Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Tiwanee van der Horst
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Studio	
Name / Theme	Explorelab
Teachers / tutors	Robert Nottrot, Martijn Stellingwerf, Jan van de Voort, Ad van Wijk
Argumentation of choice of the studio	For my graduation I wanted to design a building that would address contemporary issues within the architectural practice regarding climate change and urbanization. I got inspired to research the potential of 3D printing with bio plastic and its application in architecture. The Green Village offered the possibility for construction after graduation. The freedom of choice and organization provided by Explorelab facilitated the possibility to pursue a project like this.

Graduation project	
Title of the graduation project	**The City as Canvas, Architecture as Painting | An intuitive approach to 3D printing**
Goal	
Location:	The location could be in any complex leftover space in densifying urban settlements. As a case site I will design for the Boomgaardhof intersection with the Oude Binnenweg in Rotterdam.
The posed problem,	Rapidly increasing urbanization leads to a growing need for housing in dense cities. Raw material resources are running out and space for housing is becoming scarce, therefore we need to redefine unused, leftover space and decrease the usage of raw material in housing construction. Current construction methods are labor, cost and time intensive and account for a significant amount of raw material waste. Prefabrication methods have tried to solve some of these problems often making architecture monotone and standardized. 3D printing could be a solution in solving these problems. The technology, however, still needs a lot of improvement before it can be used for architecture that works in a circular economy.
research questions and	How can 3D printing houses with bio plastic give new meaning to complex leftover spaces in times

	of depleting material resources and spatial scarcity? How can painting techniques improve 3D printing methods for architecture?
design assignment in which these result.	

This research project investigates how 3D printing houses with bio plastic can give new meaning to complex leftover spaces in a time where raw material resources are scarce and space for housing is decreasing. By defining the architectural potential of 3D printing and bio plastic I seek to elicit a reaction in the field of engineering and material science in order to accelerate developments towards a new synergetic architecture that coincides with the development of its time.

A left over space in the densifying city center of Rotterdam will be given new meaning by making space for future urban dwellers. The possibility of making unique and complex shapes provided by the material and the technology is explored to its full potential on this location that would otherwise have been uninhabitable due to the remaining shape and size. The leftover space spread around the city provides an unexplored canvas full of new housing potential. Exploration on painting techniques present possible improvements on the existing 3D printing method, making a step towards 3D painting. The design of the house presents the opportunities of 3D painting by linking brushstrokes, painting and blending techniques to functions of the house, its enclosure and the connection with the existing structures. The house provides shelter for a working individual making use of a minimum amount of space. Minimum requirements are a place to sleep and stay.

Process

Method description

Firstly the research defines a new way of urban living from an architectural perspective driven by developments in 3D printing and bio plastic. These contemporary issues will provide the framework for further research on **the architectural potential** of this new manufacturing method to work towards a circular economy.

Secondly fused deposition modeling and bio plastic is positioned in relation to **the architectural practice**. The discussions and interviews between students, researchers and practicing architects being held at the InDeSem week present an overview of the potential impact on the architectural practice.

The architectural language is further explored through the materialization of plastic through fused deposition modeling. This is done through form studies printed through fused deposition modeling on an XYZ coordination plane. Here the research elaborates on the comparison with other additive manufacturing methods such as brick laying, concrete pouring, clay throwing and painting.

The research continues on the level of painting and investigates the possible application of painting techniques, brush strokes and blending methods in architecture to improve 3D printing methods.

The results will be put into practice through the design on the specific location on the Boomgaardhof, a side street of the vibrant Oude Binnenweg in the city center of Rotterdam.

Literature and general practical preference

- *Ad van Wijk & Iris van Wijk – 3D printing with bio materials.* This book describes the potential for 3D printing houses with bio plastic on a scientific level.
- *Arnoud van der Veen - 3D Print Canal House ; The Structural Feasibility of 3D-printing houses using printable polymers.* Research project describing the relevance of designing 3D-printed houses in order to accelerate material science for structural feasibility.
- *Bram van den Haspel – 3D printing buildings.* Specialist researching on improving 3D printing methods and designing 3D printed building elements for housing, working towards cost and time efficiency of 3D printing a house, in collaboration with DeltaSync.
- *InDeSem '15 re.Craft.* International Design Seminar addressing the impact of emerging technologies on the architectural practice. Personal interviews with participating students, lecturers (specifically Leonel Moura, Kathrin Dörfler and Moritz Dörstelmann) and tutors.
- *Franziska Ullmann – Basics; the phenomena of form.* This book deals with basic architectonic elements, their meaning and effect based on the views of Wassily Kandinsky and Paul Klee.
- *Malcolm McCollough - Abstracting Craft.* This research describes the investigation of the changing relation between hand, eye and tool showing the correspondence between digital work and traditional craft.
- *Manfred Mohr – Der Algorithmus des Manfred Mohr*. Research on 2D printing art based on algorithms.
- *Michiel Riedijk – Architecture as a Craft: Architecture, drawing, model and position.* Theory on design methodologies guided by the drawing and the model.
- *Stavros Gargaretas - Zero Wasted Space.* Research project based on the minimum needed space for users.
- Painting techniques

