Prêt-à-Construire. An Educational Inquiry into Computer Aided Fabrication.

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This paper aims to discuss and evaluate the scope and outcome of a graduate architectural design studio that investigates the notion of analogue and digital fabrication within an interdisciplinary domain. "Prêt-à-Construire" is the final studio in a series of four exploring the nature of the architectural design process as transformed by information technologies. The key pedagogical strategy in this final studio is based on the direct utilisation of 'constructional' drawings in the preliminary design phase as opposed to representational ones. This procedural twist challenges any linearity in the cognitive patterns of the designer by addressing the final phase of building production right from the beginning. The discussion concludes by pointing to the necessity of overcoming the conceptual gap while investigating the architectural potential of computer aided fabrication in countries where information technologies are still marginal within the context of building production.

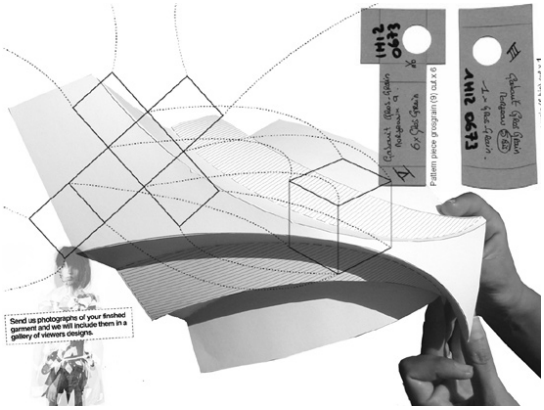

Figure 1: Composite image featuring Hande Koksal's project and John Galliano's open source Pirate Jacket produced by the author for the studio exhibition.

I.Introduction

The impact of information technologies within the context of the architectural design studio is hardly a novel issue. The digital domain informs and is informed by the contemporary culture, and its influence becomes increasingly evident within the architectural discourse, especially within this last decade (Oxman; Rotenstreich, 2005). Almost every 'cutting-edge' school of architecture has been involved in and even instigated this shift of focus from the theoretical to the technical domain. However, the discourse within the area of digital design itself is hardly uniform – it shifts and mutates as the new technologies become pervasive, and alternative approaches can be developed as a result of extensive experimentation within different contexts.

The context of the present inquiry is provided by the Computational Design Unit within the Faculty of Architecture in Yildiz Technical University (YTU) in Istanbul, Turkey. This research group, formerly known as Computer Aided Design Unit, was founded in 1993, and is the first of its kind within the schools of architecture in Turkey. The researchers have been trying to establish an awareness of the potentialities of information technologies within the domain of architecture for over a decade by organising international and national workshops and national conferences, albeit with extremely tight budgets. I joined the research unit in 1999, right after completing a project-based masters at the GSAPP of Columbia University. Interested in the possibility of pursuing a similar pedagogical approach to the paperless studios at Columbia University within a more primitive technological infrastructure, we collaborated with Mehmet Kutukcuoglu, a former graduate of the SCI-ARC School of Architecture and a practising architect, in the teaching of a series of graduate design studios during 2000-2003.

The studio "Prêt-à-Construire" is the final part of this series of exploratory studies conducted on the nature of architectural design process transformed by information technologies. The main pedagogical standpoint in the initial studios was parallel to that of the so-called paperless studios in following the idea of computers as extensions that make thought processes visible like pen-and-paper sketching. The overarching aim of the studio series was to put CAD and CAM in a practical and educational context in terms of their effect on the actual architectural design process. Preceded by studios investigating cognition and representation, studio "Prêt-à-Construire", the last in a series of four, has specifically focused on CAM and the concept of fabrication in architecture.

The paper provides a methodological discussion concerning the outcome of this last studio by addressing the issues raised during studio sessions. One such issue is customisation, and the required attitude for re-incorporating the notion of the custom made into the initial design phase. Another issue is open-source design, where the design solution is coded as information, providing room for intervention by different designers, indicating the possibility of a do-it-yourself architecture. The final key issue is the direct utilisation of constructional drawings in the preliminary design phase as opposed to representational ones, reminding the designer of the final phase of fabrication right from the beginning. The discussion concludes by pointing out the problems faced during the conduct of the studio. These problems include a significant lack of technical infrastructure, and the necessity of overcoming the conceptual gap while investigating the architectural potential of computer aided fabrication in countries where information technologies are still marginal within the context of building production.

