MSc 2 Design Studio [AR0851, 12 ECTS] - 1:1 Interactive Architecture Prototypes

Design and build the quality and luxury of a 100m2 apartment within a 50m2 multimodal studio

Tutors
Kas Oosterhuis: Non-standard Design / File2Factory / Styling
Henriette Bier / Nimish Biloria: Reconfigurable Structures / Coordination
Jelle Feringa: Robotic Fabrication
Jia Chang: Interactive Architecture
Vera Lászlo: Scripting to CNC and Robotic Fabrication
Christian Friedrich: Physical Computing
Marcel Groeneweg / Merel Putman [Blauwhoed]: Real Estate and Marketing Strategies

Societal Context
In this spring semester, Hyperbody MSc 2 embarks on a project dealing with the design, fabrication and assembly of a prototype for a ***compact multimodal studio apartment***. The project will be developed in active collaboration with ***Blauwhoed***, a leading Dutch real estate developer based in Rotterdam.

The brief of the design studio is based on observations of societal changes that take place as of today. Technical installations are making up an increasing larger portion of the building's construction budget. Fixed installation for climate control and sustainability and a multitude of appliances together create the desired comfort inside built structures. Technical installations and devices are dynamic in nature - they are basically input processing output machines - and have typically a much shorter life compared to the static built environment. When we extrapolate this trend to the near future, built structures might be seen as 50% static [dead] and 50% dynamic [alive].

The basic research question of the design studio is to what extent the technical installations and the built environment within they are placed should be integrated. While smart household appliances and climate control machines may have a typical life expectancy of say 10 - 20 years, the built structure is usually designed as to last 25 - 50 years. This discrepancy must be solved when installations and fixed built structure are fully integrated. The possible solution is to design integrated structures that have a lifespan of maximum 15 years. By then the embedded technology will be obsolete and will need replacement. Eventually we will also need new methods of financing such short-lived integrated structures, probably more into the direction of leasing.

The design task given here is design a small but well equipped apartment of 50m2 / 150m3 that has all the spatial qualities and functional performances of a standard 100m2 / 300m3 apartment. To reach that goal the technical installation must be designed as to cater radically different kind of usage during the course of a day / week / year. When you are in the living room you do not use the sleeping room, when you cook you do not use the bathroom etc. At one moment of the day the complete space could be either living room, kitchen, sleeping room, etc. Imagine the luxury of a bathroom of 50m2, or working at day and relaxing the other part of the day in a extreme makeover of the same 150m3.

The units and their constituting components are subject to a number of lifecycles of different speed. The structural framework typically is designed to last 50 years, while the exterior outfit of the envelope typically has a lifespan of 25 years. Coming to the inside the lifespan of interior components such as walls, kitchens, bathtubs usually is much shorter, more in the direction of 10-15 years, while heating, cooling, cooking, safety and control servicing equipment typically is refitted every 5-10 years. Interior components like furniture often have an even shorter life expectancy, while personal range-extenders like computers and cellphones may even hold no longer than 2-3 years. These cycles must be considered in the design brief, and especially their mutual relationships. How much are these components of different life expectancy related to each other and to what extent do they form drivers for change and modifications.

Naturally an innovative financial model must facilitate this concept. For this design studio we assume that the building costs of a high performance 50m2 space may allow a premium value of an additional 10-20%, while it

offers the same level of comfort, or better and appealing to modern lifestyles. Capital-intensivity measured in costs per kg or costs per m3 serves as an indicator of the smartness of the product.

