Collaborative e-learning in Architectural Design: knowledge sedimentation in atelier activity and virtual workshop: IUAV – experimentation 2002-2004

V. Spigai
University IUAV of Venice, Faculty of Architecture, Department of Construction Building, Venice, Italy

C. Stefanelli
University IUAV of Venice, Faculty of Architecture, LAR - Department of Architectural Design, Venice, Italy

ABSTRACT: In architecture, as in other applied disciplines (engineering, medicine, chemistry, experimental physics, etc.) the learning process mainly focuses on a continuos interaction between theoretical knowledge, notions that are acquired through example, through advice of the most capable ones and, above all, practice in the discipline itself. In consequence we have lower possibilities of a collective use and difficult sedimentation of the experience acquired through the design process.

How can all this knowledge and know-how activity be recorded, selected, enjoyable and re-used in different context through an expert web-based system able to store the experience acquired?

In Venice, during the last three years, we tried to recreate this tradition through a web based collaboration system called TDraw, *Telamatic Drawing system*, that is an asynchronous collaborative method organized as a virtual class to which students and professors get 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; all communications and notes shared during the whole design activity are preserved. The signed/selected works, the typical errors, the exemplar solution represent the greatest effort in teaching the generative process of a project and can be considered as the core of knowledge transmission.

This paper describe how to store and re-use the knowledge and the know-how transmitted through an architectural Course by the classification of the knowledge elements associated to the project and its formative steps. We have been creating a model of decomposition of the architecture complexity in order to create a kind of general memory able to gather the experiences, to automatically refresh its knowledge base on its experience, and to offer it on the web.

This system - called WITarch, *Web Interactive Archives of Architecture*, becomes then 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. Starting from the first collaborations with the researchers of the Greimas School in Paris, in the first half of the Eighties, prevalently in a linguistic-semiotic field, we have been creating a model of decomposition of the architecture complexity. This model has been interpreted as writing/re-writing through perceptive elements (expressive segments of an architectonical language) of a statement containing cultural, ideological, functional, distributive meanings through spatial structures (topological relations) following geometries normally used in architecture. That memory can be connected on the web to other records of data, both as architecture documentation, (authors, etc.) then as a reference to the knowledge patrimony of industries producing building components.

The system, in its new version, has been working since the year 2002-03 at the IUAV in Venice and in the Faculty of Architecture and Engineering of Venice, Ancona and Pescara inside the WINDS consortium (EU, IST - V Framework Program).

1 SCIENTIFIC STARTING-POINT

In school, in the university and in the world of industry, in many applied sciences (surgery, chemistry, genetic experimentation, experimental physics, engineering, computer programming, laboratory and experimental studies on models in different technical and scientific sectors) and in many applied arts (scenography, lighting design, crafts, interior design, fashion, furniture design, production industry for construction and mechanics), the transfer of knowledge occurs only partially through lessons in the classroom.

It is well-known, in fact, that students in such fields of study learn by means of continuous interaction between theoretical knowledge (from lessons) and concepts acquired through examples and advice from experts, and especially through practice on the

field (guided with the teacher and/or technical experts that are directed personally and exclusively to the individual student, staff, and workers.

In the domain of scholastic education, in laboratories and in the classrooms of Technical Institutes, Institutes of Arts and Universities, in specialized courses and masters, and in developmental courses in collaboration with the industry, the knowledge of operative-applicative disciplines and projects is transferred only partially through written texts and technical manuals.

A big amount of learning is entrusted to practical exercises conducted with various methods and instruments according to the discipline, characterized by the constant commitment of large amounts of time and energy to every single student to develop his/her personal, individual and specific preparation. Such an accumulation of didactic experience generally gets burnt into the training of the individual. In some cases they are recorded, enabling them to be handed down and entrusted on the average to the majority of obsolete and ineffective cases.

For example, regarding architecture, (the discipline to which the interests and expertise of our research group are primarily directed), even today the didactic transfer methods of theories and design remain assigned principally to a visual-oral tradition (conference with projected images) to practice in the studio (exercises, ex tempore, workshop, conducted collectively in the drawing classes) and to projected exercises executed by students individually or in a group at home and periodically submitted for revisions by the teachers.

All these methods of transfer of the *know* and the *know how* of architecture have great difficulty in being established in a unified and shared body of ideas. The difficulty is even greater than for more solid fields, due to the scientific establishment and traditional technical-training practices divided by contents of theory (for example, courses and practical studies of science of construction and rational mechanics, applied chemistry /stoichiometry).

