

## Aarhus School of Architecture // Design School Kolding // Royal Danish Academy

### Individual cast concrete elements, part 2. Berlin

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## Individual cast concrete elements, **part II, Berlin**

- a workshop on the workability, optimisation and production of concrete



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## **Preface**

As the second in a series of international workshops, that studies the physical and aesthetic potential of the material concrete in architecture, a workshop was held at Technische Universität in Berlin in the period 8th – 13th October 2007.

The workshop took place in one of Peter Behren's AEG turbine halls, which now function as a concrete laboratory for the university's Fachgebiet Massivbau. Here 10 students of civil engineering from Technische Universität in Berlin met with 10 students of architecture from the Aarhus School of Architecture, and cooperated in solving a common assignment.

The metaphorical point of departure for the assignment was a contemporary interpretation of the Brandenburger Tor in an architectural, technical sense. The basic, classical architectural and static principle of the bearing and the borne – columns and beams were to be submitted to existing and future concrete concrete technological and form-related potentials.

It was a "hands on" experience where the students created architecture by specifically sketching, developing and finally casting concrete elements in full scale.

The result reflects the interdisciplinary effect of the workshop, namely the cooperation between engineers and architects. Static stability and the course of the forces has been expressed as architectural form.

The workshop was arranged and completed in cooperation with Aalborg Portland Group as part of the research into concrete at the Aarhus School of Architecture.

Karl Christiansen

Anders Gammelgaard Nielsen



## Introduction

This workshop has been embedded in research program with the title 'industrialized individuality'. The research program is currently carried out at the Aarhus School of Architecture by Professor Karl Christiansen and Associate Professor Anders Gammelgaard Nielsen

The research program takes its point of departure in the reality of the new production methods of today.

Briefly described, previous production methods were based on craftsmanship. From an architectural perspective this resulted in designs of great variation and individuality. The 'Arts and crafts movement' resounded the essence of this production method (Mackintosh).

With the industrial revolution, the production method changed from craftsmanship and individuality to mass production and standardization. For the architectural design this change in technology led to repetition and rationality. The design components were not individually designed, but came out of standardized fabrication. Architecture lost its previous individuality and became standardized (Mies). In contemporary production methods, a shift of paradigm has arisen. Due to the computer and robot technology CAD CAM, it has suddenly become possible to produce objects and building components with individual forms. This technology rapidly developed in the car industry and is today a reality in many areas of the building industry.

In the research program, we are specifically focus on the technology embedded in pre-cast concrete industry.

Through a preliminary research program, it has become evident that the pre-cast concrete technology lacks the embedment of the new technology. A survey reveals that the industry is still in the era of standardized mass production, and even this does not seem to be the entire truth. What was to be expected today would be a production characterized by a large number of identical elements cast from the 'mother' mould. The reality in numerous concrete industries is, however, that only a few elements are cast from the same mould. This requires a large number of moulds and therefore an extensive degree of craftsmanship in the production. In other words; there is to a large extent an individual production method in the pre-cast concrete industry, it is just not based on industrial techniques but mainly on craftsmanship.

From this reality arises the paradox that a lot of new buildings aesthetically radiate the era of traditional mass production, but their real production is in fact based on craftsmanship.

The aim of our research program is to develop a series of techniques for the embedment of customized mass production in the concrete industry - or to be more specific: to develop moulds that are capable of producing a large number of different elements. This requires a crossover between different technologies, and that is why our aim is primarily to demonstrate that such a technology is plausible.

To embed a workshop in the research program, necessitates a more broad approach to the subject in order to give the student a basic knowledge and competence. As a result we have decided to broaden the focus in such a way, that it is not only concerned with the technologies related to the casting of concrete, but also to the casting of materials in general. This offers the candidates the opportunity to learn about many different casting techniques and at the same time to become familiar with the aesthetic and technical potentials of a large number of materials.







## **The assignment**

The aim of the workshop has been to cast a structure consisting of a number of concrete elements. After the workshop, the achieved knowledge and competence are to be transferred into building projects that the students have programmed themselves. This has resulted in student projects with a much higher degree of tectonic understanding and integrity. The study program has therefore been consistent in its aim: to emphasize the development of architectural projects that gives an understanding of basic relations between materials, their technical transformation, and the potential of the architectural form.

The intended construction will relate to the Brandenburger Tor in the sense that it will be a load bearing system consisting of columns and beams. In terms of design it will also relate to the Brandenburger Tor in the sense that it captivates the historic and symbolic importance of this work of architecture in Berlin.