Urban Context

Stadshavens Rotterdam: "Merwehaven-Vierhavens [*illustration 1*] is developing into an international testing ground for innovative energy and water. Accelerator is the Climate Campus where scientists, consultants and engineers share their knowledge and expertise. The harbor offers plenty of room to experiment with new concepts. Other pioneers, such as artists and entrepreneurs in the manufacturing industry, are attracted by the inspiring environment of Merwehaven-Vierhavens and have established their studio or workshop. Leaders will even live in this rugged, tough environment, such as CO2 neutral floating homes. Over time on and in the water a completely new district will emerge. The metamorphosis of the ports radiates on Delfshaven and Schiedam: the inhabitants of the adjacent residential areas find employment in the area and get attractive city fronts. Combining high quality living environments, port operations and sustainable commuting over land and water deserves much attention." (http://www.stadshavensrotterdam.nl/)

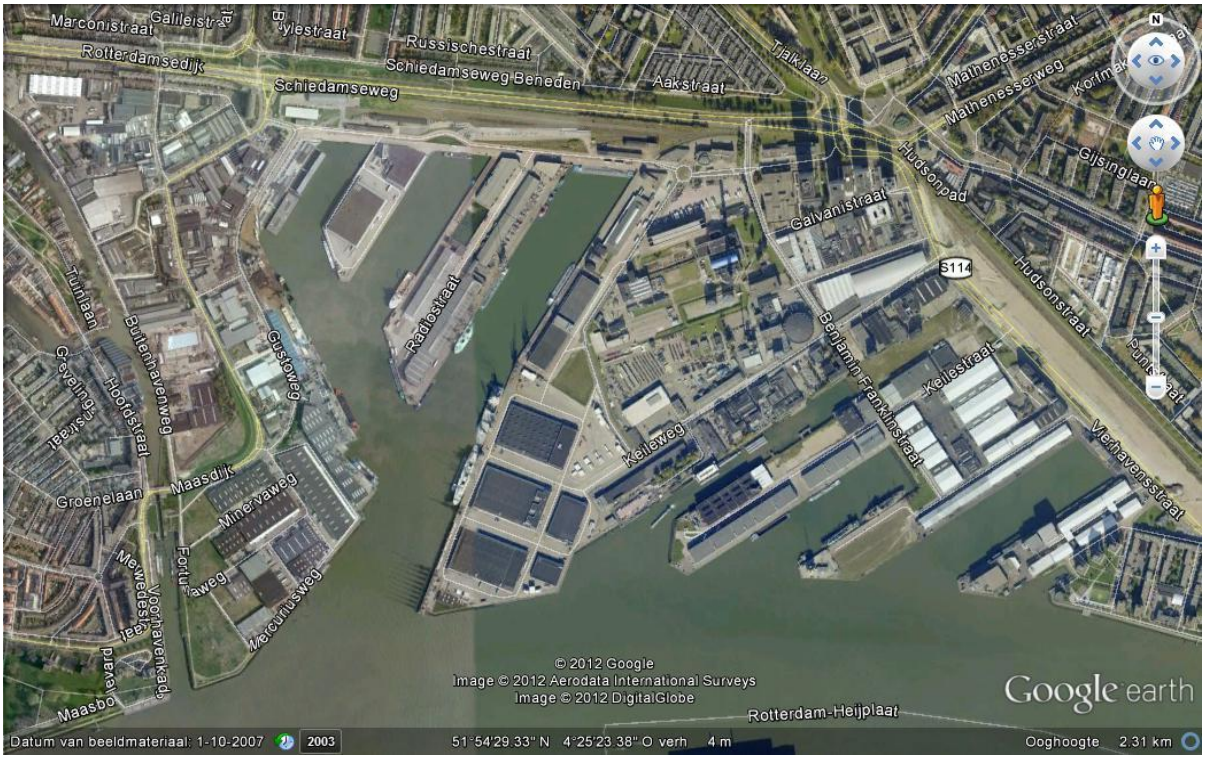

Illustration 1: Nieuw-Mathenesse, Delfshaven Rotterdam

MSc 2 Context

Students who join Hyperbody work within the paradigm of non-standard and interactive architecture. This paradigm emerged mid nineties and has since gained momentum as to form a world encompassing movement, proclaimed already by some avant-garde architects as the future dominant style of the 21st Century. Parametric design is the basis for Hyperbody's design education and research. Industrial CNC fabrication of series of unique building components has been the driver for the radical change from Modernism to Non-standard. From the first conceptual idea students implement the rules for the new economy. Design including architectural design becomes a participatory and multiplayer game, where the designer sets simple rules that unfold and are played by the players, ie the users. Parametric design does not necessarily lead to fluid, curved shapes. The bottom line is that the complexity that is driven by simple rules from within, and top-down design decisions from the outside, can reveal themselves in divergent configurations, either orthogonal or doubly curved, whereas orthogonality and fluidity as such would be a top-down imposed designer's choice.

