Architectural Design Education and Digital Technologies:

Toward a Multinational Research Observatory

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New visions that do not confine the computer to strictly technical and representation functions have appeared in schools of architecture over the past few years. The use of new information and communication technologies (NICT), in the field of design education in particular, have allowed the creation of innovative teaching tools and teaching configurations that are operational in certain European and North American schools. Unfortunately, the comparison of experiences is rare, and it would be beneficial to facilitate educational exchanges on a scientific basis.

It is clear, now, that the general use of NICT will have to promote educational programs that are evaluated scientifically, that are "efficient" and that are occasionally multinational, even if the cultural differences make the task difficult.

These considerations have lead us to the proposal of recommendations for the creation of a multinational observatory for the teaching of design that could benefit from the presence of researchers from European countries and from North America already implicated in activities in our laboratories.

This observatory is conceived as a depository of pedagogical works serving as observation material destined for scientific research. As such, it would act as an observation site for research in didactics of design.

It would allow for a new understanding of the opportunities and limitations derived from the emerging globalisation of distributed design education and offer new challenges for architectural schools.

This article describes the beginnings of this observation system and underscores its potential to produce results in the future.

***Keywords**: Architectural Design; Education; Digital Technologies; Cooperative teaching.*

1. Introduction

The introduction of computers and information technology into the teaching of the schools of architecture is recent, even though certain establishments can claim more than fifteen years experience in this area. There is a great difference between the various teaching programmes and a great difference in the practical approaches to this subject in the many educational institutions who have responsibility for the education of architects.

So, schools of architecture are evolving in a context of transforming values, technological changes and changes to research methods and professional practices. The computer transforms the profession of the architect and is added to the knowledge and skills required by architectural students and architects to carry out their projects.

This project presents the potential of an observation of existing teaching methods and configurations in each country, with the view to reinforce the innovations and to propose recommendations for the creation of a scientific observatory for the teaching of architectural design using computer technology and communication networks. The results of this project would support broader research aimed towards the foundation of a more permanent international institution as soon as initial experimentation provides an inventory of the problems inherent in its daily operation.

Two research entities are mainly involved in this project. The GRCAO (Computer-aided Design Research Group) of the School of Architecture at the University of Montreal (Canada), and Li2a (Computer Science applied to Architecture Laboratory) of the School of Architecture of Toulouse (France).

Thanks to collaborations with other research groups specializing in complementary fields, we created an observation site (www.grcao.umontreal.ca/observatoire: Jan 2002) It has been online since January 2002, and has allowed a comparison and exchange of teaching experiences in schools of architecture, which make significant use of information technology. The exchanges concern mostly aspects of transferability and efficiency of the methods and tools employed. The possibility to institute a multinational observatory of design education will be undertaken based on the observations of the research, and will authorise the definition of new research-teaching transfers.

2. Context

In the domain of architectural design teaching (a particular approach in the more general field of design teaching), a field where global expertise is extremely rare, there exist few experiments that are based on original learning configurations and specific computer systems.

Analytical methods, if they are based largely on long-standing observation techniques developed by the social sciences, come up against problems of evaluation techniques: in our highly specialized domain, what is effective learning, what is acquired knowledge, what respect is accorded the student's autonomy, what teaching methods with what logistic, documentary or operational computer support, etc.

Europe and North America have different approaches to the teaching of design and certain pedagogical experiments have now allowed the accumulation of sufficient material to permit an evaluation of the pertinence and the transferability of these experiments by extensive and systematic observation.

There is a great variety of experiences in this area, but different conditions in different countries mean that, many differences of teaching programmes and content exist, even within the same country, whilst the demands, which the profession makes on establishments involved in the education of architects are the same almost everywhere.

Following meetings with representatives of the

Royal Architectural Institute of Canada (RAIC) we were able to consolidate this research track, which is part of national Canadian preoccupations. Preoccupations highlighted by RAIC that today act as catalysts in this domain, "notably:

- In opening avenues for collaboration between practitioners and university researchers, be it for joint research or the development of policies;
- In disseminating research results through publications, conferences and exhibitions;
- In advocating policies for financing research that are apt to engender a tradition of sustained and methodical research in architecture" (www.raic.org: 2002)