2.Objectives and Themes

The main objective throughout the whole series of studios was the investigation of time resistant elements within the pedagogical context of the digital design studio. With this search providing the guiding concern, the teaching scope was intentionally free from technical guidance, due to the swift change of the technologies at hand, and students were expected to develop the ability to appropriate relevant software in conjunction with the nature of the design problem at hand. The main pedagogical strategy involved making the designers aware of their design strategies by alienating them to the process of design: Although most of the studio participants belonged to the generation termed by some as "digital natives" (Prensky, 2001), their process of designing was decidedly linear, restricted by the use of conventional formal and/or typological vocabulary.

Initially, the aim guiding the studio series was to naturalise the use of computers in the preliminary phases of the design process, however, as the incoming student profile became increasingly competent in IT skills, the focus of the studio shifted towards the cultural hypes within the domain of information technologies and how they could be integrated as into the designer's conceptual toolset. This incorporated the discussion on the arguable notion of "digital natives" (Owen, 2005) and their preferred tools, providing input for the specific pedagogical strategies to be utilised in the studios.

The last in the mentioned studio series, "Prêt-à-Construire" aimed at investigating the relevance of embodied knowledge within the discourse of digital design. By utilising the notion of fabrication as the common denominator between the analogue and digital domains, the studio sought for an understanding of the interaction between computer modelling/manufacturing and physical model making in terms of their implications for the initial phases of architectural design. Within this framework, we introduced several key notions as cognitive markers:

2.1. The 'Constructional' versus the Representational.
The main theme of the featured design studio was based on this duality. Representation and construction are the two main aspects of the design process. We were interested in their utilization in the forging of the final design. Historical examples like stereotomic drawings or the invention of the perspective provided the necessary input for questioning the nature of design communication as an instigator of the design itself.

2.2. Mass Customisation
The notion of customisation was used as a conceptual tool to shift the direction of the design research from a unique solution to a family of solutions generated by utilising the same theme. Design becomes stored data that can be transferred seamlessly to a constructed reality. The construction templates need not be identical instances; they are open to variation and customisation. As a historical precedent of mass customisation – "tailor-made design", we thought the constructional templates used in dressmaking would provide an appropriate example.

2.3. 'Open Source' Design
Open source design is generally referred to in relation to data architecture. In reality, any finished product has in itself a certain amount of encryption. Especially in disciplines related to design – be it of data structures, fashion or architecture, visual representation of the finished product hardly gives any clue to the process of construction. Templates, on the other hand, provide the "source code" to the trained designer-constructor. Open source design is one of the initial steps of design customisation. It initiates an open ended process rather than producing a single finished entity.

In proposing these themes, the aim was to expand the vocabulary of the students by the introduction of procedures and strategies, rather than types or cases.

3. Methodology
"Prêt-à-Construire" thrived on constraints and limitations – limited by time, by the lack of technical infrastructure, as well as by the extra constraints proposed by the studio conductors. It was conducted within the limits of a mere 3 hours per week, in a semester of 13 weeks. Weekly presentations, along with the "internet hunts", acted as the basis of a networked intelligence providing cross-fertilisation between ideas. Due to the insufficient number of available computers at the graduate digital design laboratory, the students were required to use their own PCs, and utilise the studio space only for presentations and/or weekly discussions.

In terms of software, students were encouraged to use Rhinoceros and occasionally 3DStudio Max for modelling and planar surface creation, although some of them chose to stick to their AutoCAD expertise for these purposes. There has also been a failed enterprise for collaboration with the mechanical engineering department of YTU in order to use their 3-axis CNC mill, but eventually, the closed nature of their production lab and the reluctance of the technical staff made it impossible for our students to experiment freely with the device.

All throughout the studio, an algorithm of making was sought for within a broad range of disciplines including traditional craft skills such as origami as well as the geometric algorithms such as tessellations from the domain of mathematics. Accordingly, the studio derived its main inspiration from the constructional templates used in dressmaking, which can be considered as an initial model for mass customisation. In this context, the recladding of Le Corbusier's Maison

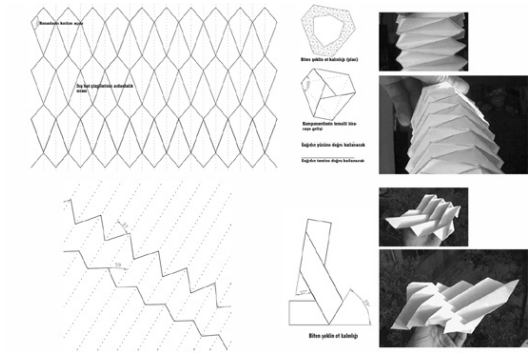

Figure 02: Project proposal by Orkun Indere investigating straight folds, and the emergent forms resulting from varying folding angles on template drawings.

