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**ETH** zürich

**MAS ETH in Architecture and Digital Fabrication**

Academic year 2022-2023



Institute of Technology in Architecture  
Faculty of Architecture | ETH Zürich



**d6** National Centre of Competence  
in Research  
Digital Fabrication



**FNSNF**  
SWISS NATIONAL SCIENCE FOUNDATION

Academic year 2022-2023

## **MAS ETH in Architecture and Digital Fabrication**

[www.masdfab.com](http://www.masdfab.com)

### **MAS Programme Co-organizing Chairs**

Digital Building Technologies

- Prof. Benjamin Dillenburger

Gramazio Kohler Research

- Prof. Fabio Gramazio, Prof. Matthias  
Kohler

### **MAS Programme Coordinators**

Petrus Aejmelaeus-Lindstrom - GKR

Yael Ifrah - DBT

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**Digital fabrication is set to revolutionise architecture. The seamless integration of digital design technologies and physical construction processes is paving the way for the realisation of new designs paradigms. ETH educates a new generation of collaborating architects, engineers and designers eager to define the future of architecture.**

# MAS ETH in Architecture and Digital Fabrication

The Master of Advanced Studies ETH in Architecture and Digital Fabrication is a one-year full time educational programme positioned within a vibrant multidisciplinary research environment. Jointly organised by the Chair for Digital Building Technologies and Gramazio Kohler Research it enjoys strong links with the Institute of Technology in Architecture (ITA) and the Architecture Department (D-ARCH) of ETH Zurich. Furthermore, the MAS is the educational programme of the National Centre for Competence in Research (NCCR) Digital Fabrication, one of the biggest and world leading interdisciplinary research clusters on digital fabrication and robotics in architecture.

## Focus

The MAS ETH in Architecture and Digital Fabrication teaches advanced methods and technologies at the forefront of digital design and fabrication and their implementation in architecture and construction. With a focus on computational design, robotic fabrication and 3D printing, projects and assignments enable students to develop strong design concepts and realise large-scale prototypes using the unique robotic construction facilities and 3D printing laboratories at ETH Zurich. Courses are designed not only to teach a thorough understanding of computation and digital fabrication in architecture but also to foster students' understanding of how new technologies, materials and processes contribute to an advanced and sustainable construction culture.

## Perspective

Participants develop strong competences in digital design and fabrication, enabling them to take leading positions in the field of architecture, construction, innovation development and production management. Knowledge of and experience with advanced fabrication equipment, as well as innovative design technologies, position participants as cutting-edge practitioners in the field. The MAS programme facilitates regular interactions with leading representatives from academia, industry and practice, providing participants with insight and access to a network that will prepare them for both practice and further studies.



Mid-term student presentations in Arch\_Tech\_Lab, December 2016  
© MAS in Architecture and Digital Fabrication, ETH Zurich

# People

The MAS ETH in Architecture and Digital Fabrication is organised jointly by Digital Building Technologies and Gramazio Kohler Research groups. Professors, researchers, PhD students, post-docs and senior scientists of both groups contribute and teach in the programme throughout the year.

## Digital Building Technologies

### Prof. Benjamin Dillenburger

Prof. Dillenburger is Professor for Digital Building Technologies at the Institute of Technology in Architecture (ITA) at the Department of Architecture, ETH Zurich. He was previously appointed as Assistant Professor at the John H. Daniels Faculty of Architecture, Landscape and Design at the University of Toronto, and worked as a senior lecturer in the CAAD group at the Department of Architecture at ETH Zurich. He holds a Master of Advanced Study degree from ETH Zurich and a Master of Architecture Degree from the Technical University Kaiserslautern.

The Digital Building Technologies group researches in new building technologies based on the seamless integration of dig-

ital design and fabrication methods. In this context, DBT investigates additive manufacturing strategies in architecture, which have the potential to challenge traditional paradigms of construction. DBT focuses on the specific performance and tectonic possibilities of high-resolution 3D printing processes. The aim is not only to rationalize the fabrication process and improve the quality of buildings, but also to open up radically new design-solutions.



Structural Oscillations, Venice Architectural Biennale 2018  
© Gramazio Kohler Research, ETH Zurich

## Gramazio Kohler Research

### Prof. Fabio Gramazio, Prof. Matthias Kohler

Fabio Gramazio and Matthias Kohler are architects with multi-disciplinary interests ranging from computational design and robotic control and fabrication to material innovation. In 2000, they founded the architecture practice Gramazio Kohler Architects, where numerous award-winning designs have been realised. Their built works include international exhibitions, private and public buildings, and large-scale urban interventions.

