Towards Ornamatics

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Abstract. *Computer aided modelling and drafting protocols – in combination with new production technologies – have contributed to wholly new ways of shaping building elements. Some examples of new techniques, which have recently become very successful in building production and in architectural design education, are: 3D Rapid Prototyping; 2,5D and 3D Milling and computer aided Shape Cutting (notably using laser and water jet modes). Such new approaches not only create new opportunities for traditional production processes (including physical modelling), they also offer new perspectives for design and manufacturing on the level of architectural components and connections. We foresee innovative approaches to building product design, with a renewed interest in expressive Ornamentation. A phenomenological development we would like to address using the concept of 'Ornamatics'. This contribution explores the potentials of product design with a renewed focus on ornamentation, involving the active utilization of computer aided modelling and manufacturing techniques. The paper furthermore documents results and findings of a series of explorative studies carried out within an educational laboratory environment.*

Keywords. *Design Driven Research; Computer Aided Fabrication; Aesthetics; Ornamentation; Education.*

Introduction

This paper explores the potentials for new ways of studying, evolving and realising ornaments in architectural design. The underlying thesis is that the implementations of computer-based modelling- and fabrication techniques will not only lead to improved procedures for architectural articulation, involving traditional production and physical modelling processes, but may lead to technical and stylistic invention, particularly in the field of building product design.

A renewed interest and sensibility to meaningful and playful forms of ornamentation offers potentials for innovation in practice. A topical issue, which we would like to address using a light-hearted, yet evocative, concept: 'Ornamatics'…

In the light of the currently topical focus on ornamentation, how might we (re)consider the role of the ornament in contemporary architectural product design?

To what extent may the active utilization of computer aided modelling and manufacturing technologies be expected to lead to new aesthetic

paradigms?

What could be the role of explorative studies in educational laboratory environments in stimulating a culture of Ornamatics?

In this contribution we consider the practice and experience of ornamentation in a historic and aesthetic context and try to identify emerging approaches that can contribute to revitalising the role of ornamentation in contemporary architecture.

The Culture of Ornamentation

Throughout history, the influx of new technologies has had a marked effect on aesthetic paradigms in architecture. Architecture is arguably best considered as an applied art form, in which aspects of convenience, materiality and skilful execution figure prominently in the way the built product is perceived and appreciated. One of the major factors contributing to the aesthetic success of an architectural artefact is undoubtedly the way in which accomplished ornamentation can be recognised within the overall composition.

Ornamentation – interpreted as a way of enriching a building's appearance as well as demonstrating the skills of the designers and craftsmen involved in its execution – has been in evidence from the earliest times. This intrinsic form of human artistry is to be recognised in various 'vernacular' architectures to this day. An example of the endurance of this practice may be evidenced in the eloquent Shinto temple complexes of Ise. These buildings, which are believed to be adapted and perfected exemplars of ancient Japanese building types, exude a timeless grace and presence through their archetypal shapes as much as their refined, disciplined decorations. The two Japanese Shinto shrine complexes, carved out of the forest at Ise, can be considered as the oldest existing timber structures in the world, having been rebuilt systematically every twenty years over a period of at least 1500 years. The buildings' material and stylistic formats are generally thought to reach back to prehistoric times.

In this light it is worthwhile to differentiate between the conceptions of Ornament and Decoration. The act of Decoration is a form-giving activity, which is closely linked to Ornamentation – and indeed one might view the act of decoration as the activity that is essential to creating an architectural ornament. In the context of this study we would like to define Ornament as the conscious articulation and skilful embellishment of one or more operative building components – for the sake of aesthetic impact. By contrast, a Decoration may be considered as a relatively detached adornment, belonging to a separate layer of artistic embellishment, which may be to a certain extent added on to a structural framework, as an object in its own right. Viewed in this context Ornamentation may be considered as an architectonic compositional devise and Decoration more as an architectural attribute.

In his influential 'ten books on architecture' (ed. Rowland, Noble Howe, 1999), the Roman architect and scholar Vitruvius addressed several of the pragmatic aspects of the building practice of his time and their (alleged) origins, but he also went into the conditions for 'architecture'. The way in which he put forward what he considered to be three essential design conceptions – firmitas, utilitas, venustas (durability, utility, beauty) – might suggest that 'beauty' could as it were be added on as a 'third' aspect, once the demands of logical construction and functionality had been met. To a certain extent this may have actually been the practice of the time; when one visits the remains of a Roman city like Aphrodisias in Asia Minor, the dramatic impact of the sculptural outer layer is striking. It is tempting to consider Sculptural articulation as the determining factor for a Roman building's aesthetic success, an eloquent interplay of artistic, representational decoration and sculptural, plastic ornamentation of the architectural fibre.