The sharing of computer-based teaching experiments in schools of architecture, both as initial instruction and continuing education, meets the objectives of both international professional organisations and those of university researchers. Thus international experts in architectural design education are allowed to observe and exchange new teaching and learning practices, especially in the area of digital representation of the architectural project. For our part, we have the advantage of the participation of the University of Montreal (SUITE grant program: Soutien de l'Utilisation de l'Internet et des Technologies dans l'Enseignement; www.suite.umontreal.ca: 2001). The creation of a digital laboratory-observatory that attempts to re-create the learning environment, the studio, where the student develops an architectural project under direction of a tutor, has been underway since Autumn 2001. This laboratory-observatory, which enjoys an international presence since this spring, is set up as a web site with a search engine to allow students all over the world to register and share research activities in the field of architectural design and digital technologies. The CAD Research Group of the University of Montreal currently hosts the site.

These exchanges are also a priority for the European Community (*Constitution d'un Espace Européen de l'Enseignement Supérieur*: 1998-2002), and some of them are to be found on the network (www.archi.fr: 2002). To paraphrase the site's description: "various French and European organizations and establishments have joined forces to create the archi.fr network to serve the field of architecture and its relationships to the territory and the city.

The goals of this network are:

- To bring in co-operative processing on their respective activities and document funds;
- To set up interactive methods and services to transmit knowledge resulting from professional, teaching or research practices;
- To provide a shared digital site open to the debate of ideas and to serve as a platform for architectural creation".

Consequently, EC has decided to propose a new, specialised, in-depth and European education for its future architects. As underlined in several of this Commission's projects, an increase in requirements due to the evolution of life styles that contribute to increasing the complexity of situations and the technical level of responses is noted. Given the European diversity of these legacies, this implies an increased responsibility at the level of architectural design and the introduction of supplementary techniques and competencies of professionals involved in the built environment of cities.

About ten years ago, the European meeting of IMARA'93 in the context of the international IMAGINA exhibition (Monte Carlo) gave rise to a demand to confront, as well as a will to clarify the role and content of computer teaching, in the schools of architecture. The original group, therefore, made an application for a project within the community, the IDEA European network – Information Technology In The Teaching of Architecture – (Léglise and McGovern, 1995). Fourteen countries where represented, but it seems the concept was

too far ahead of its time, and was not accepted for EC funding.

Now, it appears the time has come to intensify these exchanges on the education of future architects, through increased co-operation and exchange between the design world and the world of production, so as to provide a greater number of professional opportunities opening up in industry, local collectives and all careers linked to project management for new graduates.

3. Design teaching issues

Widespread but limited in their applications, the most popular software programs used in architecture have dealt with the question of representation instead of considering the design process itself (Léglise, 1995). Independently of questions concerning the learning of computer programs, university education feels the effects in that:

- The correspondence between the computer and the project approach is still in gestation;
- Students meet up against difficulties in making the transition between analogical tools (drawings and models) and computer representation, and so the computer is often left to the end of the process.
- The benefits of the computer to creativity remain to be explored.

And as we have already underlined in other research conducted by the GRCAO, a large part of the teaching of architecture is done in studio, where the student develops an architectural project under the direction of a tutor. A reflection on the pedagogy of design inevitably includes a better understanding of the theoretical foundation of the architectural project as such. Whether admitted or not, all architectural teaching proposes a model of the design process. In fact, the education of architects leads us to the practices of the project, rather than simple learning methods. Dedicated primarily to representation, the actual usage of the computer does not follow the logic of the project.

"Architectural reasoning" calls upon a number of considerations of all types (cultural, legal, economical, sociological, psychological, technical, urban, etc.) as well as indeterminacy since it implies creation (Rosenman et Gero, 1992).

In this vein, several efforts, particularly following the second world war, in the tradition of Fordism and the industrialization of the construction process, have improved what we call the decision-making process and, with data processing by expert systems, proposed new solutions for the management, modelling and digital representation of the building.

It is however, the management of complexity and indeterminacy that are the root of the problem. The computer is used for its memory storage, ability to superimpose layers of information, and its precision in the laying out of plans, whereas the process of the architectural project, as it is taught and practised, is one of a progressive definition of intentions.

Recent work in the definition of teaching modules has considered that information technologies can of course allow the support of operative aims, and of learning objectives as well. It is a change in the point of view that authorizes a greater intricacy between knowledge and know-how (expertise) and therefore better respects the complexity of design activities. This double role of the new technologies merits an evaluation through concrete examples.

