Educating Architects towards Innovative Architecture

Editors: Constantin Spiridonidis and Maria Voyatzaki

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An Innovative Educational Approach

Studying the convergence between environmental design and architectural form generation

Introduction

One of the fundamental vehicles for stimulating innovation in architectural education is questioning the predictable and the proved. Concrete fields of architectural design thinking and existing frameworks of tools and means should be redefined with an attempt to formulate the unexpected by overcoming the limitations of each system and creatively merging the competitive advantages of each component.

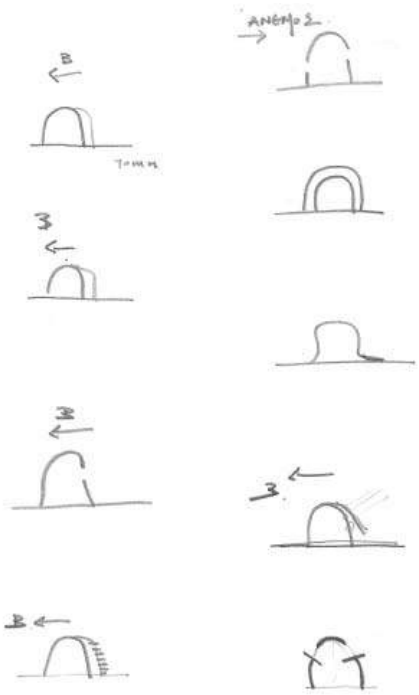
Environmental design has become a very important part of both professional practice and academic research today due to the global energy and environmental problems. At the same time digital design tools have been challenging the ways architectural forms, in particular those generated by topological geometries, are conceptualized, explored and built. However, research in the former area has been focused onto its technical aspects without taking into account the ways environmental design can be integrated in the conceptual stages of architectural design. On the other hand form generating processes based on mechanisms like *folding* and mastered through the capacities of software packages like Maya, often lead to formal statements rather than functional architecture, a practice usually justified by its experimental nature.

At the School of Architecture in Crete (T.U.C.) during the spring semester of 2010 we took an innovative approach in order to study the potential convergence of Form Generating Mechanisms with Environmental Design Methods by merging two different classes: "Digital Media in Architectural Design III" and "Environmental Architectural Design". The aim of this approach was to overcome the inadequacies that each of these two directions -the scientific environmental aspect and the conceptual form generation aspect- entails.

Design process and student projects

The students were asked to design a pavilion, placed on a specific site in the city of Chania, with one basic requirement: to embody and display through its architectural resolution a specific environmental system. The site of intervention was the square in front of Chania cathedral in Halidon street which connects the old Venetian port with the contemporary city. As a conceptual tool at the initial stages of the exercise, the abstract devices of *folding* and conceptual diagramming were used. One of the requirements of the design process was that the architectural project would have to display and embody its integrated environmental system. This requirement would influence significantly the process of design, topological transformations and conceptual diagramming.

The students had to choose from a number of environmental systems – which were given to them in the form of sketchy diagrams- and use them as starting points for design (figure 1). All further design explorations should keep the topology of these diagrams consistent throughout the process and despite formal modifications. The given environmental systems included:

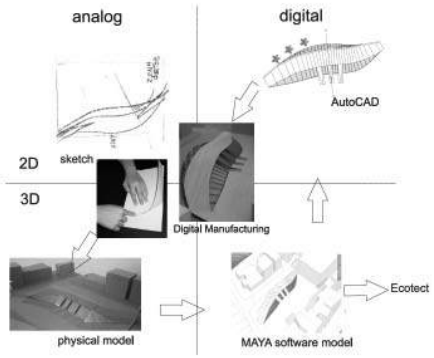


Trombe wall/Thermal mass wall
Greenhouse
Systems for direct solar gains
Movable or fixed shading devices
Systems for ventilation and passive cooling
Ventilated double skin façade, roof or envelope
Green roof or envelope
Photovoltaic or solar active systems
Systems for indirect daylight.

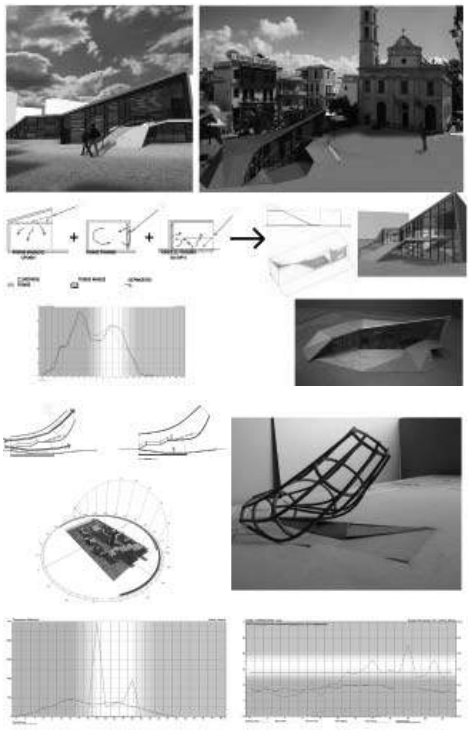
The design process (figure 2) was initiated by studying conceptual diagrams through sketches. These were followed by a number of analog topological transformations on a simple piece of A4 paper, which were modified through scores, creases, cuts, piercings, hinges, knots and pull-ups without losing the continuity of the paper surface. This process would allow the study of the form of the projects in a physical manner. All actions and interventions on the A4 paper would have to relate and be inspired by the demands of both the integrated environmental system and other functional or contextual parameters.