In fact, the architecture project- even due to the inconsistent theories of the subject-creates a moment of great effort of synthesis, in which various knowledge tied to artistic-poetic inclinations (ideas, social and cultural messages of the project) as well as to technical inclinations (functionality, habitative well-being, constructibility) but also to knowledge of the different levels of the project (from urbanistic responsibilities, to the choice of materials, of details, of components produced by the industry) - are gathered to merge simultaneously, even daringly, in the synthesis projected since the first layout on the drawing board.

How should the multiple experiences be monitored in such ways? How is it possible to record this activity, to select it, use it and make it beneficial in an expert system capable of assisting and monitoring the multiple experiences?

The peculiarity of teaching in applied disciplines resides greatly in the physical support of the student-teacher interaction, which consists of scripts, prototypes, handmade products, or presentations (artistic, sporty, etc) produced by the individual student.

In architecture, the presentation generally consists in an illustrated paper/composition. The corrected and revised paper, marked with suggestions, annotations and notes from the instructor, represents an inalienable moment of synthesis in the teaching and is a very powerful didactic instrument.

With reference to these settings, and to the questions based on them, this research is directed particularly to the following sections:

1- e-learning. The recent evolution of e-learning in disciplines that largely use the technique of "learning by doing" in construction of virtual environments with student-teacher interaction, performed according to synchronous methods or according to methods extended internally in advances systems (collaborative manipulations on the web, between students and teachers, collaborative production of papers, advances systems of mark up);

2- protocol analysis. Monitoring systems and protocol analysis of generative processes of the project (design flow). Recording and description of the flow of typical and significant concepts that are at the base of the solutions operated by expert teachers. Every flow is connected to a particular problem or objective. Every flow contains in its development multiple references to relevant cases and concepts. This representation can be used as a foundation for comparison and as an element of reference in the valuation of the flow of projects effectively used by students.

3- interface between monitoring systems and systems of the solidification of knowledge; possibility to create interface systems online.

2 THE FIRST TDRAW SYSTEM: PROJECTION COLLABORATION AND COOPERATION ONLINE

The educational development passes inevitably through communication of knowledge and operative know how with a relevant flow of ideas and abilities from the expert (teacher) to the student. The complex path of reception and view of papers and their corrections, validations of methodological and enlightening elements, needs constant references to previous experiences, experimental cases etc. Particularly in architecture, in the correction-revision phase, the instructor, describing the better strategies to the solution in relation to the project, making suggestions, references, technical foresight, advises

possible choices and the text references to which the student can find the necessary documentations.

The critical interiorization of the ensemble of stratagems carried our is the foundation on which one builds the cultural and technical knowledge of the student. We know that this process is widely de-structured and left up to the practice and experience of the teacher. On the other hand, the new interest towards economies of scale caused by the introduction of teaching at a distance in all sectors of education, points out the problem of analyzing and rationalizing these cognitive processes that traditionally happen only in presence.

In regard to the enunciated questions, our research is directed to the construction of an e-learning system based on the idea of "virtual studio" intended as a didactic environment (virtual classroom) as well as an ensemble of instruments of student-teacher dialogue for a practice of revision at a distance of the papers by the students and on the experimentation of the system itself.

In such a direction, in the last four years, it has been pointed out and experimented a didactic model centered on a kind of online classroom, that can be fixed in certain locations within the university (such as in appropriately equipped computer classrooms) but also in private terminals dispersed in the region. This system of revision at a distance, named TDraw system (1) has been the first operative experiment of exercises online in Italy in the Department of Architecture and has been successively inserted in the European research system WINDS, inside the V program quadrant IST-CEE (2).

TDraw is not an e-learning system. It rests on an e-learning course (online lessons in the virtual university WINDS) but can also be complementary to a normal course according to the "blended" method defined by users time after time. In fig. 1 the site is represented that in the last academic year had hosted fives courses and laboratories of IUAV, all users of the TDraw service (3).

Beginning from 2001, the TDraw system has been used by about 300 students from different educative courses, of which more than 100 in the year 2003-2004. Among the research objectives of today there is the extension of the system to other institutes and to experiment with it in different contexts and not only at the university level. To this proposition, a collaboration has recently been initiated with the Istituto Tecnico "I.T.I.S. Severi" of Padua (programming language, with exercises regarding the Pascal language). (4)

Also due to the collaboration and experimentation of the system by different users (5), the research group of Venice suggests today to create an upgrade of the system which represents an ulterior way to achieve the following goals:
− structure of "knowledge management" that contains a base of understanding like case studies,

best practices, etc. shared between the students and instructor
− the insertion of "knowledge manager" in architecture in TDraw
− the usage of the preceding point in order to operate the realignment of knowledge in such a way as to have the foundation of understanding evolve in a natural and continuous manner

However, TDraw, through the recording of student-teacher discussions, is potentially a monitoring accumulation and organizational system of the knowledge used in the teaching of applied disciplines.