As professors, Gramazio and Kohler developed the first architectural robotic laboratory at ETH Zurich. The ensuing research has been highly influential in the field of digital architecture, setting precedence and initiating a new research field focusing on the integration of industrial robots in architectural design and construction. They have contributed to numerous exhibitions around the world, such as the 2008 Architectural Biennial in Venice, the Storefront Gallery for Art and Architecture in New York in 2009, Flight Assembled Architecture at the FRAC Centre Orléans, and the 2015 Chicago Biennale. Their work has been widely published and is comprehensively documented in their publication *The Robotic Touch – How Robots Change Architecture*.



Arabesque Wall, 3D printed silicate with binder, 800 kg  
© Digital Building Technologies, ETH Zurich

# Curriculum

## SCHEDULE

The MAS in Architecture and Digital Fabrication is a comprehensive one-year full-time programme. It is structured in trimesters:

Trimester 1 - Skills

Trimester 2 - Design & Fabrication

Trimester 3 - Research

The MAS is run jointly by two co-organizing Chairs: DBT - Digital Building Technology, and GKR - Gramazio Kohler Research.

### Trimester 1 - Skills

The first trimester is dedicated to skilling and teaching. Lectures, tutorials and workshops are conducted on a day to day basis by both co-organizing Chairs (DBT and GKR). Courses are designed so students with different experience can follow and quickly build up skills in regard to coding (python) and fabrication. Small design projects allow for the application of newly gained knowledge and control.

September to December

### Trimester 2 - Design & Fabrication

The second trimester is dedicated to designing and building at 1:1 scale. It is split in two parts each constituting a separate but complimentary integrated Project - one with a focus on 3D printing technologies, the other with a focus on robotic fabrication. This will enable the students to apply the knowledge gained in the first trimester on a large-scale fabrication project and at the same time to deepen certain topics within the field. Students work collaboratively on all aspects from design to digital / robotic fabrication of their 1-1 scale structure.

January to June

### Trimester 3 - Individual Master Thesis

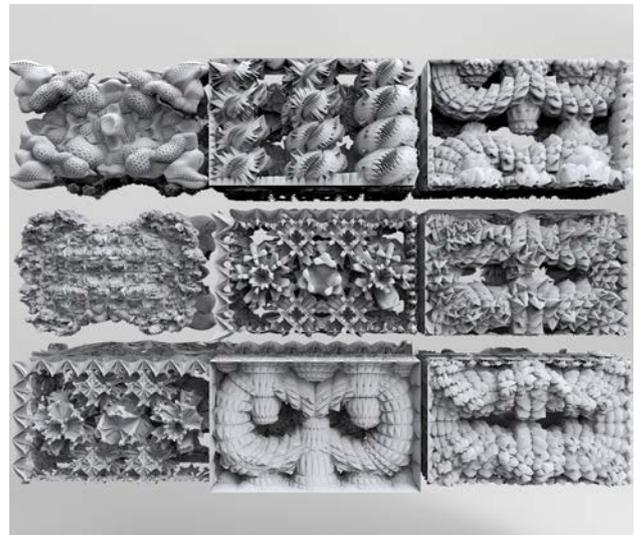
In the third term of the MAS programme, students focus on developing their own research thesis, working individually or in groups of two. In line with the programme, students select a research brief in the field of robotic fabrication processes and 3D printing technologies. Closely supervised by researchers of Gramazio Kohler Research and Digital Building Technologies, students work from a research brief to physical output demonstrating their achievements. Through a series of experiments, students gradually refine their arguments, familiarising themselves with the rigour of academic research, while at the same time contributing to ongoing research. The individual thesis work is condensed in a written thesis and presented in front of a jury of international experts.

June to September

## FOCUS AREAS

### Computational Design

Computational design refers to specific methods and techniques employed in design and architecture, in which algorithms play a fundamental part in the creative process. Parametric modelling has become common use as a method that allows for flexible, adaptable and dynamic design approach responding to variable design input. How such models are structured has a significant impact on their usability and capacity to adapt to design changes. Geometrical topology, hierarchy and non-hierarchical concepts of parametric modelling will further enable students to develop powerful parametric modelling approaches. Teaching programming skills stand at the very heart of the MAS Digital Fabrication. From design to fabrication programming skills will not only drive the design but also establish effective and fast production pipelines. The students will gradually build up skills from the very basic concepts to programming skills including procedural, imperative and functional programming (Python, Grasshopper, Processing, Arduino, UR script, RAPID etc.)



