# BACK TO CRAFT

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**ABSTRACT**
The paper reports on the interaction between a tutor, six students, the industry of cement blocks production and diverse consultants in the process of manufacturing multiple prototype moulds for the eco-stones Wallpot and Triko. Wallpot is a concrete block element for articulated facades of vertical horticulture. Triko is a concrete block for turf-stone-alike green pavements.
Throughout the process of mould generation and the research on contemporary modes of production, a deep knowledge base of moulding techniques for contemporary product design was built. Above all, knowledge was gained on how flexible moulding can be through the combination of digital fabrication *and* crafting. The paper presents and concludes on how the design helps in the creation of a *type* and a *system*, the digital fabrication adds a *generic* attribute to the type and crafting enriches it with a *genetic* attribute. As a result fabrication has triggered crafting more than the design alone would have done and crafting enhanced the engagement with the design for the students.

*Keywords: Moulds, fabrication, vertical green, ecostones, crafting*

## 1 INTRODUCTION

The design process is approached and taught using diverse methods in architectural university programs. Design abilities are considered to be enriched through 1:1 prototype manufacturing and construction of details and objects by the students. 'Fabrication' has displaced the notion of manufacturing and construction, but, at the same time, helped traditional crafting techniques (like moulding) flourish and deepen by active application. This paper reports on the process of manufacturing multiple prototype moulds for the eco-stones Wallpot and Triko.
The first, Wallpot *(Fig. 1)*, is a concrete -block element for articulated facades of vertical horticulture. Its five variations have an industrial design prototypical licence (design patent) in Greece and its production has been awarded a subsidy from the European Union, the National Strategic Reference Framework (NSRF) programme. All the variations have peculiar shapes. They combine a usual concrete block with the shape of a flower pot. It was a privately initiated project by the first author based on an idea of Matthijs Moelee, agricultural consultant. It involved students from the Technical University of Crete, where the first author was previously appointed. The students were involved in the design, as well as in a series of prototype production workshops at the professional practice of the author. The prototype production is ongoing through a workshop and a summer school. The second prototype, Triko *(Fig. 2),* is a concrete tile that was designed as part of the research project for regenerating the coast of Kissamos bay on the north coast of West Crete, in a project commissioned by the Organization of Development of Western Crete to the Technical University of Crete (TUC). The need for extended paved parking areas, together with the ecological framework of the research, lead to the design of a tile-stone that is rainfall permeable while more interesting in shape than the usual turf stones or cement grids. The Triko, a triangular formed tile with three different 'cut-outs' on its edges, based on stable points, produces variable size and shape of holes, depending on how it is combined with the detached tiles *(Fig. 3).*
For both stones, the process included an educational process, action research, and prototypes' production. Research on how to produce a generic type of mould was done in practice and by

combining traditional crafting techniques (in our own practice) and the fabrication laboratory of Technical University of Crete. The research question of this paper focuses on the interaction of digital fabrication and crafting. Has crafting added a value to parametric design as defined through digital fabrication? In this sense has it added a value, or has it perhaps generated values for a university level education?

*Figure 1. The five variations of Wallpot. Initial 3D representations. Sketch design, 2009*

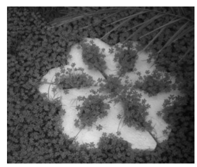

*Figure 2. The Triko stone, pilot 2011*

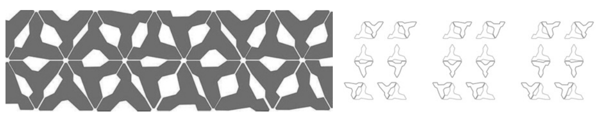

*Figure 3. Trico stone: variations of different shapes of holes, depending on the detached tile*

## 2 DIGITAL FABRICATION AND CASTING

### 2.1 Casting and Moulding

Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods. It is a manufacturing process that dates back 6000 years.[i] There is a distinction in terms between casting and moulding. Often mistaken, casting refers to the metal process, while moulding refers to a plastic process. In another distinction, in moulding, the liquefied material is poured under pressure, while in casting no external force is required for pouring the material, which flows only with its gravitational force. The distinction in terms used in this paper is defining casting as an action with a ‘single-time’ or ‘one-use’ mould, while moulding as a process of multiple (prototype) production using the same (generic) mould. We consent additionally to the differentiation in terms according to the output: in moulding the outcome is the final finished surface, while in most of the casting processes, the output is unfinished and requires final finishing.

