# Controlled Transformations:
## A method to introduce first year architecture students to digital and parametric design thinking

**Gerasimos (Simos) Vamvakidis**
National Technical University of Athens, Greece
yerasimo@gmail.com

### Abstract

The disciplinary aspects of architectural design have been most substantially transformed by digital technologies in the last two decades. Whereas an increasing number of graduate and postgraduate programs have been able to articulate a consistent pedagogic framework that incorporates the particularities and capabilities of the digital world, this task has proved to be much more difficult in the case of undergraduate studies. This paper investigates and evaluates the implementation of a design methodology which was applied during the first term of an undergraduate architectural course in an EU university. This paper will also discuss the practical implications and suitability of its implementation within the context of the first year of our course.

**Keywords**: Physical; digital; modeling; design steps; process

## Introduction

Undergraduate students tend to be inexperienced in the use of digital tools, which are often understood as simple representational skills rather than as design tools. At the same time, especially in the first years of their studies, students need to learn how to compose architectural space and not get lost in exercises that are vague and unclear. Students find often hard to understand how to compose architectural space in a systematic and controlled way, using architectural elements such as surfaces, lines and volumes. This paper explores a method of digital design thinking, before even using digital tools, as a way to teach students how to compose architectural space.

There are already examples of digital and physical modeling iterations methodologies within final year design studios of undergraduate architectural studies, such as the ones described by Asterios Agkathidis (2015) and P.Maldonado (2014).

However, the matter of introducing first year architecture students to digital design thinking through a clear method remains uncovered.

Main aim of this paper is to present and evaluate the suitability and implementation of a teaching methodology that introduces students to digital design thinking from the first term of their studies.

We focus on the ways of integrating such a teaching approach as part of the main design studio, exploring its strengths and weaknesses. We discuss the outputs of term one and evaluate the student design skills in term two, where they are actually introduced to digital design tools as a way to compose architectural space. Finally, the overall data throughout both terms are discussed in order to evaluate the suitability of such a teaching method.

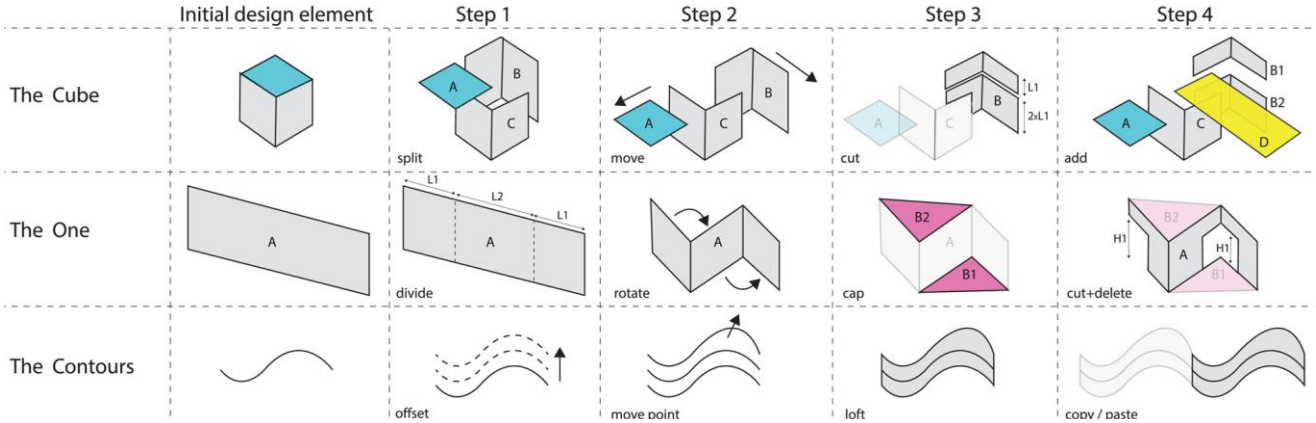



Figure 1: The three workshops and possible transformations steps

# Methodology

In order to overcome this problem, we experimented with a methodology of a series of design workshops which we named “Controlled transformations” for the first year of our design course.