MSc 2 consists of two courses design studio (DS) and skill building workshops (AS). Both are whole day activities scheduled to take place approx. 9:00-13:00 and 14:00-18:00 at locations such as Protospace, DSC,

and RDM whereas evaluations (midterm and final) are preliminarily scheduled to take place 19/04 and 28/06 in Protospace. Specifics and possible revisions will be communicated by email.

MSc2 schedule

Not available
DS contact
DS self-study
AS
AS self-study

MSc2	7 C 3.1	8 C 3.3	9 C 3.2	10 C 3.4	11 C 3.5	12 C 3.6	13 C 3.7	14 CW 3.8	15 CWT 3.9	16 T 3.10	17 C 4.1	18 C 4.2	19 C 4.3	20 C 4.4	21 C 4.5	22 C 4.6	23 C 4.7	24 C 4.8	25 CW 4.9	26 CWT 4.10	27 T 4.11
Monday	11	18	25	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1
Tuesday	12	19	26	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2
Wednesday	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3
Thursday	14	21	28	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4
Friday	15	22	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5
Saturday	16	23	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	6
Sunday	17	24	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30	7
	Feb		Mar					Apr				May					June				July

Design Studio

The Design Studio basically starts with a ephemeral Point Cloud of 6x6 reference points, hovering 3m above the water or the land. Each reference point stands for one unit of 150m3, all units together form a floating village. The unit can perform as a working place and/or as a home. Instead of thinking in terms of a fixed functional program and project brief, students are encouraged to address spatial affordances and address directly the dynamic activities of present and future site inhabitants. All 36 students chose one as their own. The students decide how to develop this given volume into a multimodal studio apartment, in vertical direction, stretched horizontally or in a compact fashion. Compactness gives the bonus of the better surface/volume ratio, the money saved can be spent in the performance of the space.

There will be no supportive mega-structure, the units themselves must secure the connectivity to other units and secure the accessibility to neighboring units. Projects are initiated individually, but develop as a densely interrelated network of architectural interventions connected to the societal, environmental and material context, within and beyond site boundaries. As much as each project is part of a larger network, in itself it is also a system of a large number of building components, objects and people, thus shaping the interface of the Internet of Things and People.

Rule-based Design

Consider that your unit is regarded as a complex adaptive system [think of it as a vehicle] feeding on information in any form [people, energy]. You must give meaning to the organization of the data of your concept in the design phase. The processing of this design-related information flow is the *e-motive styling* (inter al. Oosterhuis, 2002) of the data. The aim is to keep this initial project idea alive and raise it to mature into a serious player within the population of proposed projects. Your project acts, interacts and behaves. The

aim is to place your designs within the continuously looping information flow of the ecosystem; develop your design in the flow and from the flow. Your project has a name. By bearing a name it shows individual character, or identity. Giving a name to the project is branding the project; a fascinating and commercially essential process to win and maintain a position in the minds of your consumers and producers. Think as a designer *and* as programmer, think digital *and* analog, think bottom-up *and* top-down, simultaneously *and* parametrically.

Design Iterations

The design studio is divided into two separate phases: The first phase concentrates on the design of the projects, the second phase is geared towards the project execution as a 1:1 prototype of one of the selected project concepts.

A jury will select from the 6 group projects one winner. Students present their design is a short pitch. Out of these 6 entries only 3 projects will be chosen for further collective development. Then eventually one single project will be chosen and developed for the assemblage of the full-scale prototype.