As implied by point 1, even for the complexity within the methodology of architectonic projections, its characteristics seem to be able to easily extrapolate themselves from architecture to other disciplines; in the majority of less complex cases with less unstable statutes (applied technology and arts, engineering, dentistry, surgery, electrotecnics, precise mechanics, etc) that find in practice, in student-teacher example-imitation and in practical exercises, a fundamental moment in the educational formation of the student.

At the end of the solidification and rationalization of the flow of education at the start of 2004, an interactive relational archive named WITarch (6) was integrated in TDraw. The system archiving of such particular forms of knowledge and ability seem to have a potential grounded and epistemological value and to line interests for the didactic scope for improvement (from the pupil's point-of-view) as well as the scope of an evolution of the disciplinary contents (from the instructor's point-of-view).

3 THE MANAGEMENT OF KNOWLEDGE IN THE TDRAW METHODOLOGY: THE COMPLEMENTARY SYSTEM WITARCH (7)

A designed course represents, as it has been said, an effort of synthesis in which different abilities and understandings unite. The student-designer, in order to make them merge and interact in a designed exercise, generally refers to:
− his/her own synapses (individual and personal information, notions, intuition);
− explicit knowledge, the education based on the world of architecture- but also of painting, music, the natural world, etc.- understandings that are traceable and quantifiable and that are transferred through diverse media (by printed texts to internet sites) and are accessible in consolidated "repositories" (libraries, archives, etc);
− tacit knowledge, which is the know how transmitted at the drawing table in a collaborative interaction between the student and teacher, groups of students, groups of designers and which is based on the comparison of experiences and imitation.

This knowledge is "tacit" which is subliminal to the experiences (of studio practices) and in the traditional didactics of projection it is not formally transported in any medium; therefore, it is not collectively useable at different times.

The aim that brought to the integration of WITarch into the TDraw system, was to understand if and how it is possible to render explicit the tacit form of understanding of collaboration by way of:

– conserving the liberty of the authors with the process to use communication protocols, consolidated and natural (the table, sketch, non-verbal communication);

– rendering the contents and flow of tacit knowledge useable even tto users who are strangers to the process, even in different locations and time.

The activity of the TDraw classes has permitted, in the span of four years of activity, to accumulate an enormous quantity of data that presents hints, indications, and suggestions related to the questions pertaining to the project. This material, the recording of the activity of a community of designer-students and a designer-teacher expert, strongly outlined in the pedagogic point-of-view, is presented as very destructured, at first impression, confusing and difficult to consult with. We asked ourselves if and with what methods this wealth of knowledge- in the traditional didactic activity, destined to be erased after use- could be reused and exploited in different contexts; for example, as a new offer within a course.

However, the very nature of the education acquired through studio-practice is nonlinear and this difficult to organize, carrying the risk of reducing it into a list of abstract rules for the project-design or into a manual.

For such reasons, we developed the indexation system WITarch that provides the possibility to navigate in a personal manner through the internal contents.

Such occurs through concepts that refer to other concepts and which tend to guide and produce the associative process that the student, measuring himself/herself on a projected exercise in the special and stimulating environment of the virtual classroom, puts into action during the brainstorming phase of ideas and solutions to the proposed theme.

In the indexation system, having identified the number of the exercise and the brainstorming phase, the instructor assigns one or more keywords to objects which will gradually accumulate in the system.

This indexation motor refers to the decomposition model on a semiotic basis that recaptures the lucid and always valid intuitions of Hjelmslev, revived by Greimas and his young students at Scuola di Parigi in the 70's. the model was later ulteriorly adjusted with the decisive influence of the work of Thurlemann (Greimas's student) in the visual arts field and was reworked by our group in Venice starting from 1980. Successively, it has been experimented for more than ten years in didactic studies in projection laboratories and graduation labs in an extended experimentation involving visual arts, urban projection and building-scale architecture by IUAV.