This methodology was based on physical modeling during term 1, in order to develop a number of spatial and organizational transformations a specific geometry (a cube, a plane and a contour curve) throughout three workshops. Students were asked to come up with four consecutive transformation steps in order to develop their initial geometry (for example the cube) using verbs that characterize the digital design realm such as cut, split, trim, move, rotate, scale, stretch, offset, copy, paste etc (Figure 1). In order to explore the degree to which this methodology helps students understand and use digital software as a design tool from an early stage of their studies, they were introduced to Rhinoceros software in term 2 which they had to use as a design tool to compose a small scale architectural space.

The workshops were led by the author and it was part of a forty students’ cohort. Each workshop lasted two weeks; there were two studio meetings each week. The first week was about experimenting with physical modeling and the second week was about documenting their design steps (and verbs – “commands” they used) as well as the final design outcome through plans, sections, elevations, sketches and perspective drawings and photos of the final physical models.

Our aim was to explore whether digital design thinking can be taught, before even using digital design software, through physical modeling; a tool that is the basis of architectural design teaching, especially during the first years of architecture schools. We also document all the implications and possibilities of such a methodology. Since this is the first time we conducted such an experiment, we had the chance to compare the student outputs with those of previous years.

Feedback was given to students throughout the workshops on a weekly basis with one to one and group tutorials, as well as with a formative assessment at the end of each workshop and a summative assessment of their final portfolio with all workshop process and outputs in a single pdf file. Marks were moderated internally. All data was collected through

Students also filled in a “Personal Development Planning” form during the term as well as an anonymous student survey at the end of the year in order to reflect on their development, document their aspirations, learning questions and problems and evaluate any design skills gained throughout the term
.
Marking criteria were made available to all students and moderators. In particular the marking rubric was following the below marking criteria:

- Documentation of process and physical modeling try outs before producing the final, transformed physical model.
- Quality of cube/paper/contours transformations in order to produce functional architectural space with multiple spatial qualities.
- Production of quality drawings (plans, sections, elevations) and perspectives (eye level and bird’s eye view) for the final physical model of each workshop.
- Quality of physical models
- Layout and overall portfolio

Analysis of the monitored design output, marking rubric statistics and student survey, which will be presented in this paper are offering an analytical evaluation overview of such a methodology in the first year of undergraduate education.

Apparently, a decrease in students' average marking compared to previous years, or negative comments by mark moderators and students would be a strong indication that the teaching method applied is not delivering the expected results, thus making it not be suitable for undergraduate design studio education and vice versa.

## Results

As mentioned, a series of physical models were produced. All transformation steps were documented with physical models and 2D diagrams. Especially for the cube workshop, students had to experiment both with paper and foam in order to understand the difference between surface and volume. These spatial characteristics are hard for them to perceive within the first term of their studies without physical modeling using foam and paper (Figures 2 and 3).

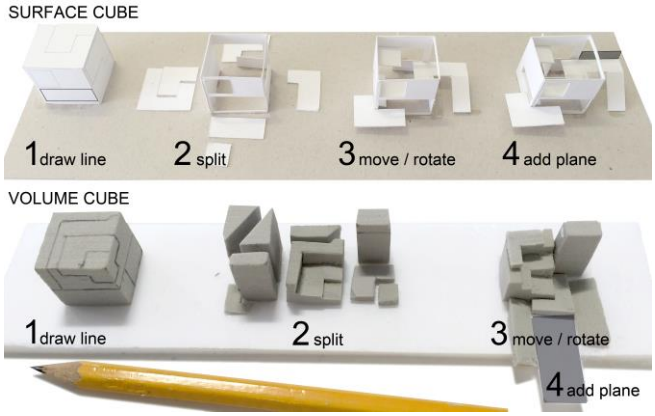



Figure 2: Documentation of paper and foam cube transformation steps (by Natalia Nedzi).

Figure 3: Final transformed foam cube physical model. All cut volumes are painted white (by Natalia Nedzi).

The same controlled transformations logic was applied during the second workshop which was named “The One”. Students had to transform a single paper plane in order to create an architectural space (Figures 4 and 5). The second workshop was a chance for students to explore contemporary design gestures such as folding through a series of design steps.

