

A CONTEXT BASED APPROACH TO DIGITAL ARCHITECTURAL MODELLING EDUCATION

ZEYNEP BACINOGLU¹ and SEMA ALACAM²

^{1,2} *Istanbul Technical University, İstanbul, Turkey*
{bacinoglu, alacams}@itu.edu.tr

Abstract. This paper presents a context based framework for introducing digital modelling and fabrication to architecture students. Modelling has been taught either as a separate skill, or introduced within a comprehensive context of conventional design approaches. We argue that, a ‘digestive context’ might guide students to gain designing experience with/in digital media in a gradual and a cumulative way. This paper is based on a series of modelling and fabrication exercises as part of a one-semester digital design and modelling studio course for postgraduate students. We focus on the impact the initial exercises we assigned our students had on the final design product; We discuss the affordance and adaptability of the method that was developed by the students..

Keywords. Digital design; fabrication; architectural education.

1. Introduction

Digital modelling and fabrication techniques provided new affordances affecting the way of making and thinking during the architectural design process. There are numerous studies on advances of digital design and fabrication tools; however, research on the encounter of digital media and architectural thinking and how digital media may inform architecture education is inadequate. Apart from the early discussions on merging digital media and digital studios (Gross, & Do, 1999; Marx, 2000; Schnabel, 2007; Pantazi, 2009; Wang 2010), there have been studies on the possible usage of digital design (Reffat, 2005; Duarte, 2007; Salman et al., 2008; Gray, 2011; Le et al, 2011; Duarte et al, 2012) and fabrication tools (Norman, 2004; Pupo et al., 2010; Brell-Çokcan and Brauman, 2010; Gu et al., 2011; Zarzycki, 2013) in architectural design education. There has been of late, an emerging interest in experimental studies such as material affordability

(Sass&Oxman, 2005; Scheurer, 2010; Thomsen&Bech, 2011), performative evaluations (Kalay, 1999; Kolarevic, 2008; Oxman, 2008) and dynamics based approaches (Zarzycki, 2010). In general using the digital tools is assumed as an independent ability since the new methods, approaches and tools has not been integrated into the architectural design studio enough.

In prior semesters, we had observed that when students come up with a new design tool they tend to spend all their energy in exploring and understanding the new tool instead of integrating the tool with their own architectural design approach. In that case the outcomes of design process is usually not communicative with the environment and far away from critical architectural discourse. There exists a lack of critical investigation about what they do, what they can do, and what has been done. Therefore, students usually do not gain the ability of evaluating their own design processes. They end up needing to encounter digital tools over and over again and in different situations to gain enough experience to constitute their own connections and contexts. However, while this assumption is valid for the novice designers, we believe that once students gain the experience of designing with/in/through digital media, their attitude might evolve and improve.

Apart from our prior architectural studio experiences, some of the problems we dealt with include:

- The tendency of students to use digital modelling tool merely as a representation medium rather than as a design environment,
- Students' inability to integrate the architectural context and the potentials of new tools,
- Students' inability to see the relation between the parts and the whole,
- Students' inability to fully realise the potential of digital tools, especially in the processes of interpretation and abstraction during the architectural design process.

Therefore it is crucial how to deal with the gap between the methodology of traditional architectural design studios and new emerging technologies in architectural education. In addition to these, there is another gap between the affordances of digital modelling and fabrication techniques and the way how students use them. Taking these gaps and tensions into consideration, in this paper we aim to discuss the potentials of our conceptual framework that we call context based teaching approach within one-semester digital design and modelling studio for postgraduate students.

From the students' perspective, objectives of the course had been defined thus:

- Improving their 3D modelling experience with CAD tools,
- Exploring different possibilities of CAD for the architectural design process,
- Gaining knowledge towards integrating different media, tools and workflow.

During the first four weeks, basics of computer aided modelling and scripting environment was introduced through samples. Over the next four weeks, context based exploratory modelling tasks were given and during the following 6 weeks the students were expected to adapt their idea generation process to an architectural design problem, specifically re-designing performative facades for existing buildings. Students were asked to experiment with different modelling tasks with our goal being to embed architectural modelling and fabrication knowledge in their minds. The second four-week part of the course included experimentation with model making exercises through the use of various digital fabrication tools such as the rapid prototype, laser cutter and CNC.