In the software adjusted for the implementation of WITarch and its consultation exist therefore two types of keywords: the first type, elementary but essential, associates student names to the number of the exercise and paper correlated. Such information is directed to who, taking the course or single unit, finds themselves having to elaborate on analogous exercises etc. The second type, of more general and theoretical interests, refers to: theoretical concepts, significance and a profound sense of the project, constructive and architectonic typologies, perceptible materials (texture, color, etc), geometry, form, conformation, syntactic structures, projected actions, compositive operations in the composition and manipulation of the project (deformation, superposition, addition, subtraction, stretching, scaling, etc), architectonic, historical and geographical references, instruments and techniques of the plan, recurring errors and didactic suggestions, etc.

4 THE DIDACTIC-PEDAGOGIC MODEL: COOPERATIVE LEARNING AND LEARNING BY DOING

The pedagogic premise of the integrated TDraw-WITarch program is the model of the constructivist matrix in which the context of learning and the collaboration among students and teachers and among students themselves all have a great importance. Learning is a social process and communication and collaboration define the learning environment.

This model implies a projection and expenditure specific to the contents and the regard for certain necessary conditions for an effective collaborative learning experience:

– members of the group must have a common base of understanding and a shared objective

– interactions must be developed in an environment of respect and trust and in a climate of informal communication

– there must be a tutor present to organize, monitor, and facilitate the development of the activity and the atmosphere of collaboration

– the building of knowledge must be active and learning is obtained through the involvement of the student and the class

– the solutions to the problems are not intended to verify an understanding already acquired but to comprehend the significance of the contents and to create a new understanding

– the presence of feedback is necessary; the exchange of reciprocal observations and impressions within the group

– it is necessary the definition of an ontology and the sharing of such can occur through the negotiation of the significants.

The psychologists Carl Rogers and David Kolb were the first to create the theory of "learning by doing" by affirming that learning is easier when the student participates in the educative process. This process has to be based on solutions to problems through experience (experimental learning) and on the ability to self-evaluate the results.

Beginning with these considerations we attempted to define a dimension in which the users interact and work together to reach a common goal of individual understanding as a result of group work. We asked ourselves about the role and contributive value of each in the construction of the elaboration of the contents and in particular in the process that leads to the definition of new contents through the integration of contribution from the class in its own course of brainstorming.

At the base, there is the intention to rationalize and organize the knowledge by ways of memorization, indexation, reuse of solutions (Design Cases) and projected processes (Best Practices). The cases crystallize significant "stories" of the project, choices, failures, technical options etc. The relationship between categories and cases is thus the same between general knowledge (conceptual) and episodic knowledge. The previous is more universal and common to a vast number of examples, the latter is more particular and related to a specific event; cases and categories become efficient instruments for the knowledge of the domain (knowing-that). The process will capture the dynamism of the evolution that from the conceptual phases of formulation develops into the solution.

5 FUTURE INTENTIONS AND POSSIBLE DEVELOPMENTS

The research described up till now has attempted to create and implement an educational program from case-study, learning objects and reasoning cases gathered from projected experiences in the laboratories or studios. In other words, the formation of a general memory of a course with a projected character, able to gather and solidify the didactic experience, to update and self-teach, on the basis of experiences, the education system and to supply it online.

Such memories of the course entrusted to a simple instructor and assistants, could be connected among them to form a memory of the department or faculty; in fist analysis organized by disciplinary sectors (for example, building versus plant design) but maybe also with transversal perspectives (hospital projections: building and plant design).

Furthermore, such memories can be connected to other databanks for architectonic documentation (history of architecture, authors, urban geography, etc) as well as in reference to the accumulations of knowledge of the productive industries for construction components. The connection can be made through the study of appropriate interface systems between keywords of the integrated TDraw-WITarch program and the keyword programs of the integrated databanks. (fig 6)

6 CONCLUSIONS

In the last two academic years (2002-2004) the online revision of the exercises of the students and the Institution of the virtual class TDraw became services that accompany the normal conduction of the courses.

Such habitual practice has been the object- exploiting the asynchronous aspect of the TDraw system to guarantee the complete documentation of the interactions between students and instructors or the virtual drawing table- of a monitoring of such interactions in statistically relevant quantities. The availability of this documentation consented to the selection and filing of the most interesting educational moments and, in so doing, to perfect the logic grid of concepts and terms that could have better indexed the rich flow of information (written and graphic) that characterize the corrections of the projected papers.

The experimentation in the last year has also consented to highlight certain substantial requisites for the perfection of the interface software and of the virtual class while the layout of the WITarch program of the settling of experiences has been consolidated.