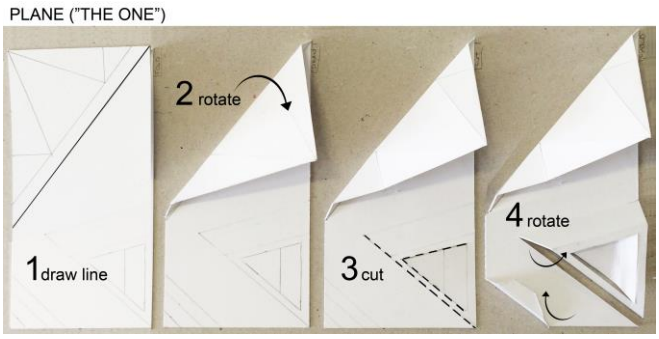



Figure 4: Documentation of transformation steps for the single paper plane workshop (by Natalia Nedzi)

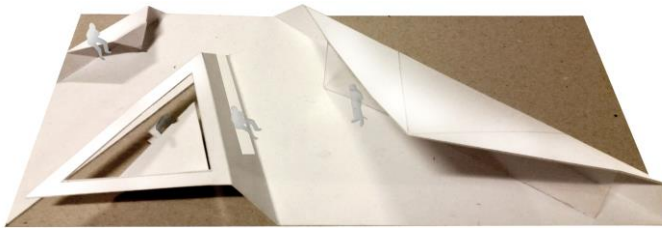


Figure 5: Final transformed paper plane physical model (by Natalia Nedzi).

The final workshop called “The contours” explored possible ways of composing architectural space by transforming one initial curve. Each student was asked to sketch one initial curve which they would have to physically model using printed paper.

Students were asked to edit the curves characteristics such as dimensions and curvature in order to create curve iterations. This technique is using the same design logic one could use to model a parametrically controlled curve in software like Rhinoceros or Grasshopper plugin for Rhinoceros software (Figures 6 and 7).

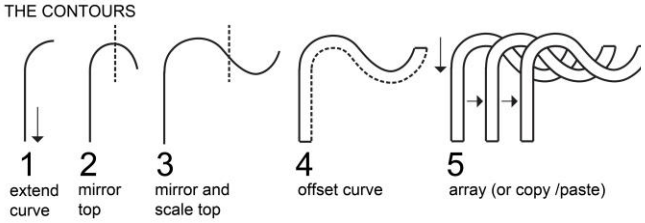



Figure 6: Documentation of transformation steps for the contours (curve) workshop (by Kotryna Jonaityte)

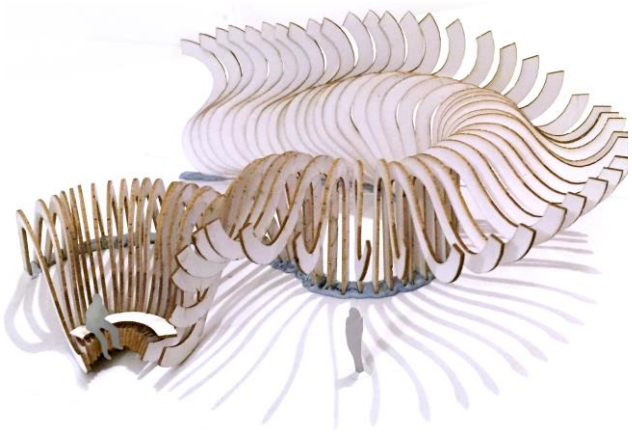


Figure 7: Final transformed contours physical model (by Kotryna Jonaityte).

Students managed to tackle the studio's design approach and requirements quite well, even though this was the first term term of their studies.

The student performance, PDP forms, anonymous student survey and final marks (compared to the last years) indicate a positive outcome on the studio's design approach as well as its suitability for a first year undergraduate design studio.

Looking at their marking statistics, 55% of the class was in the A and B band, with 33% been marked with an A and 36% been marked with a B. The A marks did rise 10% compared to the previous year, due to the clear studio objectives and teaching approach (Figure 8).

