The creative design process supported by the restrictions imposed by bioclimatic and school architecture: a teaching experience

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ABSTRACT

This paper presents a design education experience, where the concepts of bioclimatic architecture were applied in a studio environment of the Architecture Course of UNICAMP in Campinas, Brazil. At the first PALENC – 2005 Conference the authors of this paper presented a teaching experience with results that indicated the need for new ways of bringing the feelings of comfort close to the studio design discussions. In this paper, a new teaching experience shows that associating thermal comfort theory and design practice creates a series of restrictions for the design process and that these restrictions are assets to creativity, as attested by the literature. The design of a school building was the theme of a bioclimatic design class given in 2006. Two groups of pupils were formed, one working with the impositions of the school building department of the State of São Paulo, Brazil (FDE - Fundação para o Desenvolvimento Escolar), and the other group with the concepts of organic architecture. This group developed a series of artistic activities to stimulate their creative organic design process. Both groups carried out visits to schools and their environmental comfort conditions were evaluated with technical measurements. Theoretical classes, on thermal comfort and school architecture, were interspersed with design studio activities. The results showed that the imposed restrictions of FDE stimulated the development of creative student projects, with bioclimatic quality. The designs based on organic architecture were to some extend less creative, with similarity of formal conceptual approach. These designs also lacked detailed bioclimatic considerations, mostly due to the adoption of curvilinear forms with large variations of solar orientation of facades. Thus restrictions are shown to be important in the creative process in architecture, stimulating search for quality solutions and should be used as design teaching methods.

1. INTRODUCTION

In the last decades architecture schools have made important efforts in improving design education. The goals in new ways of teaching are concerned with enriching the view that architecture is pure art, through insertion of scientific knowledge and social responsibility. Environmental comfort and the question of sustainability have increased the need for technical and scientific education. Social sciences need to instill sensitivities towards the relation between human behavior and architectural elements. Results of studies on creativity should, as well, enrich and structure the design process, thus avoiding the idea that innovation stems from talent alone. Exact sciences must give future professionals a deeper understanding of the physical phenomena that are involved in aspects of thermal, lighting and acoustic conditions in buildings and open spaces. The synthesis of knowledge coming from such multidisciplinary areas continues to be a challenge in the typical design studio of most architecture schools. The studio teaching method relies mainly on the interaction of students with experienced professionals and unstructured discussions concerning the specific mostly hypothetical design problem posed.

The University of Campinas created in 1999 its Architecture and Urban Design night course with a duration of six years. An effort to reduce some of the difficulties, mentioned above, was made mainly through joining theoretical classes with design activities and multidisciplinary teaching teams present in the design studio. However, in Kowaltowski et al. (2005) the authors of this paper presented a teaching experience as with results that indicated the need for new ways of bringing the feelings of comfort close to the design discussions in the studio environment. In this paper a further teaching experience is presented, where some of the previous challenges are addressed and important findings uncovered.

2. COMBINING THEORY AND DESIGN EXPLORATION

Many studies have examined the typical studio design teaching method in relation to diverse aspects (learning experiences, efficiency, quality of design, etc.). Schön (1983) describes design as a reflective conversation with the design situation, thus addressing the human thought-processes and the language (drawings, models) used to make design decisions. Other studies identified problems in architectural education as related to design communication and the introduction and application of computer-aided design in architectural courses (Nicol & Pilling, 2000). Viewing architecture as pure art has often been identified as a problem and investigations on typical professional practices have uncovered that ar-
Architects often lack knowledge on or fail to anticipate users’ needs (Salama, 1997). Importance given to the artistic content may cause architects to ignore social aspects in architecture and to emphasize their self-expression. The aesthetic or formal bias is further reinforced by most architectural publications, used as teaching material in most design disciplines. Architectural criticism is virtually devoid of human content and directed towards the formal aspects of design (Kowaltowski et al., 2006). Even technical aspects, evaluation results and user satisfaction rates are rarely present in architectural journals used by students in design classes.