To sum things up, the principal goal and the originality of our approach to e-learning in architectonic projections is- other than the one previously describes to adjust an apparatus capable of managing the student-teacher relationship through computer technology- simultaneously, thanks to the characteristics of such a system, to gather prominent experiences and to pour them back out currently in a system of knowledge open to the use of the scientific community.

Thus, a system implementable in time and gifted with automatisms capable of acting out a certain range of self-education.

Fig. 1 - The site of the six courses and laboratories of IUAV active in TDraw in the academic year 2003-2004 (prof. V. Spigai and E. Siviero)
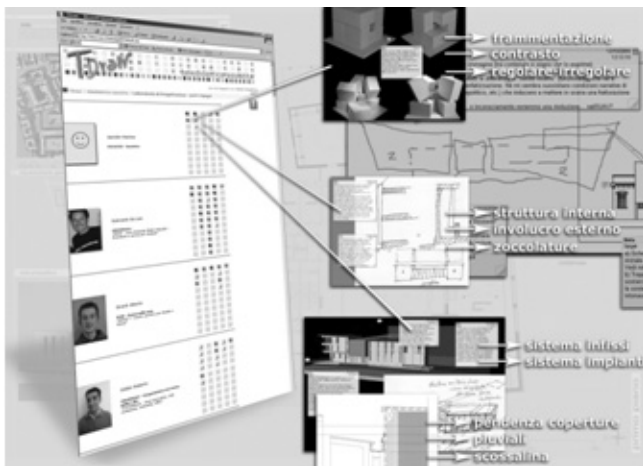

Fig. 2 - TDraw is a system for the asynchronous assisted revision at a distance of analysis tables and of the projects produced by the students in the architectonic courses. TDraw is organized as a virtual class to which students and instructors can access with different levels and share graphic files that are corrected and annotated by the instructor and made visible to all the students in the Course. The system maintains a trace of all the communication-corrections that the student and instructor exchange at eh work table throughout the Course: the materials are organized by stages that correspond to units in the course. At the end of the revision, the instructor associates one or more concepts to the significant corrections according to a system of indexation that refers to the semiotic model of the basis of knowledge.
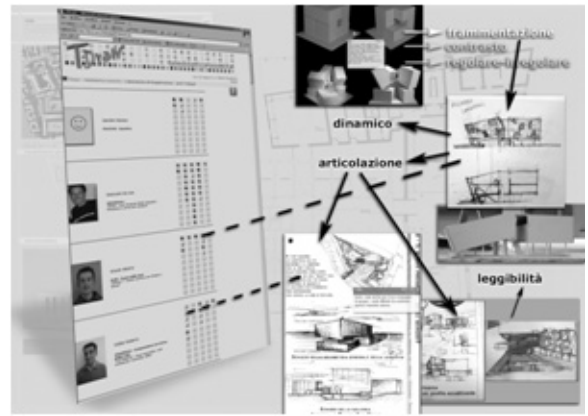

Fig.3 - In the WITarch program,; each object mastered in the virtual studio practice is connected to one or more concepts according to the projection of significance in one of the dimensions of the deconstruction model at the base of knowledge. Each concept recaptures the other concepts and objects through relations between concepts of the ensemble. Each user can, therefore, question the archive with a simple necessity (a concept), moving according to the semantic proximity of the concept, explore the semiotic category of the object or run through paths already explored by other users.
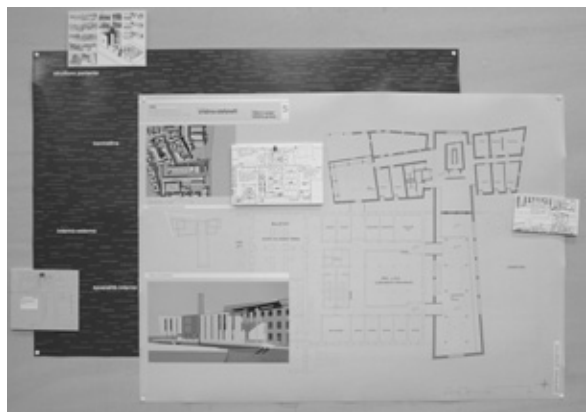