Several approaches in the traditional design process can be re-appropriated in a methodology that places the emphasis on digital modelling (in every sense of the word, not merely geometric modelling of CAD software) while avoiding the traps of imitation. In effect, the analysis of creative methodologies shows the diversity of means used by architects to manage the complexity of the project (De Paoli, 2001).

But, other ways are opened up, in different areas.

The pooling of methods, exercise topics, and different sources is suggested by the AVOCAAD project (Verbeke & Provost, 1998; www.avocaad.org: 1998-2002).

Another aspect is that the web is a powerful cultural tool, as can be seen from the "datarq" experiment, carried out at the FADU in Buenos Aires. (Montagu, 1998;
www.datarq.fadu.uba.ar/datarq: 1998).

Document bases can be used to encourage active student learning, which brings us to the process we have already suggested (Chupin & Léglise 1996, Léglise 1998; 2001), making the student an actor in his own learning.

In this way some of us promote very original tools, which accumulate structured information from several contributors. See for example Dynamo, a prototype of a 'Case-Based Design tool' for student-architects
(www.asro.kuleuven.ac.be/dynamo: 2001) and Ann Heylighen's PhD
(www.asro.kuleuven.ac.be/asro/English/Home/Ha/home.htm: 2000).

These considerations of representation and architectural design clearly show the need for a reflection on the teaching of design and the professional stakes of architects. And this need calls for a multinational research observatory that could contribute to the development of new theoretical and methodological approaches in the teaching of architectural design and digital technologies.

4. Configuration and methodological basis

The CAD Research Group (GRCAO) of the University of Montreal (Canada) and the Computer Science Applied to Architecture Laboratory (Li2a) of the School of Architecture of Toulouse (France), support the implementation and the research.

The GRCAO (www.grcao.umontreal.ca: 2002) projects are oriented towards the research and production of tools and work methods that take advantage of the possibilities offered by the computer and specifically computer-aided design (CAD). Several theses and dissertations by members of the GRCAO propose contributions to the evolution of tools destined to the design and management of physical objects in our environment, and therefore our quality of life. Since the launch of this observatory, we have noticed a strengthening of research activities of the group and a support of existing collaborations between the GRCAO and other research groups specialising in complementary disciplines. This has fuelled the work of students in the Computer-aided Design, Modelling and Manufacturing Master's program (CMFAO).

As for the Li2a, it develops its research within the following fields:

- Hybrid configurations for design learning;
- Qualitative approaches to architectural knowledge;
- Space and cyberspace: design and cross-contaminations.

Most of its members have conceived and experimented original design teaching configurations.

As previously stated the current tool for deposition and observation is a web site, that we have called an observatory, which hosts teaching experiments.

It serves as a depository, with a collection policy, as yet to be established, for teaching experiments illustrated by:

- A description of the corresponding teaching configuration;
- Student work;
- A critical auto-evaluation tool for teaching, represented by synthetic teachers texts (and eventually, those by students), creating a knowledge bank of opinions from its own founders and "users".

This source for the research, has allowed the creation of place of discussion and observation for the learning of the architecture. It could have been made with a set of links to the concerned sites.

But all these sites do not necessarily provide relevant information, so the development of a completely new method for the presentation of works of architecture is required. A method which we intend to observe and evaluate.

The future research, based on these data, will allow the start of:

- A scientific evaluation of these teachings, seen exclusively form the point of view of the learning of design;
- The refinement of pertinent axes of theoretical and experimental research of design education;
- The foreshadowing of teaching based on new information and communication technologies, and that will give a student, whether Canadian or European, the possibility to partake in this teaching from his own country;
- The specification of the classes of software necessary for the support of design education seen as a strictly "intellectual activity as part of a cultural field" (Boudon & al., 1994).

Some of the information evaluation techniques and the analysis criteria are principally based on a type of experimentation that recreates the places of learning, mainly, but not solely, the studio. Starting from analogical studies of the characteristics of proposed projects or objects, the students update certain cognitive mechanisms structuring the assimilation of knowledge and know-how specific to architectural design.

So, the future research will involve the participation of experts from several groups and laboratories associated with and invited by the GRCAO and the Li2a to reflect on how to contribute to the improvement of the quality of work of design professionals and the emergence of efficient and innovative methods for their education. This network of national and international scientists involved in this domain could thus serve as a passage to the research and teaching environments concerned.

5. The first experiment

As previously stated, the first version of the observation site (www.grcao.umontreal.ca/observatoire: 2002) has been online since January 2002.