As a specific task, students were asked to fabricate a 3D model of their own faces via a laser cutter. The specific context is aimed to integrate with abstract concepts to implement the fabrication process by designing students' own fabrication tools as a design research. Abstract concepts were described as abilities of the fabricated model such as flexibility, expandability, foldability, ability to grow, degree of porosity, degree of branching, concepts about biology-biomimicry instead of precisely showing the method, inspire to imagine unprecedented solutions for fabrication. The method of integrating specific context with abstract concepts for fabrication with laser cutter are recommended both for acquiring modelling ability and the idea generation phases of design processes synchronically.

2. Conceptual Framework

The two concepts that we introduce within the evaluation process of our approach in order to investigate the conceptual framework of context based methodology are 'digestibility of context' and 'anchoring'. We came up with these concepts not in the beginning of the semester, but during and after the responses of students to our way of introducing digital modelling and fabrication approaches. We introduced these concepts in order to distinct our methodology from existing context free approaches and secondly avoid from the meaning of 'context' as it has been used in traditional design studios. Further the term 'anchoring' is assumed to be used for a reference point of establishing 'digestible context's within constituting gradual exercises in terms of architectural modelling.

2.1. DIGESTIBILITY OF CONTEXT

The etymology of the word 'context' can be traced back to Latin word *contextus*, past participle of *contextere* which means "joining together and to weave" (Url-1). Ekbia and Maguitman (2001) describe Dewey's (1931)

notion of context through a diagram (Figure 1), underlining his two components of context as background and selective interest (Ekbja and Maguitman, 2001). Dewey considered every operation of thought as including an act of either selection or rejection, since everything is considered as unsettled in the beginning and the constituting context is the process of discovery and determination of unsettled situations (Dewey, 1931; Ekbja and Maguitman, 2001). At this point, there exists a conflict between being completely unsettled and keeping predefined connections for the initial situation. In relation to this conflict we suggest the concept of "anchoring" to understand what triggers the incubation process of thought.

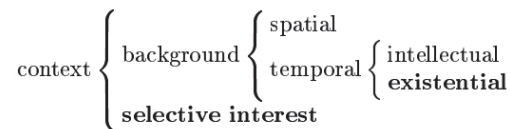


Figure 1. Dewey's notion of context (Ekbja and Maguitman, 2001).

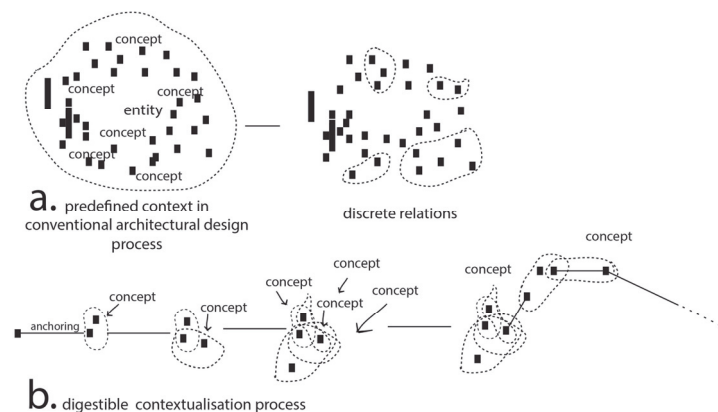


Figure 2. Interactive contextualization process

Context in a broader sense is a consequence of the action of framing the concepts in a ground by crystallizing borders around them. After the action of framing, one can describe concepts as "in" or "out" of the context. In this paper, our usage of the term context is close to an abstract conceptualization process, which differs from its "physical location" or "site" meaning in conventional design studios in terms of cultural, social or urban (Figure 2.a). Shown in Figure 2.b., we argue that it is important to introduce students to an unfamiliar and new context in terms of spatial semantics in the beginning of the modelling process. It is possible to find traces of this alienation process in Dewey's (1934) general theory of experience and thought.

Dewey's (1934) concept of experience begins with "disturbance and uncertainty", afterwards followed by intellectualization and definition of the problem (Dewey, 1934). Unfamiliar and narrow-scope context will enable students to constitute their own contexts and interpretations in relation with it.

