

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

! USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !



family name Hoorn
initials L given name Lorenzo
student number 4489862
street & no. _____
zipcode & city _____
country _____
phone _____
email _____

Your master programme (only select the options that apply to you):

IDE master(s): ☒ IPD ☐ Dfl ☐ SPD

2nd non-IDE master: _____

individual programme: _____ (give date of approval)

honours programme: ☐ Honours Programme Master

specialisation / annotation: ☐ Medisign

☐ Tech. in Sustainable Design

☐ Entrepreneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair Faludi, J.J. dept. / section: SDE / CPD
** mentor Essers, T.T.W. dept. / section: SDE / MD
2nd mentor Gerbert Smits & Joep Grapperhaus
organisation: 10 XL
city: Hardinxveld-Giessendam country: The Netherlands

comments (optional) Gerbert Smits (CEO) and Joep Grapperhaus (CTO) will both supervise me at the company as a team and help me with their expertise.

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..



Second mentor only applies in case the assignment is hosted by an external organisation.



Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair _____ date ____ - ____ - ____ signature _____

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC

Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC

List of electives obtained before the third semester without approval of the BoE

☐ YES all 1st year master courses passed

☐ NO missing 1st year master courses are:

name _____ date ____ - ____ - ____ signature _____

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ☐ APPROVED ☐ NOT APPROVED

Procedure: ☐ APPROVED ☐ NOT APPROVED

comments

name _____ date ____ - ____ - ____ signature _____

Exploring the possibilities of 3D printing with WPC on large scale printers project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 15 - 02 - 2021

05 - 07 - 2021 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

3D printing is a rising star in the field of manufacturing and design. It is developing rapidly in means of technique and materials that can be used. This fast and versatile production method is largely known from its desktop size, but during this project, a large scale industrial robotic arm will be used. During this research in collaboration with the 3D printing company 10XL, their printers will be used to explore the possibilities of large scale additive manufacturing (AM) with a wood fibre based compound they developed from a waste stream. The objective is to gain knowledge about printing with this novel material and eventually 10XL hopes to find implementations for manufacturing product for their (future) clients.

The 3D printers used by 10XL are composed of a large industrial pellet extruder, that is connected to a heated hose to a large diameter nozzle. The nozzle is installed on a large industrial robot arm, which will follow the path that is generated on the computer. Using conventional CAD and slicing software (Rhino & Simplify3D) to generate the G-Code, a post-processor software called Eureka is necessary to make it readable for the robot. The result is a print with thick layers (around 2-4 mm and taking about 100 seconds per layer) that can be post-processed or even CNC milled.

With their printers, 10XL is capable to print large object within a 2x2 meter plane. Printing layers in a horizontal face, they can go up to a height of 2 meters. If they set up the robot to extrude layers at a 45-degree angle, it is even possible to manufacture objects as long as 10 meters. Currently, most of the production done by 10XL is only printing the outside contour of a model. No infill, no support and no initial layers are printed, just the outside shape. However, as they are growing, they try to explore more ways of using their machines.

Although 10XL is still a young company, they are widely invested in developing new opportunities for large scale printing. A selection of their projects is improving the nozzle, continuous fibre and developing new printing material. The latter one being the research field for this graduation project. Currently, almost all of the prints are made from recycled polymers filled with short glass fibres. In the past year, 10XL developed (in collaboration with Volker Wessel construction company) a wood plastic compound (WPC). Printing with wood is already implemented for small desktop printers, by using PLA filament which is filled with 30% wood fibres. On a large scale it is still new and innovative, plus the pellets that were developed consists of almost 70% wood. Little is known yet about the technical aspects, its (fire)safety and the overall experience of the material. The goal now is to explore the possibilities of printing with WPC on a large scale and research what its environmental impact will be.

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introduction (continued): space for images



image / figure 1: One of the robotic printers used by 10XL for production



image / figure 2: Printing with wood is already possible for desktop printers using wood filament

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Up until now, the company has only developed the new wood compound pellets, which they can feed into the printer. However, they are not able to print anything with it yet. There are still some important questions that need to be answered before the material can be turned into products. The initial and most important research questions will be:

How can WPC be printed?

What can be printed with this wood compound?

It is important to start exploring what is possible for using WPC pellets with large scale printers. Little is known yet, so first the technical and experiential characteristics of the material must become known. Only then, feasible printing opportunities can be further explored. In this phase, two different situations will be looked at:

How can printed WPC replace objects/structures normally made of wood?

How can printed WPC be used as an alternative material in designs?

