ACE205 | Digital tools: manufacturing

Enhancing the multisensory experience of architectural materials through artistic robotic 3D printing

Fig.1. Architectural quality enhancement through esthetic 3D printing, examples from artistic research by Malgorzata Zboinska. © Malgorzata Zboinska.

Education cycle: Bachelor, Master
Course dates: 2021/8/9-27
Credits: 4.5

Owner: TKARK
Grading: Passed/not passed
Course code: ACE205

BACKGROUND

In the construction of the future city, it will be important to develop an understanding and attitude towards digital manufacturing using digitally controlled machines such as robot arms. How these technologies will be employed in architecture is key for determining their true value - both regarding sustainability and rational resource use, as well as from the standpoint of design and artistry of the architectural profession. Future environments for living need to cater both to most fundamental level of needs of their dwellers, such as shelter, as well as to higher needs, such as the innate human need for esthetic appeal and tactile experiencing of the material. Research in the psychology of built space shows that these higher needs are especially relevant in supporting human wellbeing and mental health in the present era of virtualization and digitalization.

New opportunities with robots are well summarized by the pioneers of robotic fabrication in architecture - Fabio Gramazio and Mattias Kohler:

> *"Building with the robot takes architecture far beyond the creation of static forms to the design of formative material processes […]. With this change in perspective, we open up entirely new ways of reflecting on the physis of architecture, its design and materialization […]. The robot calls into question the previously clear separations between design and construction, information and mechanics, and technology and building culture […]. In so doing, we open up new esthetic and functional perspectives and address the digital in architecture as a radically contemporary building culture."*

Excerpt from; Kohler M, Gramazio F, Willmann J. *The robotic touch: How robots change architecture.* Zurich: Park Books, 2014, p. 15, 103, 381.

COURSE SCOPE

In this course, the robot lab and its robot arms will be introduced, with the purpose of giving the students the possibility to explore artistic architectural model making using an industrial robot arm. You will follow the process of translation of a digital model into a physical object. The robot will produce the model by gradually deposing the material into a 3-dimensional object, a process known as additive manufacturing, or more simply, 3D printing.

Moreover, the students will be introduced to the intricacies of custom robotic manufacturing of architectural models, by involving in the setting up of the manufacturing process both physically and digitally. Gradually transforming from the digital model to a physical object, they will learn

how to handle and control a robot. As such, the course alternates between theory and practical work.

An extra element in the course that might be possible (depending on time, resources and prerequisites), is the opportunity to engage in a part of an ongoing architectural research study of the course examiner on architectural robotic bioprinting using liquid biomaterials.

COURSE FACILITY

The main course facility is the *Robotic Fabrication Lab* at Chalmers ACE. The *Lab* is a great place for architectural experimentation. With the three six-axis industrial robot arms, one can creatively explore new design possibilities offered by robots in architecture – from the creation of smaller architectural models to the fabrication of uniquely designed architectural pieces with larger dimensions, resembling the building element scale. The *Lab* is used in both education and research. For this course, we will use the small robot arm KUKA Agilus KR10.

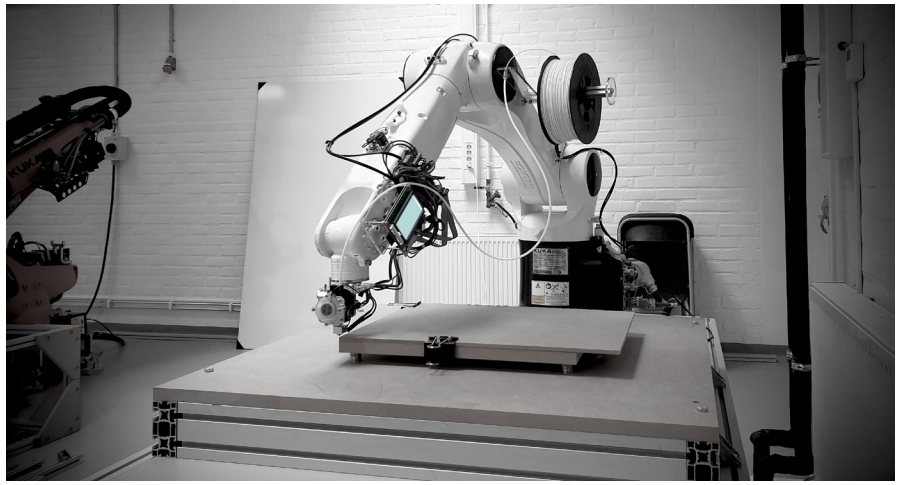

Fig.2. Industrial robot KUKA KR10 at the Robotic Fabrication Lab at Chalmers ACE, equipped with a 3D printing nozzle for filament-based extrusion. © Malgorzata Zboinska.

PREREQUISITES

Your prior skills needed to attend the course shall match the skills acquired in the following courses (or similar):

- ARK570 | Modeling with analogue and digital tools
- ARK695 | Digital tools - parametric design

In the above courses, you worked with Rhinoceros 3D and Grasshopper (3D modeling and parametric design). You worked digitally by developing and processing 3D models. You also used digitally controlled machines such as 3D printers to create physical models and prototypes. We will continue to work with this knowledge in this course.

HARDWARE AND SOFTWARE REQUIREMENTS

It is desirable to have your own laptop during the course.

We will work with following programs, and you are recommended to install them on your computer before the course:

- *Rhinoceros 3D,* preferably version 6, including *Grasshopper,* with all current Rhinoceros updates installed,
- *KUKA|prc* add-on for Grasshopper (trial version, available for download from: *https://www.robotsinarchitecture.org/kuka-prc*).

PRACTICALITIES

Organization

The course embraces 3 weeks of full-time work corresponding to 4.5 credits. A mandatory introduction to robot lab safety is included. You will develop your knowledge through inspiration lectures, digital and physical demonstrations, individual and peer-supported learning, and completing course assignments. Course organization, scope, schedule and instruction type (digital on Zoom or physical in the Lab) may change due to external circumstances and university guidelines on COVID-19.

Course leader and examiner

Malgorzata Zboinska.

Important dates

2021/04/30 – Enrollment deadline.
2021/06/31 – Acceptance notification (at the latest).
2020/08/09 – Course start.
2020/08/27 – Course end (final hand-in of digital files, physical model(s) and other documentation specified prior to the course start).