Further explorations were made through 3D digital parametric modeling which implemented, tested and subsequently redefined the analog model. Processing of the digital model led to the production of the final –analog- model through the use of different rapid prototyping techniques (CNC router, laser cutter and/or Z-Corp printer).

The digital models would be further explored using Ecotect – a sustainable design analysis software. Giving the necessary parameters, such as material properties, wind direction, orientation and geographical position as well as site parameters, the students were able to arrive at analytical diagrams which would depict the environmental function of spaces and surfaces: temperature distribution throughout the year, solar gains, the fluctuation of temperature throughout a single day, or between external and internal environment etc. Depending on these results students would have to modify the form of their structure in order to obtain more efficient environmental behavior.



In project no. 1 (figure 3) a thermal mass concrete wall, which is either vertical (wall), horizontal (floor or roof) or diagonal (stairs) is generated out of the folds of the flooring of the site itself and is synthesized effectively with the external envelope. This is a triangulated surface made of wood which was designed in Maya, unfolded and flattened in Form-Z and laser cut. The process started off with abstract diagrams of the environmental system, moved on to the first sketches and the physical model to explore the form, and finally arrived at 3D renderings and the final laser cut model.

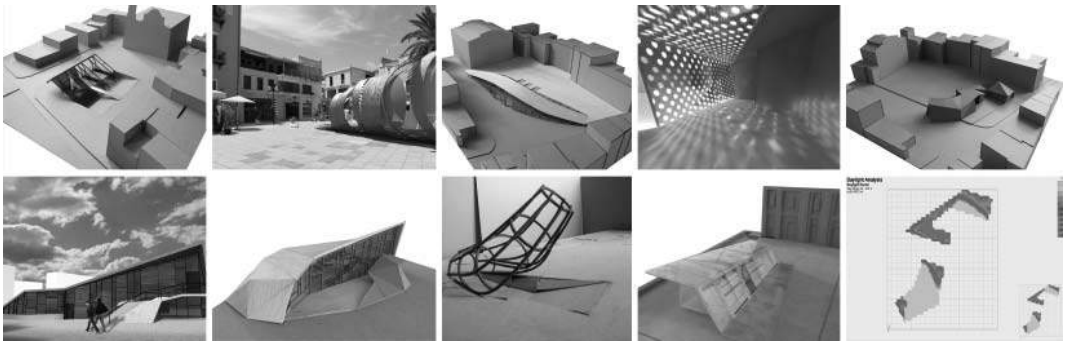


Project no. 2 (figure 4), manages to combine its environmental aspect - passive cooling and ventilation- with a form that expresses that function explicitly through a diagram which combines two ventilation methods: facing openings and high open roof. The form is a huge funnel which allows air flow horizontally or guides the warm air through the funnel and up towards the opening of the roof thus managing its ventilation through its simple, yet compelling form and achieving effective cooling. The effectiveness of this project and its integrated system was demonstrated by the Ecotect test which showed that temperature fluctuations are within the comfort zone both throughout the year and throughout specific dates.

Other projects (figure 5) included a green roof on a folded surface, a photovoltaic roof with enclosed functional space, and an extensively pierced triangulated structure for direct daylight.

Conclusion

What became rather self-evident from the above educational approach is that, in the design process, the possible convergence between form generation processes (through folding devices) and environmental systems is possible and worth exploring it further. Using both digital and analog means to explore the formal and contextual aspects of the projects worked rather well in terms of form manipulation while the use of Ecotect allowed students to detect possible drawbacks of their projects' environmental behavior. As a result they had to "correct" them by going back to the previous stages of their exploration and modify formal or material aspects in order to make their project environmentally acceptable and efficient. Another important finding became evident from the process: the fact that optimization of both the architectural and environmental out-



come involved the collaborative work and contribution of both the designer (student / architect) and the computer (Ecotect performing calculations of environmental behavior according to parameters set by the designer).

An equally important innovation in this class was the way both analog and digital, 2D-3D tools converged. Since the answer to the pseudo-dilemma of analog or digital is both (designers today simply use a plethora of analog and digital tools in many different, innovative ways) there is a vital need for innovative methods in architectural education that will guide students in exploring the convergence, complementation and evolution of the two worlds.

The gap between analog and digital, and also between 2D and 3D, remains a challenge. The subsequent inefficiencies, delays and duplication of information are merely one side of the story. Since transitions from one media to the other are not –yet- univocal, the ineluctable ambiguity tolerates mistakes and unexpected results. Renee Cheng points out that «*any tool is more powerful if it is part of a cycle of digital and analog, going back and forth*". This back and forth process, helped students understand the particularities, advantages and confinements of each tool and means while realizing what information is either revealed or obscured. The aim was both to acquire the skills to use these tools and means as well as to understand them as conceptual methods for communicating ideas and exploring architectural problems.

To innovate is a fundamental competence. Innovation in architectural education should emerge through critically questioning both the established methods of design thinking and the prevailing framework of design tools. We are confident that our course led innovative thinking one step further by integrating aspects of architecture that have usually been explored in isolation and by contributing towards shaping the evolution of design tools and means.

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