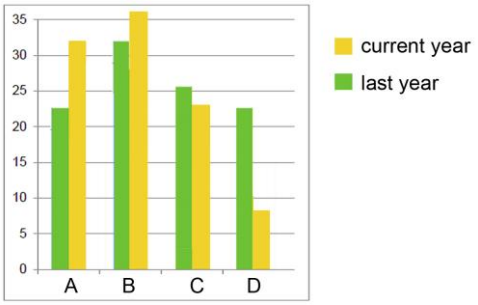



Figure 8: Marks comparison between the last and current year

The anonymous student survey gave students the chance to mark with a scale from 0 to 5 a series of questions. Grade 5 stands for strongly agreeing, grade 4 for agreeing, 3 for neutral, 2 for disagreeing and so on. The survey showed that 100% of the students found that these design studio workshops have improved their knowledge and understanding of the subject. At the same time, 86.7% agrees that this module has been relevant to their course/pathway and career aspirations. Precedent design examples were presented to the students before each workshop, as well as relevant theories, which enhanced the

learning process and led to an 80% of the students agreeing that the course is intellectually stimulating (Figure 9).

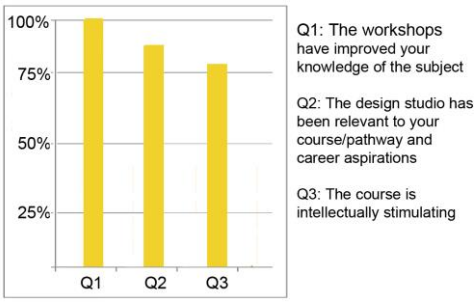



Figure 9: Anonymous student survey results

## Discussion

Students had the chance learn how to compose space by setting their own design rules for the cube, paper plane and curve physical models transformations. This process mimics the way they would set the design rules and parameters in a digital and / or parametric model. This gave them the chance to control and understand each design step, which they could rethink and change throughout the design process, the way they would use a digital model. For example, they could go back to step 1 and redraw the initial shapes on the cube edges and observe the different final physical model this change would produce.

Students can be liberated from the misunderstandings and anxieties normally associated with the use of digital technologies in architecture, through the use of physical modeling in an early term through the controlled and documented design process described above.

Figure 10: Final physical models produced for the Cube workshop.

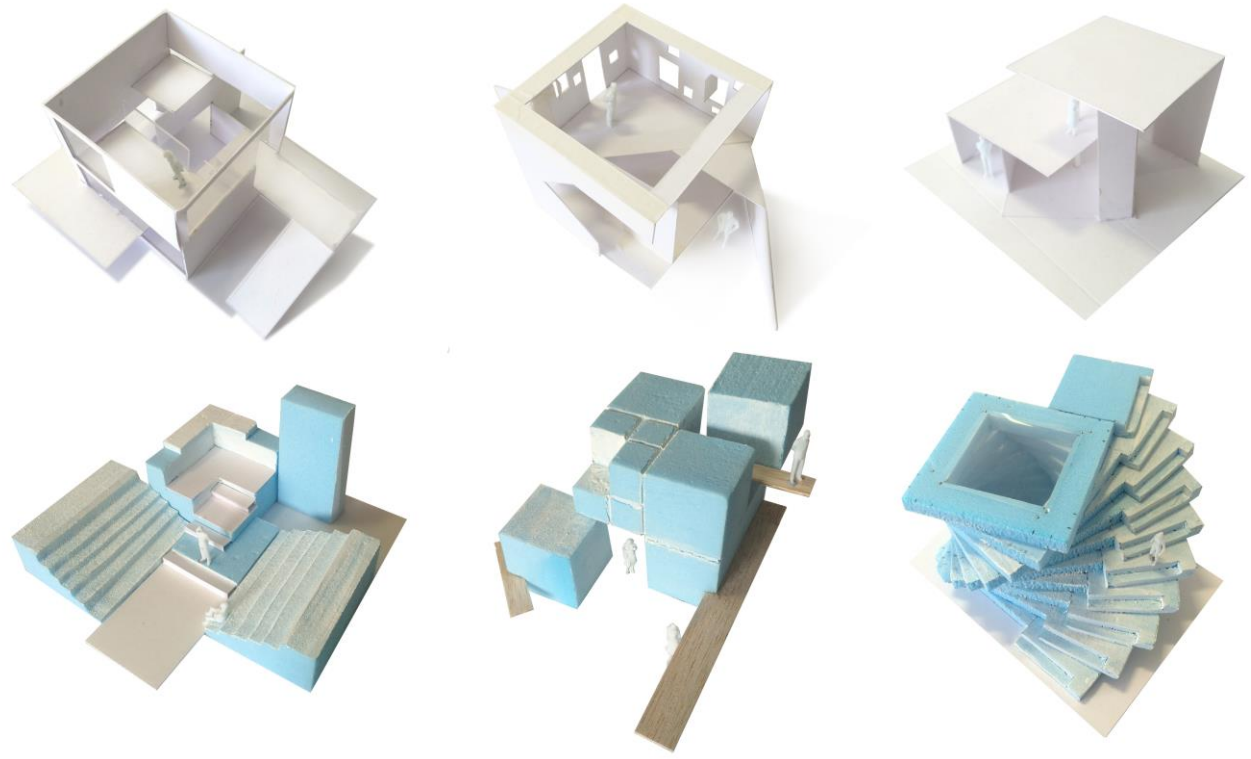
This approach can significantly leverage the rigor, depth and breadth of the architectural design from the very early years of architectural education, while subtly introducing students to digital design thinking.