Algorithmic mesh subdivision process done with Processing  
© MAS in Architecture and Digital Fabrication, ETH Zurich

### 3D Printing

Additive manufacturing promises non-standardized construction and nearly unlimited complexity at no extra cost. One strand of the MAS programme will explore new applications of 3D printing in building construction. Based on the tectonic logic of 3D sand printing, new construction systems for integrative building components can be developed. The focus is not only the design of the outer form but also the inner structures of those components to generate functionally graded elements in high resolution. These explorations will be related to the study of traditional prefabricated building components. The students will work with customized algorithmic design tools and materialize designs both as prototypes as well as full scale 3D prints.



© Digital Building Technologies, ETH Zurich



© Gramazio Kohler Research, ETH Zurich

### Robotic Control

Industrial robotic arms can be considered as one of the universal tools of the digital age having been instrumental in shaping the notion of digital materiality. Their ability to position building material very precisely at a desired location and with a given orientation has allowed for the construction of large scale complex spatial structures at unprecedented precision and speed. The MAS Digital Fabrication will teach the basics of robotic control and tool-design, including mechanic and electronic requirements for specific fabrication tasks. Students will make creative use of the acquired skills on modelling, scripting and fabrication exercises, and develop their own robotic coordination, path planning and kinematic simulation. The MAS provides a setup of six UR5 industrial arms as well as a ABB dual robotic setup to author spatially complex, non-standard control and assembly processes. As a unique laboratory the new Robotic Fabrication Laboratory with four cooperating ABB robotic arms suspended from a gantry covering a working area of 45 x 17 x 6 meters will also be accessible for the MAS.

### Material processing

The relationship between the raw material, material production and advanced material processing are vital to the creation of material-informed design processes. Through a deeper understanding of material capacities, assembly systems and joining details, a highly differentiated use of material and fabrication process can be enabled. Students will investigate an array of available materials used in digital fabrication, their material properties and related state-of-the-art fabrication technologies. The application of the acquired knowledge will be trained in practical fabrication exercises producing both small and large scale prototypes.



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# Activities



© NCCR Digital Fabrication

## ETH, ITA and NCCR Community

MAS participants will be supported by the broader community of ETH, ITA (Institute of Technology in Architecture) and NCCR (National Centres of Competence in Research) researchers throughout the course of study. Doctoral researchers working within the ITA bring a wide range of expertise and interdisciplinary knowledge to the programme. When complimentary topics or interests are identified, PhD researchers may take on a mentoring role for MAS students or projects. PhD researchers support the skill development of the MAS students while also providing exposure to a research environment and academic standards, preparing MAS students for a potential career in academia.



© MAS in Architecture and Digital Fabrication, ETH Zurich

## Lecture Series

A series of lectures featuring leading minds from practice, industry and academia will provide important external input and a forum for discussion within the MAS, but also for the broader ITA research community. The lectures are intended to bring experts together for discourse and exchange on topics pertinent to digital fabrication in architecture as well as to provide a forum to discuss the broader cultural, technological and practice related implications of digitalisation in architecture. In the past years guests have included Neri Oxman, Xavier de Kestelier, Nader Tehrani, Philip Yuan, Geoffrey West and others.

## Excursions and events

Excursions will be organized to visit architectural sites, leading companies and other schools. These events will be a fundamental part of the curriculum and are designed to broaden the students' experience, inform their course work and provide opportunities for networking and collaboration.

# Facilities

The MAS in Architecture and Digital Fabrication has access to a unique range of study- and fabrication-related resources.

## MAS Cluster

MAS students will have their permanent working spaces in a dedicated space inside Arch\_Tech\_Lab, the MAS Cluster. Arch\_Tech\_Lab is a state of the art building opened in September 2016 on ETH Höggerberg campus that houses all ITA professorships (Institute of Technology in Architecture), their researchers, PhD students as well as MAS DFAB students. Aside from working desks, the MAS Cluster is equipped with six small-scale industrial robot arms UR5 which will be used for teaching and project development purposes. They are used exclusively by MAS students with the ratio of three students per one robot. The Cluster is also equipped with several FDM (fused deposition modelling) 3D printers used during the class for printing designs and tools. Additionally, shared as well as personal tools and equipment is available for students to streamline their work on physical models and prototypes.