Fig. 4

Fig. 5 - An example of projected experimentation with the assistance of the integrated TDraw-WITarch. (this is a project for the enlargement of the IUAV branch near the venetian ex-cotton mill of St. Marta). The reading is on three levels: the first (dark table) represents an image of the cloud of concepts to which one touches to receive hints, suggestions, advice; the second (light table) represents the projected expense; the third (windows) represents the result of the research consultation within the archive of corrections made during previous courses.
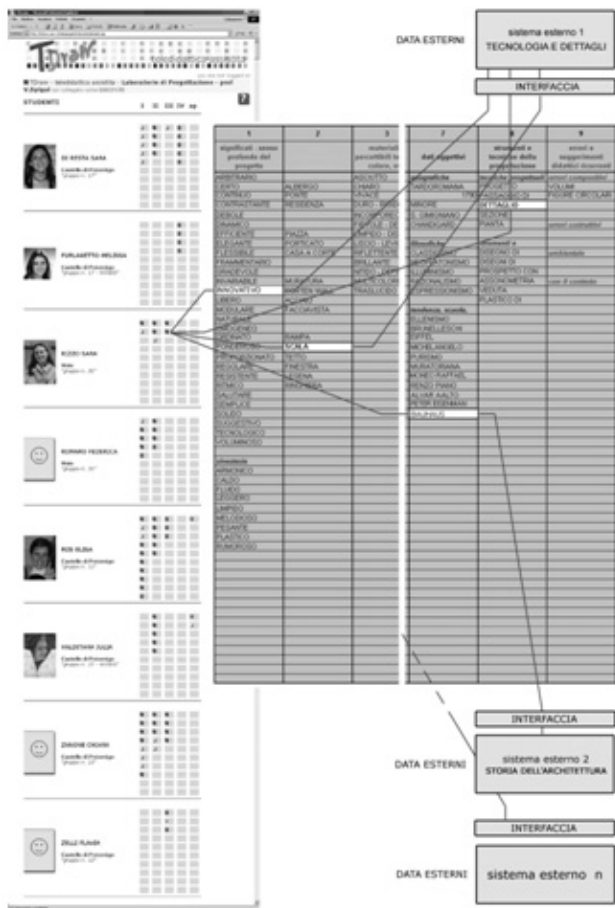
Fig. 6 - Model of links and interface between interactive archive WITarch and other external systems of data filing.

7 NOTES

1) TDraw is an acronym for Telematic Drawing. For a complete elaboration of the specific techniques and communication characteristics and collaboration of the TDraw system, refer to articles of previous Didamatic Conventions 2002 and 2003.

2) The research "WINDS- WEB BASED INTELLIGENT DESIGN TUTORING SYSTEM IN ARCHITECTURE AND ENGINEERING" - coordinated by prof. Mario De Grassi-IDAU - Department of Engineering in Ancona, was financed internally by the CEE program: Information Societies Technology (IST) - Fifth Framework Programme, European Commission, 1998-2002 and 2002-2004. Twenty-seven institutes collaborated to the research from European universities, research institutes (METE s.r.l., CNR- Institute of Psychology) and software and computer programme production companies Nemetschek and FIT.

3) The WITarch research - Web Interactive Archives of Architecture, closely interrelated to the WINDS program, has obtained cofinancing from the Miur inside the following researches:

a) "Definition of the didactic environments for teaching assisted architectonic projection using intelligent tutorial systems" - MURST ex 40% 1998-2001.

b) "Architectonic projection and industrial production for components. Towards an integration for new languages and constructively advanced formats" - MURST ex 40% 2000-2002.

c) "Didactic and collaborative projections online. Virtual laboratories at a distance, implementation systems of the tutorial experience in e-learning integrated with systems task knowledge" - COFIN MIUR 2003-2005

4) The section of the experimentation concerning the student-teacher interaction online was accomplished by the WINDS research of the Multimedia Section of LAR - Laboratory of Research in architectonic projections for the Department of Architectonic Projections of IUAV, under the supervision of Roberto Grossa and specific contributions from Cristina Stefanelli and, for the software elaboration, of Ciro Palermo of SINT- Computer and new technological services- IUAV.

5) In the academic year 2003-2004 the TDraw method was used for the first time in an Construction Science course, prof. E. Siviero - IUAV.

6) WITarch - abbreviation of Web Interactive archives of Technology and Architecture. The logical model for the construction of such memory recaptures the orientation of a previous research on the construction of informative interactive archives for architectonic projections in collaboration with IDAU of Ancona and IUAV of Venice (cfr. Spigai V. (1994), Comporre per framment di memoria, "Research department CNR - Progetto finalizzato Edilizia", Ancona). Matteo Vairo and Cristina Copetti, with the collaboration with Alessandro Ghedin and Alessio Bolgan who significantly contributed to the WITarch research, with the consultation of Roberto Grossa and Ciro Palermo.

7) points 3 and 4 were written by C. Stefanelli.

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