### 2.2 Digital Modelling, Fabrication and casting in design education

Digital Modelling and Fabrication is a process that joins architecture, the construction industry and product design through the use of 3D modelling software and CNC machines. In a shifting profession, computer milling and fabrication produces what the designer has envisioned and developed using computer aided design *(Fig. 4)* [ii]. In this process, from conception to design to fabrication, the sequence of operations becomes critical. Architects can propose complex surfaces, where the properties of materials are what drive the design. Furthermore, this process allows the architect to examine, first hand, the materiality of their design, an experience beyond that offered by a two-dimensional computer screen and adapt the design accordingly. Digital modelling also assists the fabrication of (usually) more organic forms through the fabrication of actual moulds. Whereas traditionally, the making of a mould is an involved process, basing moulds off of Digitally Modeled and Fabricated designs possibly not only involves a complex 3D surface, but one that is closer to complete having already gone through several iterations of design moulds.

In Architectural educational processes, that involve moulding, students usually design and construct an object where the mould can be used only one time. In many cases the hard polyurethane foam is used and is destroyed afterwards. In digital fabrication pedagogy (Hemsath T., 2009, p 22) the main research issue is the high level experimentation in form, advances in materials and innovation of articulating techniques but usually not the mass production *(Fig. 5)*. Pioneering courses offered in universities entitled 'File-to Factory' are a high level of explorative and innovating performative geometries while the interaction with the industry production (factory) and restrictions is not a priority. Although contemporary design and construction processes have been heavily influenced by the system of mass production developed at the end of the 19th century (Ficca J., 2013), exploring type as a universal endlessly repeated component has become a fascination for the students. The more and more costless prototyping prevail the production of a system.

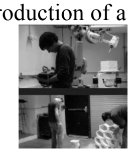

*Figure 4. Shifting profession: Architects redefine their design while in the FabLab rather than in the office*

*Figure 5. Institute for advanced architecture of Catalonia, Fabrication Class, Prof. E. Cabay & T. Diez, ass. by Al. Dubor. The production of articulated components which are slightly different from one another demands various prototype moulds. The alterations of the moulds are parametrical but are they corresponding to a system of industrial repetitive production?*

### 2.3 Crafting and casting

A craft is a pastime or a profession that requires some particular kind of skilled work. In a historical sense, particularly as pertinent to the Middle Ages and earlier, the term is usually applied to people occupied in small-scale production of goods.[iii] In the older days the skills were usually communicated inside the small communities, from father-to-son or from books and manuals. Today, due to the Internet, more and more businesses operate from home, from their garage or their garden, offering their crafted products online. Small manufacturers, with crafting techniques that go back many centuries, upload their knowledge on the Internet, in the form of videos of crafting in action, where everyone can view and share it. Our knowledge on moulding was enriched through online posts in blogs and videos of crafting in action in online communication platforms. People shared their local crafting techniques so that an eclecticism of techniques is being produced, as opposed to the old-fashioned 'father-to-son' craftsmanship.