Recent trends in globalization of the profession have increased competitiveness and demanded higher design qualities and productivity. This new order implies that students have a deeper understanding of background knowledge and acquire new abilities and attitudes towards design. To this end the University of Campinas structured its design classes on the construction of theoretical knowledge, combined with the use of tools and the development of an individual student design processes. The first year of the Unicamp course, concentrates on basic design elements and theoretical background on the “meaning of architecture” in today’s society, with multiple exercises developing drawing and model making abilities as well as three-dimensional vision. In the second year, the multidisciplinary nature of architectural design is explored and future professional social responsibility is addressed through discussions and design projects that bring urban reality into the studio. The next two years combine theoretical classes on environmental comfort with design problems of specific architectural typologies (schools, theaters, libraries, etc.). The last two years then attempt at increasing the complexity of design problems and specific trends found in growing cities in the developing world as “verticalization” of architecture are practiced. Finally, all students must develop an individual design project accompanied by a written report with theoretical and technical justifications of architectural and urban solutions chosen.

Bioclimatic design is taught in the third year and usually combined with a school building theme. Schools as an architectural type are chosen since they continue the social interest discussion of the second year. Evaluation data demonstrates that many school buildings fail to provide adequate thermal comfort conditions for the local hot and humid summer climate with dry and mild winters and most public schools are not mechanically conditioned. The principles of bioclimatic architecture are therefore important for school design.

The teaching team of this design class includes architects, engineers and physicists. Schools are discussed in relation to trends in education and bioclimatic design concepts are presented in depth (Kowaltowski et al., 2005). Students evaluate an existing school building with technical measurements and study specific thermal comfort issues through a number of exercises (climate characterization, human response to climate, thermal indicators, solar geometry and design of shading devices; ventilation conditions, building construction materials and techniques and their influence on thermal mass and heat transfer calculations). In parallel, a school building design is developed with a given site and program of an existing school in the city of Campinas. This studio situation demonstrates that a bioclimatic school building design creates a number of design restrictions with which the students must come to term. These restrictions are seen here as important aspects of design education, in so far that studies on creativity have shown that limits are essential to the creative process (Boden, 1999).

3. CREATIVITY

In design education the question of creativity is often considered an implicit factor and in higher education little emphasis is given to teaching methods that develop creative, independent and individual abilities. Thus most graduating professionals are capable only of applying what is common knowledge in conventional ways (Alencar, 2004).

Studies on the creative thought process have identified that it depends on characteristics of an individual: receptiveness or attitudes in search of innovative solutions, immersion into the problem at hand, dedication and motivation, questioning attitudes, analysis of ideas, especially flawed solutions (Kneller, 1978). The capacity to solve problems depends, as well, on two factors of cognition: repertoire (facts, principles, concepts, etc.) and heuristics of problem solving (systemization of insights). Creativity can be defined as a process of becoming sensitive to a question, to a flaw or a missing link in an area of knowledge. Innovation is the identification of difficulties and the formulation of hypotheses of such flaws to finally attain a solution, test it and communicate it to a wider audience.

4. A TEACHING EXPERIENCE

To test the strength of restrictions or insertion of specific artistic activities in design education, the bioclimatic architecture discipline of the Unicamp course, given in the first semester of 2006, was divided into two groups. The first group designed a school building within the recommendations (restrictions) of the local school building advisory board FDE – Fundação para o Desenvolvimento Escolar do Estado de São Paulo. The other group developed a school project under the auspices of “organic architecture”, through specific artistic activities during the semester. The two groups were separated in the studio activities, but participated together in theoretical classes (bioclimatic and school architecture) and final design presentation and “crit” activities. In the State of São Paulo public school buildings are regulated through defined architectural programs and construc-
Comfort standards are based on local codes and simple recommendations, for example the relation of window openings to floor space. Designers obtain a catalog of school building “components” as their “brief”, with a check list of requirements. Although very much standardized, schools as “cookie cutter” designs are avoided through the participation of various professionals in the design process. Figure 1 shows a typical example of a school building in the State of São Paulo based on the FDE requirements. The first student group, of the teaching experience described here, worked within these FDE restrictions and a rational, modular approach to design. The second group was given theoretical classes on organic architecture by a tutor with a large professional experience in designing private schools, based on organic principles in the State of São Paulo (Fig. 2). Students also developed a number of artistic activities at the beginning of the semester. These were seen as important to put them into the frame of mind of organic thinking. The second group was given theoretical classes on organic architecture by a tutor with a large professional experience in designing private schools, based on organic principles in the State of São Paulo (Fig. 2). Students also developed a number of artistic activities at the beginning of the semester. These were seen as important to put them into the frame of mind of organic thinking.

