Marche, research group leaded by prof. M. De Grassi) with the contribution of other research groups of: IUAV (Università IUAV di Venezia), POLIMI (Politecnico di Milano), UPC (Universitad Politecnica de Catalugna), EAAE (European Association for Architectural Education) and IRB (Fraunhofer-Informationszentrum Raum und Bau IRB).

design theories: they are the *Conceptual Design*, the *Contextual Analysis* and *Theories and Concepts* sectors.

The following figure represents the detailed hierarchical structure of these specific sectors, in which are traceable the T-Labs' conceptual categories previously described.
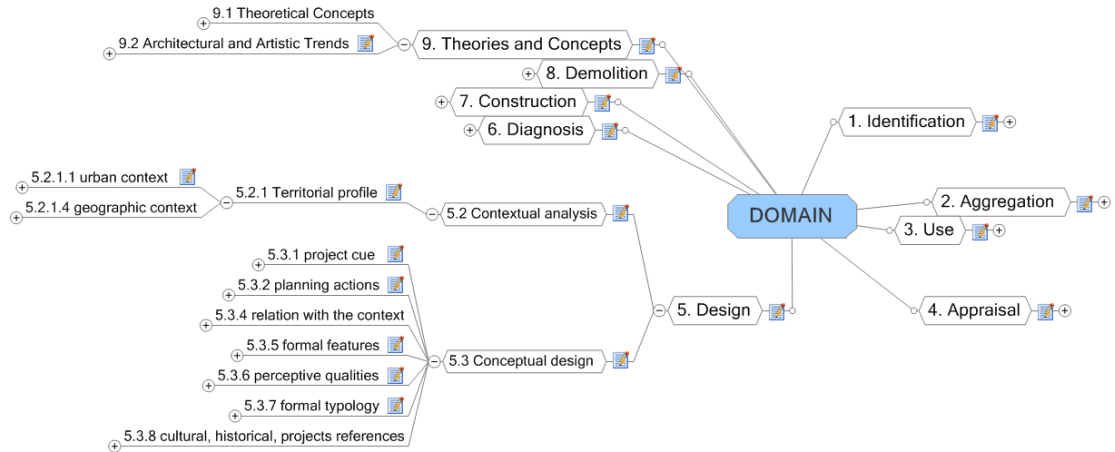

Figure 8: A detail of the Mind Map Taxonomy. (A similar hierarchical granularity is present in each main category in which the Domain has been subdivided)

CONCLUSIONS

While in the first developing phase of the MACE project, the T-Labs experience worked as a scientific starting point, now (or in a not too distant future) the potentialities of the MACE system and its tagging and searching interfaces could increase the utility and the impact of T-Labs idea and concepts.

In fact all the cases study and the notions grown in the atelier activity, stored in the T-Labs database, could be easily harvested by the MACE system given that all the categories used to tag and classify the design activity are featured in the MACE Taxonomy and glossary.

But above all and in addition to this, the possible contamination between the T-Labs philosophy and the MACE project, could trigger a new approach about the creation and management of the learning repositories, by including in them not only "official" learning documents (i.e. lessons paragraphs, famous texts, ...) but also all the continuous flux of knowledge produced in the didactic labs and all the workshops activities carried on in the Universities' halls, which constitute a knowledge only partially coinciding with the notions transmitted by *ex catedra* lessons and by official textbooks.

In this way all the knowledge produced in the didactic laboratories, but also all the notions grown during the design and developing phase of a project both in didactic exercises and professional activity, can be stored, classified and reused.

In other words, it's possible to create an educational program from case-study, learning objects and reasoning cases gathered from projected experiences in the laboratories or studios.

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