Phase 1: Introduction & Fabrication and interaction design workshops [Week 1-4]

The MSc 2 semester begins on the 11th February 2013 with three lectures/information sessions followed by individual and group research in the first week and three weeks skill building workshops.

1. An Interactive lecture by Kas Oosterhuis. Students can interact with the slides and statements as delivered by Kas Oosterhuis via Twitter feeds that are projected on the second screen. Kas Oosterhuis will respond to students' remarks / questions and start the immediate discussion. Main topic of the discussion will be the question whether or not there is a relation between interactive architecture and complex geometry.

2. Lecture by Nimish Biloria and Henriette Bier covering issues of adaptation and robotics in architecture. 3. Presentation and information session by Blauwhoed (the developers) covering their vision, aspirations and analysis of real-market scenarios (before and during the recession period).

Workshops on Fabrication and Interaction Design are described in the section MSc 2 Workshop [AR0851, 6 ECTS].

Phase 2: Six concepts for sketch design phase [Week 5-9]

The students will be divided into 6 groups, each working with a different profile of users and activity patterns. Based on this, the geometric as well as adaptation characteristics should be evolved keeping in mind fixed as opposed to movable elements. This way adaptation in time will become an important focus per group. The six groups will thus work with six project ideas at the unit scale and a basic idea of combination of units within the sketch design phase.

Each group is required to develop a thorough understanding of the design assignment and project context and propose an architectural concept based on that understanding. Instead of thinking in terms of a fixed functional program, students are encouraged to address spatial affordances and address directly the dynamic activities of present and future building inhabitants. The students are encouraged to investigate different spatial configurations of the proposed units, like horizontally arranged, vertically stacked, closely packed, spherical, loosely bound.

At the end of week 8 the configurations of all group projects and ideas will be presented in the form of a slideshow presentation containing sketches, 3D models, operational and conceptual diagrams, and early working prototypes of building components. Special attention will be drawn to fabrication methods and materialization of both the structural components and the versatile interior components. Apart from this, the usability of the ideas from an inhabitant's perspective will gain paramount importance within the critique sessions.

Phase 3: Three proposals for design development [Week 10-12]

Following an intermediate evaluation of all designs by a jury consisting of tutors and guests, only three of the selected project concepts will be chosen for further development. This evaluation is preliminarily scheduled on

19/04 and will take place in Protospace and in the weeks following the evaluation two groups of 18 students will be formed to proceed with the task to combine the most promising of the presented concepts of the initial two groups of students dealing with a combination of complex geometry and complex behaviour into two explicit design proposals, hereby following the advice of the intermediate jury panel. Each student will be assigned a specialized task in the design development of the two merged design proposals. Students will be asked to chose to be a structural designer, a stylist, a climate designer, a real estate developer, a user, a cost surveyor, a manager, etc. and develop the design from that specialized perspective.

Phase 4: One single design for the execution design [Week 13-16]

End of week 12 a jury will select one single winning project that will be further developed as a full-scale prototype. Students will cooperate to develop details and mechanisms for the project in accordance with their specializations and will consult the workshop tutors (from Phase 1) for expert advice on realizing the project.

Phase 5: Production [Week 17-20]

CNC produce the various building components, both for the structural components as for the versatile interior components. Materials that are currently considered are EPS foam produced with Hyperbody's ABB robots at the RDM Innovation Campus and sheets of plywood shaped by Hyperbody's flatbed CNC milling machine at the Delft Science Centre and the Hyperbody's laser cutter at the DSC. The design studio ends with the presentation of a working, full-scale prototype of one single multimodal unit. This will be the most intensive but also the most rewarding phase of the studio and will be concluded with the final evaluation preliminarily scheduled to take place on 28/06 in Protospace.