Domino was given as the main design problem, along with several methodological constraints. The main constraint was to develop the design idea through constructional drawings instead of representational ones. The students were asked to develop their volumetric ideas through digital 3D CAD models while working out structural solutions on a physical 1/50 model of Maison Domino. There was also a material constraint for the model, where only specified types of non-structural paper could be used. At this stage, origami provided the working model for adding structural strength to sheet materials.

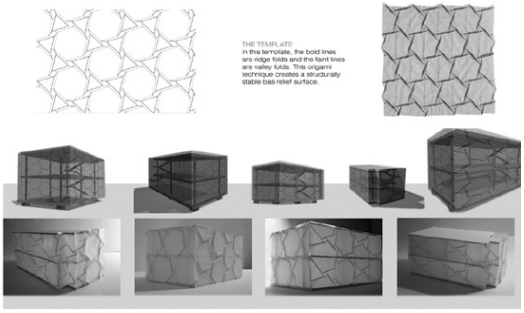

Figure 03: Project proposal by Hande Koksal showing selected structural pattern, digital model and physical model (top to bottom).

The final output required from the students was a matrix showing the process of their design work throughout the whole semester. The central piece of the matrix was to be composed of a colour coded superposition of proposed templates, in the manner of the dressmaking templates distributed by DIY fashion magazines. Along with this, the students had to produce a series of component alternatives together with their methods of derivation and their physical models, a 1/50 scale physical model of the reclad Maison Domino, and a visual report of their research work with relevant references.

The important constraint was to consider the 1/50 model as a construction problem in itself, rather than a representation of a bigger scale object. Hence, no glue or cardboard was permitted; the students were to transform non-structural paper into a valid structure.

5.Conclusion

Mark Burry, in his article "Handcraft and Machine Metaphysics" discusses the pedagogical relevance of an integrated approach involving analogue and digital strategies, and points to the setbacks of technological determinism in relation to the adoption of IT within the domain of architectural design (Burry, 1998). The importance of utilising analogue and digital means together cannot be stressed enough. In order to achieve a sincere understanding of the key notions of IT in architectural design of which fabrication is but a single example, the genealogies of those notions should be taken into consideration. The need to utilise the available technologies should arise from the nature of the design problem, and not be determined by the latest trends promoted by software companies. Developing a set of skills is vital for tackling with design as a research activity, but a considerable portion of these skills would be conceptual.

The author acknowledges the advantages of using the actual prototyping technologies, and the importance of a hands-on approach from a pedagogical perspective, but the lack of the technical infrastructure should not negate the possibility of developing the set of conceptual skills necessary for incorporating the notion of fabrication into architectural education. In our case, the main objective was to overcome the conceptual gap in order to be able to fully investigate the architectural potential of computer aided fabrication in a country where information technologies are still marginal within the context of building production. The studio "Prêt-à-Construire", in response to the much hyped design experiments utilising cutting edge technology, shows the possibility of an alternative approach within the technological low-end.

Acknowledgements

I would like to thank my colleague Mehmet Kütükçüoğlu, and the students of the Computational Design Graduate Program at Yıldız Technical University who participated in the Prêt-à-Construire studio during Spring 2003. The result of this graduate studio was exhibited in the GrowthSpurt section of the AIA-TAP ACADIA Conference: Fabrication in November 2004, and was published in its proceedings.

Figure Credits

The "Pirate Jacket" shown in Fig.01 is designed by John Galliano as a part of his A/W 2001 collection. The dressmaking templates were then broadcast on the showstudio site as an alternative example of "open-source" design. The downloadable templates are available at: [INTERNET; WWW], ADDRESS: http://www.showstudio.com/play.html

The curvilinear origami pattern shown in Fig.01 belongs to David Huffman. These patterns are available at:
[INTERNET;WWW],ADDRESS: http://www.graficaobscura.com/huffman/index.html

The straight origami folds shown in Fig.02 are available at:
[INTERNET;WWW), ADDRESS: http://www.sgi.com/grafica/fold/page001.html

The "honeycomb" origami pattern shown in Fig.03 belongs to Alex Bateman. These patterns are available at:
[INTERNET;WWW],ADDRESS:http://www.sanger.ac.uk/users/agb/Origami/Tessellation/tessellation2.html

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