## 3 CASTING AND MOULDING THE STONES: SEARCHING FOR A SYSTEM RATHER THAN A TYPE

### 3.1 Casting and Moulding the Wallpot

In manufacturing the Wallpot, initially multiple models out of paper were made in order to test the joint possibilities and the irrigation system flow *(Fig. 6)*. Digital fabrication and the industry were catalysts for the design. We collaborated with industry, specifically, with two companies in Crete that are producing concrete blocks. Through our collaboration we had to re-design the Wallpot and re-adjust its height so that it would fit to their machines. We also talked and collaborated with two mould making companies, one in Italy and one in Germany, that are producing moulds especially for the machines of the industries and we exchanged drawings and knowledge. We also discussed the mould making with smaller metal workshops and mechanics. All the solutions were very 'fixed', while we needed a mould that could be both re-useable and at the same time adaptable to our mistakes, the demands of the industry and to changes based on functional or aesthetic reasons. Normally, a test-mould for these shapes would have been made from latex, gypsum or from iron by an experienced technician. Combining the input of the industry and our eclectic knowledge gained from numerous

short movies we watched online in one-way communication platforms (movies that varied from commercial instructions of moulding materials to 'homemade' videos of small artisans making moulds in their own workshop) we decided to make multiple moulds from wood. This would offer the advantage of producing inexpensive moulds that can test both the variations in shape and form of the stone and the variations in chemical consistency. A wooden mould can be re-used and at the same time it is more flexible to crafting alternations than an iron mould. The moulds were designed and manufactured with multi-layered triplex wood using the CNC router in the Fabrication Lab (FabLab) of Technical University of Crete *(Fig. 7)*, were the previous appointment of the first author was. The horizontal layers *(Fig. 8)* were designed to allow for a slightly conical hollow cavity in the mould, so that the prototype comes out of the mould easily and the mould can be re-used with minimum or no damage. Also considered in the design was the limits of our CNC machine which had a maximum limit of 5 cm thick material and operated in three axes (x,y,z). In order to achieve this conical cavity, every layer of plywood was slightly smaller (0,5 mm) or different than its neighbouring one *(Fig. 9)*.
According to the interpretation of workmanship of certainty and risk (Pye D., 1971), which "relies on a personal creative knowledge of the tools, materials and techniques" (Boza E., 2006 and Hemsath T., 2009), we started with the restrictions of the machine and our interpretations of them to end up to the creation of a manufacturing system for a type of flexible moulds. This system was also used by other students afterwards for other courses. The students had witnessed part of the process in the FabLab. The first prototypes produced were from a mixture of concrete, lime, pearlite and powder colours *(Fig. 10)*. We realized that the smooth surface we were striving for was disadvantageous compared to the coarse one. Firstly because, for a smooth surface we would need a thinner material consistency to keep the material in the mould until it dries, while for a thicker consistency we could de-mould immediately, simulating the industry process that we had witnessed *(Fig. 11)*. This would mean a production of 9000 pieces per day. Secondly, and most important, the layers of the mould would leave a trace, while for the coarse surface they would not. The traces were aesthetically not acceptable. During the process, several changes, mistakes and consults from colleagues affected the mould with smaller or bigger adaptations: one or more of the layers would be 're-milled' in a different shape and/or size and subsequently the design file would be revised. In this sense the layered mould became more a 'system' that could generate varieties, rather than a prototype or a 'type' of mould.

*Figure 6. Paper models of Wallpot*

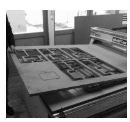

*Figure 7. CNC Milling of Wallpot moulds in FabLab of Architecture Dept, TUCrete*

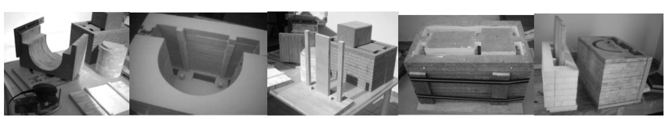

*Figure 8. Some of the innumerous 'layered' moulds of Wallpot*

*Figure 9. Layered mould with conical cavity for the immediate extraction of the prototype*