Reflection

Relevance

Changes are taking place globally and locally; the critical situation of global economics and the increased fragility of society have shifted focus towards more concrete and problematic issues of today. Such as the growing need for urban housing and environmental change. It brings about change in environmentally ethical attitudes of the architect towards the available materials and tools, resulting in a synergetic new architecture.

3D painting; enabling abundance in times of scarcity addresses an extreme future scenario for housing in a society in which material and space have become scarce. By highlighting the architectural potential and proposing a new printing method derived from existing painting techniques, I seek to elicit a reaction in the field of engineering and material science, in order to accelerate developments towards a new architecture addressing **scientific, social** and **environmental** relevance.

Time planning

Time planning

(Based on 2014-2015 and 2015-2016 academic calendar)

February (week 7-9)
Week 7: Introduction Explorelab
Week 8: Define preliminary research question, Elevator Pitch
Week 9: Literature references and positioning within framework

March (week 10-14)
Week 10: Specialist interviews, Gilbert Curtessi. Work on chapters Technology and Material
Week 11: Interview Bram van den Haspel, Marcel Bilow. Choosing design and research tutors.
Week 12: Work on chapters
Week 13: Define design research methodology and print first form studies 1:100. Interview Bob Geldermans.

April (week 15-18)
Week 14: P1 presentation
Week 15: Bio based economy congress, write about potential of bio plastic application in architecture. Print studies 1:100.
Week 16: Interview Adrian Ravon. Define design research framework for form studies. Write hypothesis InDeSem '15.
Week 17: Wicked Workshop

May (week 19-22)
Week 18: Write hypothesis form studies.
Week 19: Print studies 1:50.
Week 20: Research possible grasshopper application within design
Week 21: Research digital tool and the possibility for using algorithms in design.
Week 22: Prepare InDeSem. Theoretical and practical research on materiality and plasticity. Build own 3D printer.

June (week 23-26)
Week 23: InDeSem '15 interviews and observatons, Print studies 1:50. Future visions on the impact of digital fabrication on the architectural practice. Opportunities, disadvantages and challenges for digital fabrication in architecture. Define design location and concept based on research results.
Week 24: Process research results into chapters. Present ideas on the materiality printing method. Interview Leapfrog.
Week 25: **P2 Presentation** – present form studies, research observations, paintings, location, design assignments.
3D scan location.
Week 26: Summer break

July (week 27-30)
Week 27: Summer break
Week 28: Summer break
Week 29: Summer break
Week 30: Comparison brush and nozzle, painting techniques. Start design.

August (week 31-35)
Week 31: Continue form studies in prints, painting, clay and other modeling method to test the design possibilities through painting 1:50
Week 32: First attempts of scaling up form studies to 1:20 in relation to design.
Week 33: Process results in chapters and design
Week 34: Second iteration form studies 1:20.
Week 35: Rethink ideas on the materiality and build up of façade elements in functional layers of the PLA, additives and needed printing method.

September (week 36-40)
Week 36: Process results into design.
Week 37: Concept building technology.
Week 38: Further development of design.
Week 39: Process design obstacles into research report.
Week 40: Develop a desired design and printing method. Perform LCA. Finalize research report. Print model 1:50 and detail 1:20.

October (week 41-44)
Week 41: Develop building technology concept.
Week 42: Concept drawings of materiality.
Week 43: Develop technical drawings 1:20.
Week 44: **P3 Presentation** – show the potential of the 3D painting method for specific case.

November (week 45-48)
Week 45: Develop technical drawings 1:5.
Week 46: Develop digital model with detail. Print test models 1:20.
Week 47: Present technical drawings (1:20, 1:5) Develop presentation of possible construction process for scenario present and future.
Week 48: Finalize design. Print model 1:200.

December (week 49-52)
Week 49: **P4 presentation** – explaining the printing process and materiality of the design. Situation (1:500), series of drawings showing house (1:50), technical details (1:5) printed models 1:20, 1:200.
Week 50: Prepare final files for printing.
Week 51: Print final models.
Week 52: Christmas break
Week 53: Christmas break

January (week 1-5)
Week 1: Finalize drawings and details
Week 2: Development of final models and illustrations of 3D painting method.
Week 3: Finalize report and presentation.
Week 4: **P5 presentation** – Final presentation showing the potentials of 3D painting through the design.