During the Renaissance, the surviving architectural artefacts of the Roman period would be

rediscovered, becoming the standard of stylistic reference. The resulting framework of formal conventions came to be recognised as the 'classical language' (Summerson, 1980) of architectural design, whereby aesthetic 'correctness' depended to a very large extent on justifiable imitation of the canonised sculptural components of architectural form.

The synthesis between architectural structure and ornamental articulation was arguably even stronger in the Gothic building tradition. Arguably, this creative praxis eventually reached its culmination in the highly original, groundbreaking work of Antoni Gaudi. Through the detailed models of his structural proposals for the Sagrada Familia, which the aging master left behind, it has become possible to continue the realisation of his project using state of the art technology (Burry, 2004). The newest extensions to this emblematic cultural artefact demonstrate the successful mimicking of his complex geometries, however without the richly profuse ornamentation of the earlier work, which to the public at large remains the benchmark by which the new additions are critically measured.

Ornamentation and the Modern Paradigm

Up to the end of the end of the nineteenth century, expressive architectural articulation was to a large extent made possible – and more importantly: affordable – through the availability of well trained, low income artisans. After the Industrial Revolution began to make its mark on the architectural landscape of the eighteenth century, the Arts and Crafts movement attempted to turn the tide by emphasizing the importance of 'honest' craftsmanship for architectural Form. Character and Truth became the key conceptions for the appraisal of a design's aesthetic merits.

In this context it is interesting to note that as early as the late eighteenth century – well before the onslaught of the Industrial Revolution – a practice had already arisen in Britain, whereby artisan culture was being replaced in the production of objects of 'fine art' in architecture, using a refined system of sculptural moulding and artificial stone (Hill, 1999). Complex decorative elements were produced and distributed in considerable numbers – from catalogues as well as on demand – allowing for the imitation as well as the invention architectural ornaments on the basis of precedent. A practice, which may be indicative of the kind of contemporary applications we envisage in the context of this exploration of Ornamatics…

In retrospect, the Art Nouveau movement may be viewed as the last architectural style that was essentially reliant on skilful (or more precisely: masterly) building craftsmanship. Successive twentieth century movements – such as Art Deco – saw ornamentation becoming steadily more graphic and product-based, whilst in the Modern Movement the classical 'rulebooks' of architectural composition would be thrown out of the window and ornamentation was declared obsolete, even an 'undesirable element'…

Around the turn of the century, classically trained designers, such as Behrens and Perret, were still applying rudimentary classicist forms in their work, but it was only a matter of time before stylistic ornamentation would be considered totally redundant, with the advent of a radical, functionalist Modernism. On a perceptual level the reductionism this implied might be one of the most important reasons why Modernism – as a style – did not manage to capture the collective imagination – and indeed affection – of the public at large. Nonetheless, particularly in the post-war redevelopment era, rational modernism became the norm. The damage was considerable: on a detailing level the tone was set by globally distributed, standardised building products. Emphasis on low-cost building and limited upkeep further contributed to the reduction of the architectural palette, with the role of ornamentation seemingly played out...

The subsequent reactions of 'Post Modern'

movements tended to fall back on compositional aspects of 'historical' architecture, even though the results were frequently conceived as 'flattened' caricatures of classical shape grammars, with ironic treatment of details from precedents and exaggerated proportions, symbolism, colour schemes and lighting. Robert Venturi, one of the leaders of the Post Modernists, introduced the concept of the 'decorated shed', with a bias towards billboard graphics as a means of articulation (Venturi, Izenour, Scott Brown, 1972). In his work he identifies what he calls "explicit ornament" (Venturi, 2005) – as opposed to what one might consider as implicit ornament.

This distinction is meaningful, as the 'implicit' ornament – the kind of ornament which is closely linked to the tectonic qualities of architecture has never been completely out of the picture… Even in manifestly 'functionalist' architecture – such as in the work of Duiker and Bijvoet – structural elements would frequently be refined in such way that they would acquire an implicitly ornamental, aesthetic quality. In the wake of this practice, certain architects of the latter half of the twentieth century, such as Herman Hertzberger, felt inspired by fin-de-siècle ornamentation, trying to create stylistically up-to-date transformations of cherished references in their own work. In the work of classically inspired architects, like Charles van den Hove, we can recognise a steady progression towards the reaffirmation of the ornament, initially implicit, gradually becoming more and more explicit. Lastly, the 'High Tech' movement of the late twentieth century undoubtedly did a great deal to renew the interest in the ornamental potentials of the building's construction and envelope, particularly on the level of articulate detailing.

