Capital A to Z

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Abstract. Throughout the history of architecture, the Capital – the intermediate between a column and the beam or surface it supports – has been a recurring feature in architectural composition and articulation. In this paper we describe results and findings from the Capital A to Z exercise within the Ornamatics Course from the TU-Delft MSc curriculum. We will show how this exercise combines various digital and physical processes for form finding and how further insights can come from the actual production of models and prototypes. Conclusions will be drawn regarding the integrated educational setup and regarding the influence of different methods and tools on the design process and the design results.

Keywords: Computer aided manufacturing and modelling; composition; prototyping; ornamatics; education-based research.

Introduction

From ancient Egypt, via the archaic and classical eras of ancient Greek architecture, through the Middle Ages and into the early and late ‘machine’ ages, the capital has been used as a device for the sake of ordering and ornamentation in the hands of generations of architects and builders.

Apart from logical considerations, aspects such as technical skill and elegance have contributed to the lasting appeal of the capital… The introduction of new materials (notably cast- and wrought iron) brought forth wholly new methods of production, but also new proportions, as can be seen in the library designs of Labrouste and the stylistically innovative oeuvre of Hortá. Furthermore, to this day the capital has continued to play a role of importance in various indigenous ‘vernacular’ architectures. With the introduction of functionalist modernism, the role of the capital in western architecture seemed to be played out, partly due to a strictly ‘embellishment-free’ aesthetic and partly due to the demise of traditional building crafts, which were supplanted by the radical standardisation of de modern building industry. The post-modern ‘reaction’ of the second half of the twentieth century briefly brought the capital back as a topic, but usually in a reduced, frequently ‘ironic’ form.

In recent years, the issue of ‘ornamentation’ returned onto the agenda… Architects no longer seem to be afraid of using decorative elements in their compositions, but instead are actively developing new ornamental concepts that ‘fit’ in this day and age, rather than falling back on historic precedents.

This renewed interest in ornamentation coincides with new approaches to the production of building elements. ‘Tailor-made’ components can
now be produced in relatively small series to the explicit specifications of the architect. They are designed, but more importantly: manufactured with the aid of computer-based technologies. In this way the ‘skill’ of the traditional artisan can to a large extent be replaced by the – relatively affordable – instrumentation of Computer Aided Manufacturing (CAM). In connection with such procedures, computer aided physical modelling techniques are used in the development phases, to generate scaled-down design models, real size prototypes or components for casting etc..

The educational environment can be a fruitful development- and testing ground for new technical applications and uninhibited stylistic explorations. One such education-based study application is the ongoing Ornamatics project, which is into its third year of experimentation. Over the last two years, groups of MSc students were asked to develop propositions for wholly new types of architectural capitals. The task: to come up with an innovative column/capital concept, initially using either digital or physical sketch models and subsequently using refined versions, which could be ‘3d-printed’ as physical scale models. Furthermore, the students were stimulated to model full-scale prototypes and to propose materialisation- and production scenarios for production on a small-scale, industrial level.

The exercise has yielded a considerable number of noteworthy results that give an insight into the interests and concerns of young designers on the level of contemporary aesthetics and technology.

**Ornamatics**

In previous papers we have discussed the CAMlab and our prospects for the Ornamatics course (Breen and Stellingwerff, 2002, 2005). The CAMlab consists of three distinct groups of machines: laser cutters for 2D cut-outs and surface engraving of plate materials, CNC three-axis milling machines for 2,5D surfaces, plate cut-outs and single or double sided moulds, and mono and colour 3d-printers that build models from starch-powder and binder fluid. The neighbouring model-making workshop supports manual pre- and post-production techniques such as sanding, spray painting, vacuum moulding, casting, compositing etc…

First we will briefly discuss the general design of the Ornamatics course; it’s means, methods and goals. Then we will give a selection overview of the project results and findings as well as an appraisal of the growing role of computer-generated forms of ornamentation on the basis of the Capital A to Z case study. In a concluding section we will try to pinpoint more general understandings about the educational insights and design-methodological aspects.

Ornamatics stands for a combined challenge: the issue of ornamentation linked to mathematics / aesthetics / informatics. Starting from historic and contemporary inspirations, the students focus on two exercises: the DigiTile exercise and the Capital A to Z exercise. The DigiTile exercise was presented during the previous eCAADe conference (Breen and Stellingwerff, 2007).

We have gone through different phases of the DigiTile exercises. First off, we made full scale CNC milled and than vacuum formed tiles, which were then used as counter forms for poured concrete. Thus tiles could be produced in series. In a second session the 3d-printers were used. This helped in producing even more detailed 3d tiles. These tiles were scaled down in order to keep the prints affordable. A third, slightly different exercise focussed on CNC milled plywood panels. This technique was more cumbersome regarding the stubborn relation of drill and wood. The interesting part of the panel exercise was however the sometimes surprising effect of lines and colours in the alternating layers of wood in the plywood plates.

Originally, the DigiTile exercise was meant to be a short introductory exercise to get the students acquainted with the new approaches and available machines. The unexpectedly rich and broad variety of imaginative results made us decide to maintain
the DigiTile exercise as a recurring feature of the Ornamatics course, consisting of roughly the first half of the exercise as a whole.