Organic architecture is considered the counter point of rational design, based on modular principles. Antoni Gaudi, Alvar Alto and Frank Lloyd Wright are considered the main representatives of this architectural language. The constructive ideal evolves from the human body. Sharp edges are avoided, giving way to fluid forms as a living organism (Tarragó, 1991). Natural materials are emphasized, as are forms inspired by nature. Scientific methodologies emphasize rational and analytical thought. The organic design process however needs artistic activities as its foundations (Mösch, 2002).

5. TEACHING EXPERIENCE RESULTS

Two examples of student designs of the teaching experience, described in this paper, are presented in Figures 3 and 4. In general, the designs of the first group (FDE) were more diverse, thus demonstrating that the restrictions imposed did not curtail creativity. Also, this group was more careful in addressing bioclimatic design issues. Form and orientation of volumes, as well as façade treatment was carefully considered in most examples. Designs of this first group were able to achieve a higher level of detailing. Modular design and a rational approach helped in finding a solution faster, with time spent on construction technique definition. Students were more confident in their design solutions as a whole. The FDE restrictions stimulated students to go...
beyond them as a challenge to standardized solutions. Thus, the design shown in Figure 3 demonstrates that restrictions can produce creative and artistically interesting designs. Also, even though this student did not opt for the best orientation of classrooms, mainly due to site restrictions, the design presented innovative solar control elements. Open spaces were given importance, through landscaping elements, and outdoor activities were designed into the total solution with proper shading conditions and protection from winter winds.

The design solutions of the second group (organic) were more uniform. The artistic activities and the special classes on organic architecture induced students towards circular similar forms. This form creates a centralized distribution of spaces, which pedagogically could be a favorable solution in school buildings. However, such designs lose control over orientation and each classroom would need its special and specific solar control elements. The central space in schools also may create acoustic problems, which demand barriers and careful architectural treatment of surfaces. These problems were however not addressed by the students of the second group, which indicates that students were so concerned with finding an “organic” form for the functional necessities of their school, that bioclimatic and other comfort issues were relegated to second place. This group showed a tendency to hold on to a formal architectural form (first found), without measuring other design consequences. The search for a “perfect” overall form of the school complex was apparent, as well, in the siting of the designs. They were less sensitive to the site conditions than the former group, giving the impression that design solutions were not developed in coherence with the lot, but as isolated, independent objects.

Figure 3 Student design project based on FDE principles
Climate consciousness of the first group of students was primarily represented through: recommended orientation of openings (north), form of volumes (long and thin, east-west axis), introduction of shading elements on the north elevation (extension of floor or roof slab), ventilated attic or insulated roof slab. Green roofs were a popular option to increase roof insulation. The second group had difficulties in combining their organic forms with bioclimatic recommendations for the local climate, although roof overhangs and ventilated attics were part of many solutions. Both groups gave emphasis to vegetation in open spaces.

6. CONCLUSION

Design is an artistic activity with the application of scientific and technological knowledge and is an investigation of finding the best form for the shelter necessities of human activities. Due to the complexity of the architectural design process there are no precise and fixed formulas that bring together form, function and site conditions. With an understanding of scientific phenomena (exact and social), experience and intuition, most designers reach heuristically their design solutions. However, not always the best solution is reached. With this in mind, design education needs the conscious introduction of: research data, design analysis tools and a structured design processes, which organizes creative thought. Design restrictions should be introduced, specifically to stimulate the creative process in finding quality solutions to design problems.

The teaching experience described in this paper has shown that most students cling to their first design solution, considered aesthetically “pleasing” and are reluctant to abandon this, even when problems are pointed out. Bioclimatic issues, although of primary concern in this teaching example, were mostly treated superficially when a first non-ideal solution was chosen. One of the major problems in teaching bioclimatic design is the difficulty in representing graphically thermal phenomena (Kowaltowski et al., 1998). Ventilation, typically represented by arrows flowing through the section or plan of a drawing, generally does not convey an accurate, physical phenomenon and may cause delusions of comfort, only discovered after a building is occupied or at commissioning time. In the teaching environment these phases are absent.

Thermal comfort research is based on scientific theories and measurements, represented by graphs and tables, not directly applicable to the design drawing environment. Simulation tools are of great help here and have been shown to be of importance in the teaching design studio (Kowaltowski et al., 2005). Further research is needed to test the introduction of methods that stimulate creativity in architectural design and that increase students’ sense of responsibility in relation to social and comfort impacts of design proposals.

REFERENCES