Computable Configurations

The influx of computers in architectural design and building production undoubtedly led to new opportunities for creative composition and research. Initially, the emphasis lay largely on elementary aspects of spatial geometry and shape grammars, with the computer primarily viewed as a tool for the generation of large numbers of variants. Although these studies yielded some interesting results, they failed to make a mark on the practice of architecture, which tended to be more involved with issues of visualisation and communication, as well as standardisation and efficiency in design processes.

Subsequently, the unprecedented potentials of complex geometries afforded by the computer gave rise to a wave of design proposals in which the predominantly cubic 'formats' of twentieth century architectural expression were shifted and stretched, sometimes beyond their limits. In 'real life' many of these 'conceptual' proposals turned out to be quite disappointing, particularly on the levels of materialisation (complex geometries having to be realized largely in 'rational' building products; still largely either linear or planar in nature) and detailing (connections frequently becoming manifestations of the enormous difficulties encountered when trying to weld unwilling building components together on the building site).

Although the practice of 'building on demand' steadily presented a serious alternative for the previously rigid edicts of large-scale industrial production, the kind of building where each element and detail is at least to a certain extent 'different' generally proved too much of a good thing (not in the least: financially). However, very serious progress was made, albeit on a more 'modest' level. Computer aided modelling and drafting protocols – in combination with new production technologies – contributed to wholly new ways of shaping building elements. Some examples of new techniques, which have recently become very successful in building production and in architectural design education, are: 3D Rapid Prototyping; 2,5D and 3D Milling and computer aided Shape Cutting (notably using laser and water jet modes).

Such new approaches not only create new opportunities for traditional production processes

(including physical modelling), they also offer new perspectives for design and manufacturing on the level of architectural components and connections. In addition, new life might be blown into the original notions concerning digital form-generation, on the basis of clearly defined formal parameters and constraints.

In this context it seems legitimate to look forward to innovative approaches to building design, with a renewed role for meaningful and playful ornamentation: towards Ornamatics?

Perspectives for Ornamatics

The Ornament is clearly back on the architectural agenda… If one critically observes the steady outpour of architectural artefacts and the articles in the professional press, it seems clear that ornamentation is once again an issue to be reckoned with (Healy, 2005). Ornamentation is no longer something of a 'hidden agenda', but has once again become manifest upon different levels of design. Trend-setting designers – such as Herzog & de Meuron, Jean Nouvel and Norman Foster – are constantly in search for new architectural form concepts, in which ornamentation – particularly on the level of the building's 'skin' – figures prominently. Simultaneously, we see a variety of trends whereby building objects are approached as large scale sculptural objects, whereby formal themes, such as articulate surface patterns, elegant spatial/material collages and even 'sampled' classicist schemata, are re-invented, but with a twist. In all of this, a renewed inventiveness on the level 'making' is very much in evidence. Architects have been discovering and exploring opportunities afforded by the kind of mass customisation that increasingly offered by the building industry, prompted by computer enhanced fabrication processes and technical innovations, notably in the steel construction and glazing industries. At the same time many designers attempt to 'bend the rules' of emerging production techniques, for the benefit of aesthetic impact.

Examples of such personalised production approaches, whereby computer driven techniques that have recently become available are made instrumental in an innovative way, may be found in the work of a new generation of computer-literate designers, interest in using newly available technologies for the realisation of physically stimulating, aesthetically challenging compositions, such as Hild und K (Stuhlmacher, 2005) and PLY Architecture (Klijn, 2005).

Some of the techniques that have surfaced in recent years:

Graphic treatment: embellishment of planar elements – such as glass and composite panels – employing regular or random patterns, with the use of silk screening and etching techniques;

Surface articulation: working of surfaces using 2D or 2.5D subtractive techniques (i.e. removing material), employing computer aided milling apparatus, CNC techniques or laser machines, possibly involving layering and/or montage production techniques;

Sculptural moulding and casting: creation of 2.5 D or 3D elements, using form – counter form principles, employing milling or prototyping applications and casting techniques with the use of cement-based or plastic materials;

Component detailing: evolvement of 3D study objects either as solid or in the form of interlocking components, using either subtractive (3D milling) or additive (3D printing) techniques, which may be successively be transformed into full scale (cast) prototypes.

In the examples mentioned above, aesthetics plays an increasingly important role. However, the design disciplines of our time do not appear to be governed by one, universally recognised, aesthetic paradigm. On the contrary, the contemporary architectural landscape is best characterised by its pluriformity and dynamics, whereby conventions and inventions seem to flow freely into new paradigms, which may vary from group to group and

even be ascribed to individual architects/teams.

In this cultural environment we believe it is of importance to confront students of architecture with the consequences of the dialectic relationship between architectonic and architectural considerations. At the same time, it is our view that the academic learning environment offers unprecedented opportunities as a laboratory for design driven study, particularly in the perspective of Ornamatics.