We use the term 'digestibility of context', to refer to encouraging students to begin with relatively simple and abstract conceptual relations. Instead of a concrete predefined context, it is expected to provide a dynamic layout for design in an ongoing process and some set of relations that are constituted by students through the modelling exercise and design process. Beginning with the simple and unfamiliar, we argue, will help students constitute their own way of looking.

2.2. ANCHORING-INCUBATION

We suggest starting with an anchor for two reasons. First, in order to avoid the complexity of an extensive problem; Secondly, in order to escape from the chaos of the state before the design. Anchoring is considered as an activator of the contextual incubation process. Instead of a concrete, well-defined and familiar context, we feel that a singular concept or a set of concepts or an unfamiliar becoming process can be introduced to students. In other words, a singular abstract concept or a set of concepts may be introduced to students as an 'anchor' in order to either alienate them from the established architectural context in their mind to find 'new' (unexplored) relations or provide at least one starting point for constituting their own way. It is possible to find traces of this alienation process in Dewey's (1934) general theory of experience and thought. Dewey's (1934) concept of experience begins with "disturbance and uncertainty", afterwards followed by intellectualization and definition of the problem (Dewey, 1934). Unfamiliar and narrow-scope context will enable students to constitute their own contexts and interpretations in relation with it.

4. Student Works and Evaluation

In this section we will evaluate and criticize our own way of introducing digital modeling and fabrication exercises through selected works of students. The Exploration and Adaptation process explained in the figure below comprises the student's exploration, not as a linear process but as a reflective and growing process, which comprises interactive reciprocal ever-increasing relations. The Adaptation and Exploration processes can be considered to be a student's self developed 'formational relations' (Figure 3).

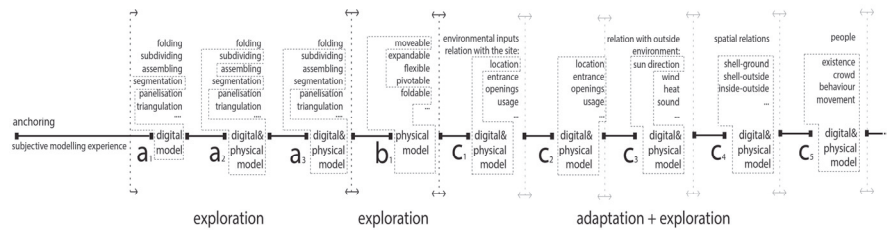


Figure 3. Process diagram

As an anchor we asked students to fabricate physical models of their own faces through digital methods. They were expected to find a customizable and adaptable method.

When they brought first in physical models, we asked them to integrate their models with some set of abstract concepts. In particular, we asked them to add 'abilities' to their models; they were expected themselves to define the kind of these abilities. In the following weeks, we discussed with them the affordances of their conceptual models.



Figure 4 Exploration of the customizable method for fabrication

These exercises allowed us to test the students' design tool making activities at different scales and in the context of different spatial relations (Figure 5).

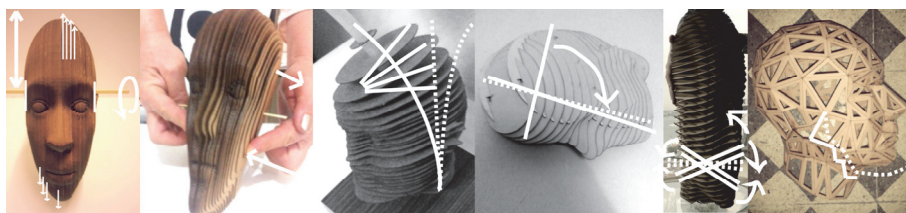


Figure 5. Some of the "abilities" of the physical models explored by the students