This methodological approach emphasizes process over final results and allows for students to understand how to compose and test spatial configurations using architectural elements such as volumes and surfaces. It also connects the physical and digital realm making it particularly suitable for teaching during the first year of undergraduate studies

Physical modeling helps designers and students combine the physical with the digital realm, a process that has become irreplaceable in the architectural design production.

One of the difficulties we had to overcome was the timeframe for each workshop. We understand that depending on the school and student level, the workshops can vary from two to three weeks. Adding one last week for going through all outputs before the final submission made students feel more secure of their final output.

Further development will focus on the student outputs through term 2, where they were asked to design a small scale architectural space with a specific program using both existing practice methods as well as digital design tools such as Rhinoceros software for a series of “Controlled Transformations” in order to compose architectural space. Once more, we will examine the student outputs, internal and external examiner feedback and we will compare student marks to last year and comments from an anonymous student survey, hoping to present it in a future conference.



,

## Acknowledgments

We would like to thank all students that particiated in the workshops as well as the fellow tutors and mark moderators for their constant support and feedback.

This paper is part of a broader PhD research which is funded by the "IKY Fellowships of Excellence for Postgraduate Studies in Greece - Siemens Programme".

## References

Agkathidis, A. H. (2015). Generative Design Methods. Proceedings of eCAADe 2015,Vienna, 47-55.

Van Berkel, B. , Bos, C. (1999) Move (3-vol set). Imagination/Techniques/Effects, Amsterdam: Groos Press

Van Berkel, B. , Bos, C. (2006) UNstudio design models, New York: Rizzoli

Deleuze, G. (1994), Difference and repetition, New York: Columbia University Press

Di Mari, A., You, N., (2013) Operative Design,Amsterdam: BIS Publishers

Eisenman, P. ( 2004), Eisenman Inside Out: Selected Writings 1963–1988 (Theoretical Perspectives in Architectural History & Criticism), Yale: Yale University Press

Eisenman, P. (1999), Diagram Diaries, New York: Universe Architecture Series

Jackson, P., (2011) Folding techniques for designers, London: Lawrence King Publishers

Paredes Maldonado, M 2014 'Digital Recipes: A diagrammatic approach to digital design methodologies in undergraduate architecture studios', Proceedings of eCAADe 2014, Newcastle, 333-342

Oxman, R and Oxman, R (eds) (2013), Theories of the Digital in Architecture, London: Routledge

Yi-Luen-Do, E., Gross, M., (2001),Thinking with diagrams in architectural design, Artificial Intelligence Review 15: 135-149, Dordrecht: Kluwer Academic Publishers