The construction will consist of a total of five members, - tree columns and two beams. All the members are to be designed individually, but in a way so they together form a totality (this is one of the most important purposes of the workshop). Each member has to respond to the overall construction, and at the same time it has to be optimized as a construction member (all unnecessary material has to be "carved away")

The five members will be designed in five groups of each four students (each group consisting of two engineer students from TU and two architect students from AAA).

The five members are to be cast in five individually designed moulds. These moulds will consist of an inner core of polyurethane foam and an outer formwork of plywood. The polyurethane foam will be cut with a hot wire.

All materials and tools necessary for the workshop will be supplied and paid for by Aalborg Portland. The concrete will be delivered from a supplier in Berlin (We will need one truckload 4.5 kubikmeter).





## Sketching

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During a process of sketching by hand drawing and model making the five groups of students developed a series of design proposals for the structure. These proposals were constantly revisited and elaborated through a number of critiques, at which different design aspects were discussed (context, production techniques, static and stability performances, junctions e.g.)

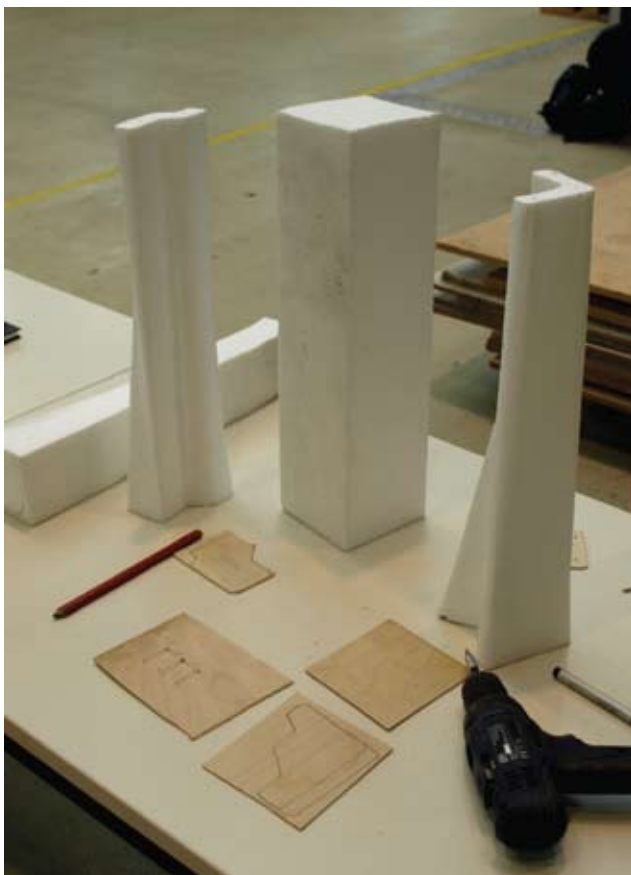






*This page*

Various design suggestions for structures. Sketches made in polystyrene in scale 1:5.



*Opposite page*

Critique and evaluation of design suggestions. Critiques were handled as "open spaces" for students and teachers, in order to facilitate the optimal situation for new designs.











*This page*

The designing and making of full scale templates for the cutting of the polystyrene blocks. All templates necessary for the structure are finally displayed of the floor.



## Mould making

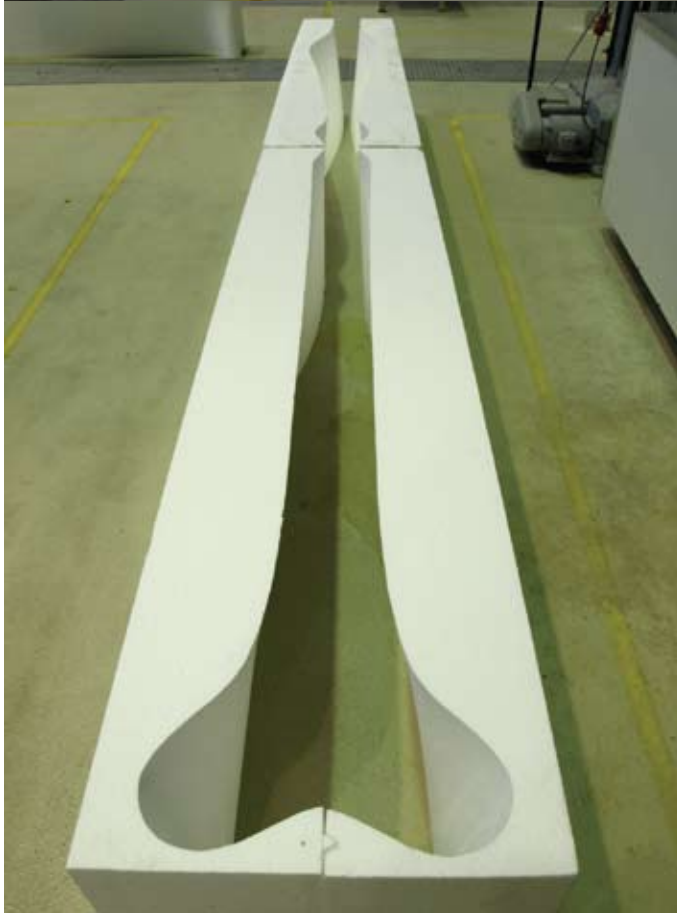
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*Top.*