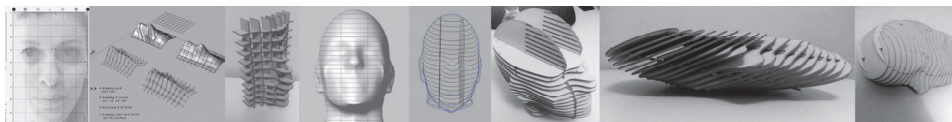


Figure 6. Exploration process both in physical and digital media

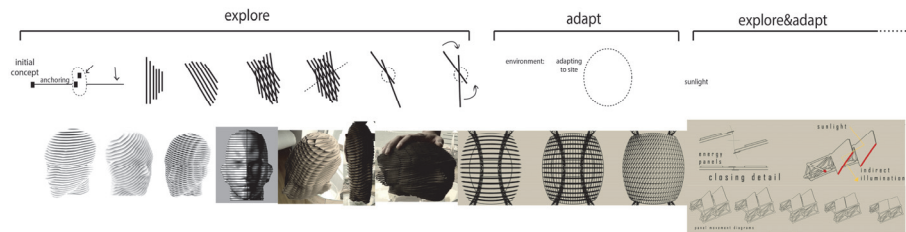


Figure 7. Exploration and adaptation cycle

While the 'anchor' concept governs context based modelling in the first part of the course, new spatial relations explored intuitively during the process break away from the initial context (Figure 6). Thinking about the (organisational) formation process of an entity via an 'abstract concept' allows students to constitute their own context by exploring relations of complex spatial patterns (Figure 7).

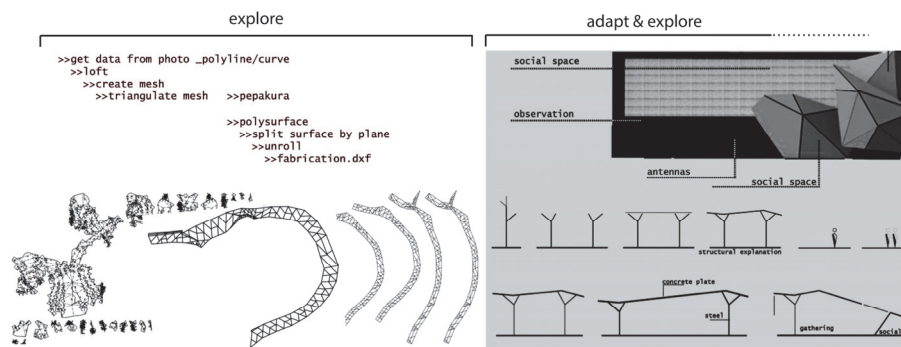


Figure 8. Integration of previously developed customizable method to new design task.

Later we introduced a specific site and asked students to adapt their previous digital and physical models into the site as a façade design (Figure 8). This time they were expected to explore and find inputs from the site and merge with their ongoing adaptation process. This process comprises the adaptation of the explored 'design tool:customizable method:formation' to the new context interacted with environmental and performance based inputs (Figure 9).

5. Discussion

In this paper we evaluated our own way of introducing modelling and fabrication methods to students through a context based approach, which we term the 'digestible context'. We argue that the exploration process of the potentials of digital media by the students requires to be introduced in a new context and a new experience of context making. It is important to encouraging

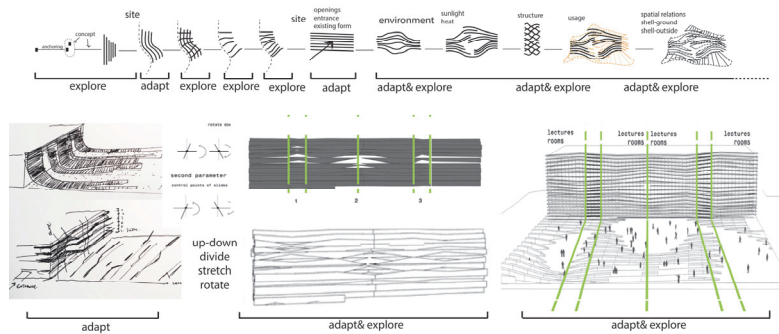


Figure 9. Exploration and adaptation cycle

students to develop idea in a new context in which the existing presumptions of them will not dominate / mask their learning process.

Through our one semester experimental study, we suggested a segmented 'exploration and adaptation' process in order to overcome the complexity of a new design task while acquiring the modelling skill integrated with design methods, which were gradually becoming an abstract level fostered student's way of thinking in architectural design process.