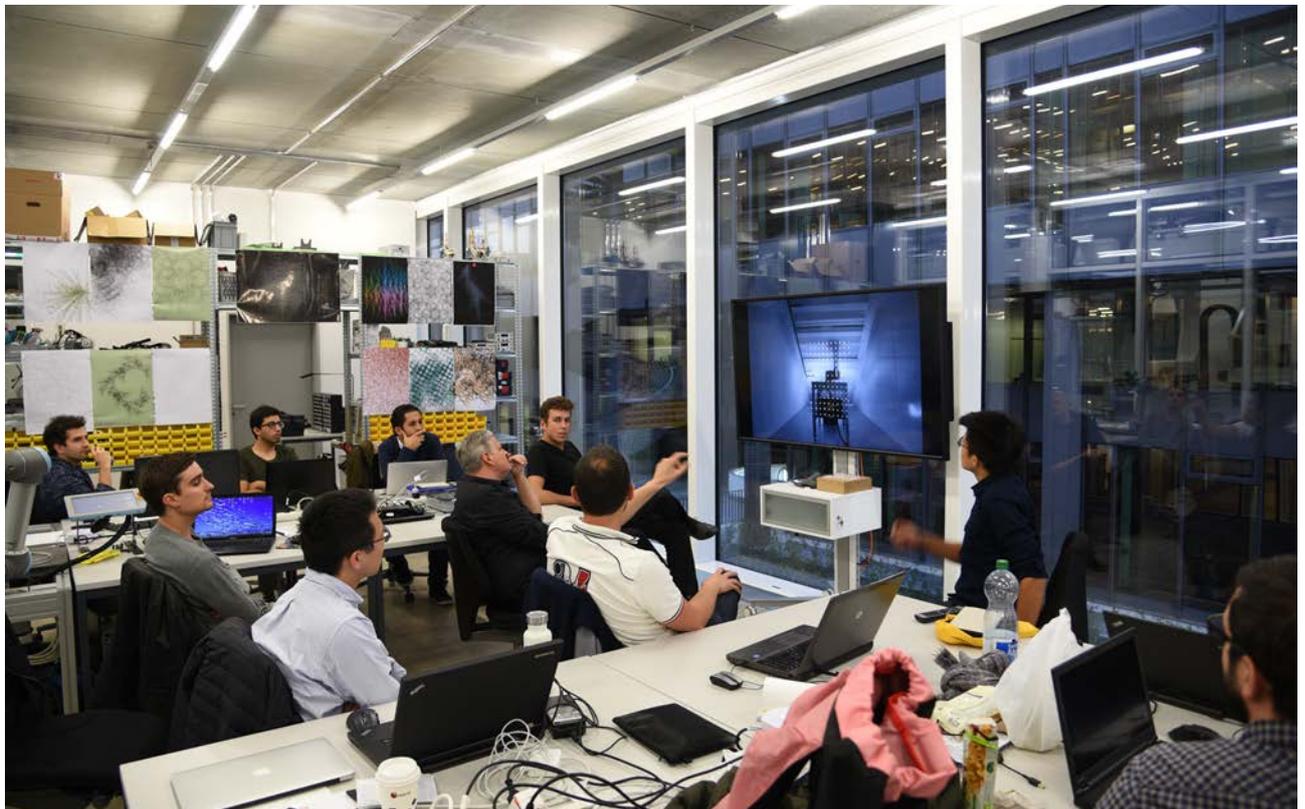
## Robotic Fabrication Lab - RFL

During integrated project weeks the students will be able to access the large-scale robotic facility inside Arch\_Tech\_Lab - Robotic Fabrication Lab. It consist of a unique robotic setup with

four ABB industrial arms mounted on a hall-sized gantry system. The use of this setup is restricted to researchers with a potential of student projects being developed on the system under planned supervision. Nevertheless, the use of this setup is subject to yearly MAS project planning as well as to the ongoing ITA projects and will vary from year to year. RFL also houses a dedicated large-scale twin ABB robot setup mounted on a single linear axis. This setup can be used by the MAS students during teaching, planning and execution of their large scale projects. The actual use of the setup is planed together with the MAS teaching team according to the yearly schedule. The RFL also accommodates a separate space with multiple 3D printers (stereo-lithography SLA, digital light processing DLP, fused deposition modelling FDM) which can be used by MAS DFAB students.