Some experiments

In recent years, the Delft Form & Media Studies group has implemented a CAMlab (Computer Aided Modelling laboratory), whereby the ambition is to bridge the gap between physical and digital modelling platforms (Breen, Nottrot, Stellingwerff, 2003). A number of experimental studies have been carried out, in which implicit and explicit manifestations of Ornamatics are high on the agenda.

Some examples of recent studies include student work from a concrete design workshop and preparatory experiments for further courses in the subject of Ornamatics. The workshop focussed on digital milling techniques to make moulds for pouring small concrete objects. Working in relatively short development cycles [sketch > computer-model > milling file > mould > concrete object] proved to be very inspiring for the students. Within a week many variants were made and discussed. During the next two weeks, there were two more development cycles in which the design was refined or totally different experiments were undertaken. Each consecutive week, the students gained new skills and insights on many different technical and cultural topics. It was interesting to observe the interplay between computer literate modellers and the people who were more skilled in the physical production and refinement of the ornamental objects. The integration of physical and digital techniques was most exciting and made us decide to go on with such workshops.

Figure 1. Many hand sketches were made before, during and after the computer models were made.

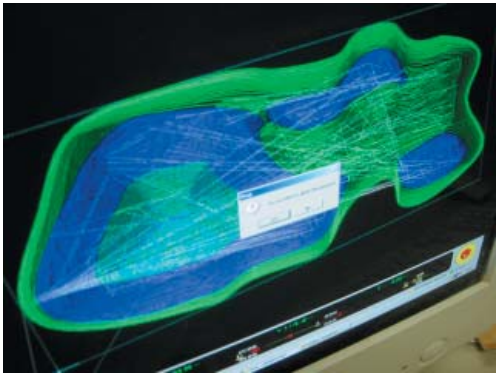

Figure 2. Computation of the milling paths.

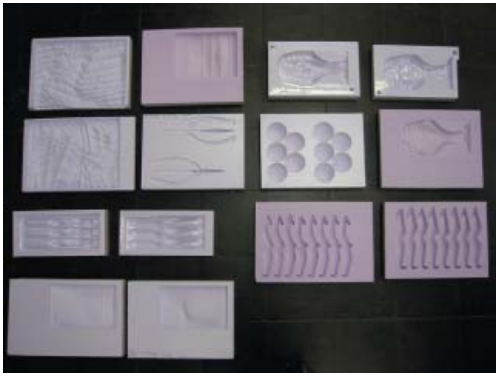

Figure 3. Milled moulds for production of concrete elements.

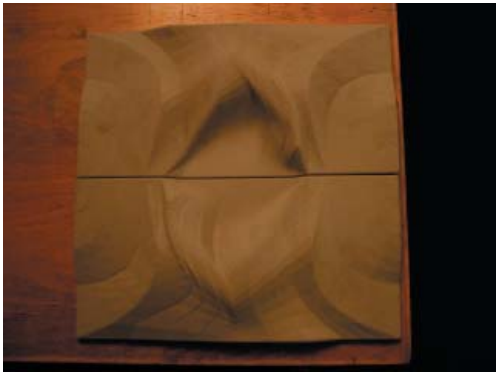

Figure 4. Concrete tiles.

Figure 5. Computer generated concrete free-form object.

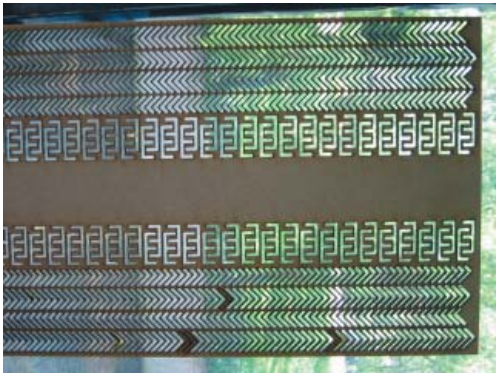

Figure 7. Pattern in the rest materials from the laser-cutter.

Figure 6. 3D-printed patterns from superimposed waves.

As preparation for further experiments, we started to look at different approaches, both educationally and technically. The workshop showed a large dependency to modelling skills of a few excellent students. Therefore we would like to introduce more different types of digital equipment (e.g. 3D-scanners) to serve as input for the manufacturing machines, as well as alternative ways to develop digital ornamental patterns and structures (e.g. spreadsheet data or data from mathematical scripts).

Not just the equipment at the CAMlab [3D-printer, a milling machine, laser cutters] and available modelling software is important for a good educational result. Also the careful development of the design task and a schedule for development cycles is necessary to get interesting outcomes. Above all, the course should have introductions to get curious about the forgotten aspects of orna-

ment in architecture and about the new chances to combine ornament and informatics / cybernetics / poetics.

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