On the other hand, although the course aims to encourage students to use their explored 'formation organisation' as a design tool for an open ended design process; we think that 'the established context of the performative facade task' constrained student's exploration process by constituting familiar relations with the developing structure. Therefore, we think that keeping a degree of ambiguity is important for new ways of modelling and designing.

For the future direction of the digital design modelling course, we suggests to continue the evolution and exploration of students' individual design tool by encountering them with various abstract concepts step by step throughout one semester. By facing with a new concept in each step, a parametric generative design tool can continue to evolve and develop gradually through students' interpretation and contextualisation process with in a digital environment. We comprehend that both graduate and undergraduate students should not think in the limited frame of established contexts such as facade design, instead with this approach, students can alter their own contexts dynamically through a reflection action cycle.

We think that when the process comprises of further narrow-scoped small tasks, it may adapt- explore-improve more effectively and in a become more open-ended. The design tool they explored has potentially become a part of everything they will work on in the future through the adaptation& exploration cycle. We should conclude that our assumptions are based on one semester-long observation for the post-graduate students who has used digital

media mostly for representation purposes in undergraduate education and did not have experience in digital fabrication. How the students develop their design ideas with/in modelling and fabricating tools might be different in long term experience, such as , once they gain the basic understanding of fabrication process they might reflect to more complex design tasks in a different way.

Acknowledgements

The authors would like to thank to students of Digital Architectural Design and Modelling course of 2012 fall semester in Istanbul Technical University, Department of Informatics, Architectural Design Computing Graduate Program, by alphabetic order Aren Semerci, Ayşe Çolakoğlu, Barış Ateş Dila Sel, Gözde Temiz, Hande Karakaş, Kezban Güneşdoğdu, Mutlu Güngör, Özde Özdal, Selim Tanrıseven, Sinem Kırkan, Tolga Karasay, Zeynep Enhoş, Zeynep Şahin. The authors also thank to Prof. Dr. Sinan Mert Şener for his encouraging the authors to explore new methods within his design studio.

References

- Brell-Cokcan, S., & Braumann, J.: 2010, A New Parametric Design Tool for Robot Milling. In *ACADIA*, Vol. 10, pp. 357-363.
- Dewey, J.: 1931, *Context and Thought*. In Richard Bernstein (ed. 1960), pp. 88-110.
- Dewey, J.: 1934, *Art as experience*. New York: Capricorn Books
- Duarte, J.: 2007, Inserting New Technologies in Undergraduate Architectural Curriculum, in *23th eCAADe Conference*, Frankfurt, pp. 423-430.
- Duarte, J. P., Celani, G., & Pupo, R.: 2012, Inserting Computational Technologies in Architectural Curricula. In N. Gu, & X. Wang (Eds.) *Computational Design Methods and Technologies: Applications in CAD, CAM and CAE Education* (pp. 390-411). Hershey, PA. doi:10.4018/978-1-61350-180-1.ch
- Eckert, C., Stacey, M., Wyatt, D. and Garthwaite, P.: 2012, Change as little as possible: Creativity in design by modification. *Journal of Engineering Design*, 23: 337-36.
- Ekbja, H. R., & Maguitman, A. G.: 2001, Context and relevance: A pragmatic approach. In *Modeling and Using Context* (pp. 156-169). Springer Berlin Heidelberg.
- Gray, C. M: 2011, Design Pedagogy in Practice: Barriers to Learning and Evaluation in the Design Studio. <http://dossier.colingray.me/assets/Gray_Design_Pedagogy_in_Practice.pdf> (accessed 2 December 2013).
- Gross, M., Do, E: 1999, Integrating Digital Media in Design Studio: Six Paradigms in *Proc. ACSA (American Collegiate Schools of Architecture) National Conference '99*, Minneapolis.
- Gu, N., Jones, W., Williams, A: 2011, Examining the Use of Digital Design and Fabrication Technologies in Design Education. *E-Business and E-Government (ICEE)*, 2011 International Conference on. IEEE, 2011.
- Gu N., Wang, X.: 2012, Computational design methods and technologies : applications in CAD, CAM, and CAE education. DOI: 10.4018/978-1-61350-180-1, ISBN13: 9781613501801.
- Kalay, Y. E.: 1999, Performance-Based Design. *Automation in Construction*, Volume 8, Issue 4, April 1999, Pages 395-409.
- Kolarevic, B.: 2008, Post-Digital Architecture: Towards Integrative Design. What Matters: First International Conference on Critical Digital, Harvard University, Graduate School of Design, pp. 149-156