## ETH Zurich RAPLAB

The ETH Zurich RAPLAB is the basic fabrication facility of the Department of Architecture (DARCH). It houses laser cutters, a ZUND cutting plotter, a vacuum former, a 3 axis CNC mill, cement and wood workshops, and access to professional specialists. The facilities and equipment are available to all ETH Zurich students. The MAS students will receive an introduction into the use of RAPLAB facilities and machines at the beginning of the programme.



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# Requirements

## Target group

The MAS in Architecture and Digital Fabrication programme is designed for university graduates from Switzerland and abroad. The MAS will accept qualified applicants who are specifically interested in improving their skills and gaining experience in the areas of advanced digital design methods, digital fabrication and the application of robotics and 3D printing within construction and architecture.

## Requirements

A master's degree in architecture or engineering recognised by ETH Zurich, or an equivalent educational qualification (i.e. a bachelor's degree and a minimum of two years of professional experience in a directly related field) is required. Also required are proof of creative design skills and technological capabilities. Documents submitted with the application and a portfolio review will be used to assess a candidate's qualification.

## Language

All instruction will occur in English. All applicants are expected to be highly proficient in English (spoken, written and reading). Interviews may be requested to evaluate a candidate's language abilities.

## Tuition fees

Tuition for the course is CHF 13,500. Fees and administrative costs are CHF 1,460 for three trimesters.

The total for the programme is CHF 14,960.

## Credits

The MAS in Architecture and Digital Fabrication provides 60 credit points according to the European Credit Transfer and Accumulation System (ECTS), a standard for comparing university studies within Europe. This corresponds to one academic year or 1,500–1,800 hours of study.

## Accreditation

Students who successfully complete the programme receive their Master of Advanced Studies ETH in Architecture and Digital Fabrication (MAS ETH DFAB). A diploma supplement is issued together with the MAS certificate according to the guidelines laid out by the Rector Conference of Swiss Universities.



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# Application

The School for Continuing Education is responsible for all applications for admission to MAS programmes. The application process opens on January 10th 2022.

Please submit your application via the online eApply ([www.lehrbetrieb.ethz.ch/eApply](http://www.lehrbetrieb.ethz.ch/eApply)) and pay the application and handling fee using your credit card.

Candidates will be informed of their acceptance by March. In case of acceptance, the candidate has 30 days to provide a final response.

## Deadlines for submitting documents

**The application deadline for the MAS ETH in Architecture and Digital Fabrication is February 28th 2022.**

## Portfolio requirements

The portfolio should feature three projects which you feel demonstrate your design capabilities as well as your technical knowledge. Layout quality will also be evaluated and should emphasise images and design diagrams. The portfolio can be uploaded in PDF format and should not exceed 10MB. Please include a letter explaining why you would like to participate in the programme and three letters of recommendation.

## Late applications

Late applications may be considered if places are still available. The programme accepts a maximum of 18 students per year.

## Scholarships

ETH Zurich offers various scholarships. For more information please contact the ETH Scholarship Office or the Geisendorf Foundation for Architecture.



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# Links

**MAS Programme:**

[www.masdfab.com](http://www.masdfab.com)

**Online Application:**

<https://sce.ethz.ch/en/apply-and-study/how-to-apply.html>

deadline: 28.2.2022

**Housing Office of University and ETH Zurich**

[www.ethz.ch/en/the-eth-zurich/working-teaching-and-research/working-environment/accommodation](http://www.ethz.ch/en/the-eth-zurich/working-teaching-and-research/working-environment/accommodation)

**Arriving in Switzerland for international students:**

[www.ethz.ch/en/the-eth-zurich/working-teaching-and-research/welcome-center/arriving-in-switzerland](http://www.ethz.ch/en/the-eth-zurich/working-teaching-and-research/welcome-center/arriving-in-switzerland)

**Information on general living cost in Switzerland:**

[www.ethz.ch/en/the-eth-zurich/working-teaching-and-research/welcome-center/services-and-downloads/cost-of-living](http://www.ethz.ch/en/the-eth-zurich/working-teaching-and-research/welcome-center/services-and-downloads/cost-of-living)

# Contact

For questions concerning the application, please contact:

## **ETH Zurich**

### **Centre for Continuing Education**

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The MAS administration reserves the right to change any content stated in this document without further notice.