All polystyrene moulds necessary for casting the structure.

*Bottom*

Polystyrene moulds for the casting of the top beam.



*Opposite page*

Mounting the templates on the polystyrene blocks. Cutting the polystyrene blocks with a hotwire using the templates as guides.









*This page*

Core, cut out of the polystyrene block. Detail showing the junction between column and beam.

*Opposite page*

Cores cut out of the polystyrene blocks. All members of the structure.







Treating the inside of moulds with a wax-oil solution.



Assembling the formwork. Mounting the inside polystyrene moulds in an outside load bearing structure of plywood and rafters.







### **Casting**

Pouring the concrete in the formwork. Top illustration show break down of formwork, due to improper reinforcement of outer load bearing structure.





**De-moulding**

Removing the formwork, the outer load bearing structure and inner polystyrene mould.





## Mounting

Mounting the structural elements.





## Summary

The advantages are many when study programs are embedded in research.

Some problems may, however, occur due to the differences in the nature of research and teaching.

Research has by nature a well defined point of departure – the hypothesis. In opposition to this, it does not have the same predefined results – the conclusion. If the conclusion was known on beforehand, there would be no research. In other words, research follows the rule: if we know where we are going, there is no need to go.

In our opinion study programs should follow the same rules. In order to stimulate the students' creative and innovative potential, study programs should have no predefined results, nor should they have a predefined road to follow: only an initiating point of departure and the supporting environment. So far research programs and study programs follow by the same rules.

The differences occur mainly in the way they zoom in on the study object. Where research is free to zoom in anyway it pleases, study programs in general have an obligation of a more broad approach. This is to ensure that the candidate has a general knowledge of the different aspects of architecture, and that he can orient himself in these aspects.

During the study program, including the workshop, the students have constantly been informed about the progresses and results of our research program. At the same time they have had the possibility of contacting the same concrete industries that we have been in contact with. This has given the students access to a lot of knowledge that has been accumulated in these companies.

At the same time the companies have supported the students financially which, in terms of the workshop, has been essential.

In other words; the students have benefited from both our research program and the companies that we have been involved with. At the same time we have in relation to our own research program benefited from the study program in the way that it has inspired us, and uncovered new ways to follow in future research programs.

Seen from a pedagogic point of view, the aim of the workshop was to focus on the complexity of teamwork in the professional world of today's building and construction.

Secondly it was the aim to give the students the experience of going through a full architectural process from beginning to end; from the primarily freehand sketches, through the adjustments of the design due to the various design parameters, to the real making of the forms, and finally to the inauguration of the construction. An experience that is only rarely possible to give students because of economical and practical reasons. Unfortunately, one may say, because it is the only experience that fully open the eyes of the students towards an understanding of the integrity of the architectural process.

As a conclusion of the workshop it is to be said that the students were fully confronted with the complexity of today's teamwork. The large number of design parameters that were brought into play forced the students to keep the design process open and dynamic. In the beginning this brought about a number of discussions and negotiations between the groups, as well as internally in the groups; discussions, that in many ways paralysed the design process. As a result the designs were constantly redesigned, and with a deadline that was rapidly approaching these disagreements became a valuable source for finding architectural solutions. This was perhaps the most valuable experience of the workshop as the students discovered the possibilities in a problem, that from the beginning seemed impossible to solve.

Professor Karl Christiansen

Associate Professor Anders Gammelgaard Nielsen





**Participants**