In both situations, the sustainability of this production method in combination with the material must be analysed. 3D printing takes up a lot of energy, so the question rises if it is environmentally beneficial to print with wood waste on a large scale and if we should even try to replace parts made of wood with WPC? Furthermore, in which of the two referred aspects this printing technique can be best implemented. Overall, this novel material production technique must have a positive impact.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Explore and develop the opportunities to use WPC to print on large scale industrial 3D printers. The aim is to use materials based on wood or other cellulosic waste in a way it is beneficial to the design experience and measure how much it can improve the sustainability of manufacturing.

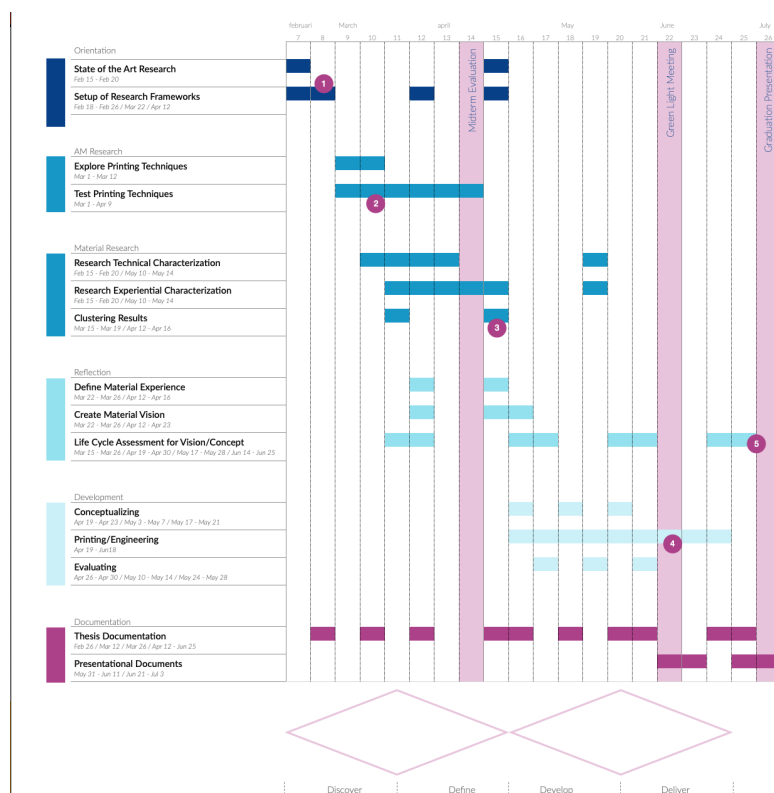
PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 15 - 2 - 2021

5 - 7 - 2021

end date



During this project, the goal is to discover what the possibilities are for large scale printing with this compound that consists substantially out of wood. Moreover, taking into account that using sawdust as the material source for making this compound and printing it with a large industrial robotic printer is sustainable beneficial.

To do so, the starting point of this project will be the material. Using the Material Driven Design (MDD) method as a guide in this experimental product design research, the aim is to get an understanding of the material's characteristics (Technical and Experience) after printing. By 'tinkering' with the material, new knowledge about the WPC must be discovered. From the results of this phase, a material experience can be defined by doing a variety of (user) tests.

While conceptualizing a valuable representation of the results in the second phase, a Life Cycle Assessment (LCA) will show how much environmental improvement there is (or is not) with this material-production combination. This is determined by comparing it to alternative production methods and materials to print with. Eventually, the final result must be a further developed material concept that is sustainable and can be implemented into large scale robotic additive manufacturing.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

This project was partly set up while I was doing my internship at the 3D printing company 10XL. My affection for novel technology was the main reason I wanted to learn more about this developing production method. During my Master program, I have learned more and more about 3D printing and the endless possibilities that are being researched. I became curious and started to research what was possible beyond just prototyping with PLA. In my three months as an intern at 10XL, I saw how much more was possible in the field of large scale 3D printing. This was when I knew I wanted to contribute to this and do my master thesis in this research area.

For me as a master student IPD, 3D printing is the perfect combination of technology, material and design. My goal is to prove my competences on the technical aspects, like mechatronics and modelling. During my exchange period at AALTO University in Finland, I have developed my skills in the area of Design Experience and Design Experimentation. Therefore, I will approach this project in this way of tinkering and experimental thoughts. Testing my new skills in combination with the overall competences I learned during my Bachelor and Master at TU Delft. To deliver a novel way of producing in the field of Industrial Design.

Furthermore, some extra focus will be put on running the project. Keeping the planning up to date and making deadlines. I want to challenge myself to use the lean project planning and keep a structured working process that is clear to communicate.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.