The other half of the exercise, using a similar pedagogical set-up and use of techniques, is quite different from the DigiTile theme by its much more structurally embedded nature. The Capital A to Z exercise demands considering structural connections to a column, the floor and roof surfaces and potentially: beams.

A diverse selection of results: Capital F, I, M, S and Y

Up till now five groups of MSc students have completed the Ornamatics course. By collecting and thematically comparing the results we now begin to distinguish different working methods. In this paper we present and briefly discuss five specific results, as an indication of the different attitudes and design approaches.

Focus on aeronautical form reference: Capital F

We always start the course with a call for individual references and inspirations. Students are asked to collect and share a number of images concerning ornamentation, which they may find fascinating, but
also which they dislike.

Such references can come from any domain, e.g. nature, industry, art, architecture, etc... Capital F demonstrates the rather literal formal reference to a fighter jet. In other results, the references were much more ‘processed’, whereby intermediate formal explorations underpinned the vividly expressive (re) search processes.

**Focus on tectonic construction elements:**

**Capital I**

Capital I appears to show a clear reference to a standard steel I-profile. However, the student’s ambition was to keep the capital as such open in its centre.

He focused on the possibilities of working with steel, including profiles and connections and the typical ways in which industrial steel may be formed. This resulted in an elegantly ‘open’, indeed almost non-existent, connection between columns and the beams.

**Focus on modelling and milling:**

**Capital M**

Capital M shows a result that is determined by the designer thinking in terms of design tools and process steps.

Firstly, a Maya (nurbs-surface) model was made by rotationally lofting the square column face to the four starting faces of the beams. The shapes were mirrored and copied and this resulted in almost Corinthian-leaf-shaped sides.

Subsequently, the shapes were cut on their intersection lines and remaining faces were cut out and corrected in SketchUp. A quarter of the shape was then milled out of a block of medium dense polyurethane foam.

In order to speed the milling process, a 6mm sphere-head drill was chosen and the step-size between the drill-paths was also 6mm. This resulted in a waved surface form. Normally this surface would get another milling operation in order to get much smoother planes. However, the carving lines from the milling bit turned out to be so beautiful, that they were seen as an added value from the milling process.

The constraints of the tool as an aesthetic benefit?

**Focus on the interplay of formal conventions:**

**Capital S**

The Capital by Martijn Broekhuis has several historic and contemporary – as well as iconic and ironic – references.

Figure 4 shows a collage of inspirations: how one

![Figure 3](image)

*Figure 3*  
Capital M by Roel Philippa.
Figure 4
Capital S by Martijn Broekhuis
single ‘blob-like’ shape is intended to accommodate different structural demands, while it also playfully refers to classic elements.

Within context of the Ornamatics exercise, the somewhat eclectic resulting form was 3d-printed, but the idea is also reminiscent of combinations of cast- and riveted iron constructions. We imagine it might be interesting to ‘realize’ such a product-proposal in cast aluminum or possibly in (combinations of) other materials.

**Focus on pseudo-organic scripting:**

**Capital Y**

David Rutten joined the ornamatics group while he was also working as a programmer for Robert McNeel & Associates. He had a great deal of experience with shape creation methods using RhinoScript and he used the same scripting language in his Ornamatics explorations.

Starting from a study of tree trunks, he came up with several recursive growth algorithms. Different parameter options in the script were investigated: the angle and length of each new branch and the randomness versus equality of branches. Finally David decided to make a 3d print of an algorithmic ‘column’, which is reminiscent of…. What?

Spaghetti? Broccoli? Seaweed? Or … something altogether new?
Conclusions and Perspectives

The five examples, which have been briefly discussed in this paper, can give only a limited insight into the rich variety of results of the Capital A to Z exercise, in the context of the Ornamatics initiative. What has become apparent is that a great many, very individual design paths can be explored.

The MSc Students that participated in this free-choice explorative exercise were stimulated to bring along their own personal inspirations, methods and preferences. By excluding several aspects of designing building as a whole, they were able to focus on cultural as well as technical aspects. The Ornamatics course thereby brings together historic and contemporary aspects of design and building culture and practice.

While the ‘DigiTile’ exercise brings themes like pattern, tile-ability, moulding, casting, de-moulding, seems, surfaces and materials to the fore, the Capital A to Z exercise adds aspects that relate to the structure of a building, the connection to the ground and the ceiling (with or without beams).

Ornamatics students can determine their own design paths on the basis of their own inspirations and furthermore get acquainted with all kinds of digital tools (modellers, scripts, maths-software), machines and tools in the CAM-lab, own form finding methods, materials (concrete, wood, foam, etc.), physical post processes (e.g. vacuum moulding and concrete casting) and digital post processes for presentation.

The pedagogical setup, with active integration of wholly different themes, which are discussed and exchanged in weekly sessions, has proven to be a stimulating learning environment, for the participating students as well as the members of staff. While each student cannot be expected to cover every potential aspect in his or her own design process, the members of the group learn from each other and finally get the whole scope.

The outcomes of this experimental project may give an indication of new formal agendas and product and production modes, using state-of-the-art computer technologies.

After five semesters, we keep seeing surprising new results and intend to continue this experimental course for the time being.

Our ambition: an exhibition and book in which the DigiTile and Capital A to Z experiences are presented concisely and analyzed systematically.

References