- Lee, J. H., Gu N. and Sherratt, S.: 2011, Developing a framework for evaluating creativity in parametric design. 5th Annual Conference of the Architectural Science Association, AN-ZAScA 2011, The University of Sydney.
- Marx, J.: 2000, A proposal for alternative methods for teaching digital design. *Automation in Construction*, 9(1), 19-35.
- McClelland, K. A.: 2006, John Dewey: Aesthetic Experience and Artful Conduct. *Education and Culture*, 21(2), 6.
- Miettinen, R.: 2000, The concept of experiential learning and John Dewey's theory of reflective thought and action. *International Journal of Lifelong Education*, 19(1), 54-72.
- Norman, F.: 2004, Find in CUMINCAD Digital to Analog Exploring Digital Processes of Making. Proceedings of the eCAADe conference, Copenhagen, Denmark, pp. 112-118.
- Oxman, R.: 2006, Theory and design in the first digital age. *Design Studies*, 27(3), 229-265.
- Oxman, R.: 2008, Performance based Design: Current Practices and Research Issues. *IJAC International Journal of Architectural Computing* Vol. 6 Issue 1 pp. 1-17.
- Pantazi, M. E.: 2009, Digital Design Media: Tools for Design Exploration in the Studio Process. ICSID World Design Congress 2009, International Council of Societies of Industrial Design Conference, "URL-1": <<http://www.icsid.org/education/education/articles1079.htm>> (accessed 25 December 2013).
- Pupo, R, Duarte, J and Celani, G.: 2010, Find in CUMINCAD Introducing digital fabrication into the architectural curriculum - Two similar experiences in different contexts. *Proceedings of the eCAADe conference*, Antwerp, Belgium, pp. 517-524.
- Reffat, R. M.: 2006, Computing in Architectural Design: Reflections and An Approach to New Generations of CAAD. *ITcon* Vol. 11 (2006), Reffat, pp. 655-668.
- Salman, H., Laing, R. and Conniff, A.: 2008, The Changing Role of CAAD in the Architectural Design Studio. *The Built & Human Environment Review*. 1, 25-39.
- Sass, L., Oxman, R.: 2005, Materializing design: The implications of rapid prototyping in digital design. *Design Studies*, Vol. 27, No. 3, 325-355.
- Scheurer, F.: 2010, Materialising Complexity. In Rivka Oxman, Robert Oxman (eds.), *The New Structuralism*, AD Vol. 80 No. 4, Wiley, London, pp. 86-93.
- Schnabel, M.A.: 2007, Parametric Designing in Architecture. *Computer-Aided Architectural Design (CAADfutures)* 2007 eds. by A Dong, A v Moere & J S Gero, Springer, The Netherlands, pp 237-250.
- "URL-2": 2013. <<http://www.thefreedictionary.com/context>> (accessed 4 December 2013).
- Thomsen, M. R., Bech, K.: 2011, Embedding response: Self production as a model for an actuated architecture. *Digital Media + Networks + Transdisciplinary Critique, The Fibreculture Journal*, FCJ-130, Issue 19: Ubiquity, Open Humanities Press, fibreculture-journal.org, pp. 31-46.
- Yürekli, H: 2002, Architecture in Context. Lecture Notes, Istanbul Technical University.
- Wang, T.: 2010, A New Paradigm for Design Studio Education. *International Journal of Art & Design Education* 29 (2): 173-183.
- Zarzycki, A.: 2010, Find in ACM Digital Library Intuitive Structures: Applications of Dynamic Simulations in Early Design Stages. Proceedings of the Spring Simulation Multi-conference, Orlando, USA, pp. 193-201.
- Zarzycki, A.: 2013, Learning with Digital and Physical Mock-Ups Using BIM. In R. Stouffs, P. Janssen, S. Roudavski, B. Tunçer (eds.), *Open Systems: Proceedings of the 18th International Conference on Computer-Aided Architectural Design Research in Asia (CAA-DRIA 2013)*, Singapore, 323-332.