The observation field is constituted by three different types of learning units. This diversity is intentional, paving the way towards a multicultural approach. The first unit is on line, the next two will be hosted in a few weeks.

- The studio in Computer-aided Design and Modelling (CMAO) that brings together students from the Professional Master's Program of the School of Architecture at the University of Montreal and the students of the Master's of Environmental Design – Computer-aided Design, Modelling and Manufacturing Option (CMFAO). This approach favours the learning of new communication strategies that aid reflection and stimulate collaboration between students who can share web pages to exchange knowledge, criticise, correct and evaluate the presented projects. This very site, has been, since the winter 2001 semester, a studio for students who present their work in the form of web sites, which are used as a new approach in the presentation and structuring of the architectural project. This approach shows, by images, animations and text, the creation process of the project. It is an electronic notebook that resembles a book of electronic notes that allow the student to show his competencies and the attainment of studio objectives.
- The "Architecture, Mémoire et Conception" third cycle seminar of School of Architecture of Toulouse sets up conditions to question creative operations in general and, in particular, those concerning the architecture project. It mixes analogical and digital methods to create a structured memory specific to an architect, supported by precedents (Chupin, Léglise,1996). In this way, little by little, students build up a "thesis information system"

gathering scattered elements that they accumulate to add depth to their work. An Intranet network and electronic notebook are two major elements of the teaching configuration.

- The "Ateliers Coordonnés" module of School of Architecture of Toulouse. The co-ordinated workshops module consists of a cross-disciplinary, first-year training group on the project. Its educational goals target mastering digital and data techniques in learning about the representational work, conception and communication of an architectural project. The notion of a development configuration (with means, methods and information, etc. made available in an organized way) provides for a strategic mode to attain the three main levels of an architectural project's representation: prescriptive, descriptive and speculative.

These teachings all develop experiments of pertinent design assistance for the production as well as for the creation and appropriation of cognitive tools, supported by case studies, some of them giving rise to the production of a thesis.

One can see the presence of pluridisciplinary teaching of the complete integration of computational tools aside more traditional tools and means of representation.

6. First observation

We stress, in this regard, that experimentation already undertaken has allowed the start of the observation of work on digital design by other research groups such as the Emergent Design Group Software Projects of the MIT School of Architecture in Boston (www.mit.edu/edgsrc: 2002) and the Graduate School of Architecture, Planning and Preservation (GSAP) (www.arch.columbia.edu/gsap: 2002) of School of Architecture of Columbia University in New York. This experiment could allow for the proposal of collaboration with other university architectural institutes in order to create an International Master's program specialising in the digital domain. This would allow the enrichment of exchanges on our proposition of a multinational observatory on architectural design education and digital techniques to promote international (i.e. multicultural) encounters on design education and digital techniques in architecture.

7. Conclusion and perspectives

The results obtained tend to confirm our recommendations for the definition of a multinational observatory on design education. This observatory could profit from the presence of researchers from Canada and European countries already involved in the activities of the GRCAO in Montreal and the Li2a in Toulouse.

These laboratories would, therefore, be an excellent tool to provide the desired research framework to rapidly respond to the definition of new performance criteria for students in programs in architecture that foresee a bridge between the criteria defined in the multicultural context of North America and the European Union in the next few years. USA are concerned, too: see "EC/US Cooperation Program in Higher Education and Vocational Education Training, European Commission", (europa.eu.int/comm/education/ec-usa/usa.html: 2002). The co-operation between Canada and the European Union, which was the subject of a specific agreement in 1996, makes provision for a part of its budget to be used for the study of general themes for specific action on a "Society of Convivial Information" which incorporates studies on new work methods, multimedia and its tools. These themes preoccupy not only professional orders of architecture, but also and in particular the Canadian Architectural Certification Board (CACB) and the "Conseil Supérieur de l'Enseignement de l'Architecture" which defines the accreditation criteria for French education.

This observatory will use information and communication technologies to promote digital proj-

ects and the abstracts of results of didactic research in different schools of architecture.

It also would be a good way to offer the research framework desired to quickly respond to the definition of new performance criteria of students from professional diploma programs in architecture that foresee a bridge between the criteria defined in different countries.

Last but not least, the creation of the observatory will help to disseminate instrumented works such as seminars, publications, and periodical communications, the objective being to enlighten pedagogical action by providing it with the instruments and frameworks for critical evaluation.

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