*Figure 10. First prototypes*

*Figure 11. Industrial production in Crete*

### 3.2 Casting and Moulding the Triko

The design of the Triko stone followed that of Wallpot. The experience previously gained was already an attribute in Y. Initially, the design with the 3D modelling and physical modelling *(Fig. 12)* with cardboard was performed. The design was part of a research project for a public area, while the pilot 'fabrication' and tile placement was part of a private small landscape project of the first author's own practice. Due to the ongoing construction of the latter we decided to use the work force on site for both the moulding of the prototypes and their placement on the pavement. At the same time we would make the moulds ourselves using the FabLab of the architecture school of TUC, where the research project was initiated. Initially, two moulds made out of polyurethane foam were used to make the prototypes for the crash-testing *(Fig. 13)*. Then, thirty two wooden moulds were used twice a day *(Fig. 14)*. For the manufacturing of the moulds, we used 32X6 wooden plates/layers *(Fig. 15)*, all CNC milled. For the optimal use of material (both wood and concrete mixture) we used cutting optimizer and moulding simulation software. Each mould has 6 different layers that have an identical outline, while their inner line is each time set off 0,5 mm, so that the prototype can be extruded without destroying the mould.

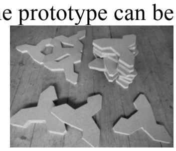

*Figure 12. Cardboard models of Triko*

*Figure 13. and Figure 14. Crash test of Triko, and Re-useable moulds*

*Figure 15. 'Layered' moulds*

## 4 A GENERIC TYPE WITH A GENETIC ATTRIBUTE: CRAFTING AND FABRICATION

Throughout the process of moulds' generation and the research on contemporary modes of production, a knowledge base of moulding techniques for contemporary product design was built. Above all, the flexibility of moulding through the combination of fabrication and crafting was determined. While the Wallpot moulding process simulated more of a factory process with the flexibility of craftsmanship, the Triko process was more of an artisanal process, although enriched with the knowledge gained earlier. In other words, we reverted more to craftsmanship while proceeding. In both parts, CNC milling played a crucial role in the genetics of a 'generic' type: in Triko we knew from the beginning that we will work with layers and the CNC router and we designed something that can be generic in its placement. Wallpot was more a project-based learning process: The digital fabrication triggered the production of a systematic mould, which was not the initial intention but influenced other projects in the same university. Concluding the process, we could say that the design helped in the creation of a type and a system. The digital fabrication added a generic attribute to the type and crafting enriched it with a genetic attribute. As a result, Fabrication has triggered Crafting more than the Design alone would have done and Crafting enhanced the engagement with the Design for the students.

## 5 CONCLUSIONS

In concluding on the interaction between crafting and fabrication based on these two case studies, we can distinguish three levels: *On the level of an educational process*. Re-designing while in the FabLab, as well as bringing knowledge from the industry, as mentioned before, can stimulate related activity in the university. Students that took part in this initiative were more informed by the industry than in a limited time of a file-to-factory course. The learning goals of such courses are usually not the objectives of the industry, or in any case they do not share the same priorities in the process of innovation. Based on this observation, we think that university FabLabs should be more open to external parties, people with ideas and initiatives, like it happens in private FabLabs *(Fig. 16)*.

*Figure 16. FabLab Waag Society, Amsterdam*

*On the level of the student-designer.* There was a much faster generation of the final object and a deeper understanding of the process. The machine 'democratized' the processes that may be too technical for an average student (or a teacher) when done in the traditional way: it has never happened that there are equally skilled students in one course. There can be persons with talent and motivation but with difficulty in manual skills. *On the level of the importance of the workshop*. There can be more iterations of an idea, as there is the luxury of the machines "inside the classroom". Endless variations of prototypes are integrated in the design studio, while the proximity of the lab to the studio is crucial for the interaction with a lot of students.

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[ii] Definition: http://en.wikipedia.org/wiki/Digital_modeling_and_fabrication , accessed on 17/02/13.
[iii] Definition: http://en.wikipedia.org/wiki/Craft , accessed on 17/02/13.