Expert tasks during the design development and execution phases

1 The stylist: The stylist designs the overall form and articulation and imposes intention and emotion to the otherwise undefined shape.
2 The structural designer: Architecture must be fully synchronized with structure, structure design and surface design perform best when working together.
3 The manufacturer: Designing with complex surfaces and smooth styling induces the necessity for a new attitude towards production. Mass production is passé, mass customization is the new paradigm. Series of the same are no longer beautiful; the new aesthetic of parametric architecture naturally favors series of one-offs.
4 *The material designer:* The material expert is responsible for researching and supplying performative materials, implementing an educated choice.
5 The interaction designer: Interaction design is explicitly a design discipline constructing the way the users exchange - minute to minute - a variety of personal intentions with the immediate built environment.
6 The climate expert: The mechanical, electric and plumbing designer [MEP] takes care of all installations of the building, embedded in the swarm of individual building components.

Apart from these six experts, each student should inherently assess and evaluate their outcomes from a user's point of view. Reality checks with your own perception of how, why and when would your designed spaces be utilized to the fullest should always underpin your design developments.

Basic recommendations for the design proposals

Dry assembly: The structure should not rely on fixed foundations, be fit for assembly and disassembly, and in pre-assembled state fit into sea containers.
Scripting: In all aspects the project should be designed with an eye on script-ability, i.e. the capacity of the designed structures to be generated and handled by scripted algorithms.
CNC Fabrication: In order to minimize manual steps in the production and assembly of the 1:1 prototype, CNC fabrication methods should be employed.
Lean approach: The project should be lean in multiple ways. This includes the efficiency of the design process, the immediate communication between experts, the method of assembly, the adequate use of material, excellent energy performance, and the adaption to environmental conditions.
Design Information Model: The building must be designed as an information system, which spans from the earliest design sketch to CNC fabrication and streaming interactivity.
Buildable. Special attention has to go into smart solutions, which simplify and minimize labor, in terms of time, effort, costs, space, workforce, waste, and so forth.

Affordable: Design choices should be linked to cost control spreadsheets to design within a given budget.
Awesome: Above all, the design proposal should be an appealing structure, generating a flock of viewers on YouTube.
Useful: The design should be useful for the inhabitants. it should impart a feeling of ease, comfort and should tempt them to own it.

MSc 2 Architectural Studies [AR0851, 6 ECTS] - 1:1 Interactive Architecture Prototypes

The MSc 2 Architectural Studies workshops are preparatory courses for the design and fabrication of the multimodal apartment. We have defined some basic principles that frame the workshops:

- The apartment is an assembly of a swarm of substantially big building components
- We start with base materials like sheets of plywood [1,5 x 3m] and blocks of EPS foam [1x1x4m]
- We design as to minimize the number of transformational operations on the base material
- The building components are as big as possible using the CNC machines and the robots
- The building components are assembled using dry assembly techniques
- The building components are individually demountable
- Some key building components will be adaptive/interactive while others remain static in their behavior

Workshop A [week 2] Tutor Jelle Feringa [PHD Hyperbody], Vera László [programmer Hyperbody]
Robotic Fabrication: This workshop will focus on robotics-supported design to fabrication processes of geometrically complex architectural structures. The workshop takes place at Hyperbody's robotics lab at RDM in Rotterdam and will enable students to explore large-scale robotic fabrication and provide insights into the production processes of robotic fabrication. For a video impression of earlier workshop held at Hyperbody's robotics lab, please have a look at this link.

Workshop B [week 3] **Tutor** Jia Ray Chang: [PHD Hyperbody], Vera László [programmer Hyperbody]
Interaction Design: This workshop will focus on the usage of sensing and actuation systems for real-time spatial and ambient adaptation. Intricacies of programming as well as hardware and their networks shall be explored in relation to the agenda of the studio. Students will be encouraged to produce one prototype per group of an envisioned real-time adaptation case.

Workshop C [week 4] **Tutor** Christian Friedrich: [PHD Hyperbody], Vera László [programmer Hyperbody]
Physical Computing: This workshop will focus on establishing creative linkages between fabrication and interaction routines from a perspective of enhancing participation and optimized usability of architectural spaces by their end users.