(Im)materi al Processes
New Digital Techniques for Architecture
Since its foundation in 2000, _Gramazio & Kohler_ has been exploring digital realities within architecture, working with the firm conviction that the digital paradigm will inevitably redefine the discipline. One of the most radical consequences of the digital revolution is the computer-controlled fabrication machine. As decades of artificial intelligence research have shown, a physical body is a precondition for every kind of intelligence. Architecture cannot be reduced to a conceptual, geometric, or mathematical phenomenon. Artificial 'intelligence' in architecture can only manifest itself through a tectonic logic and a physical, material 'body.' The application of a fabrication machine in architecture allows a direct coupling between information and construction. In digital fabrication, the production of building parts is directly controlled by the design information. This seamless link between data and material, design and building, dissolves the apparent incongruities between digital and physical realities and allows a new constructive understanding of the discipline. In order to investigate the consequences of informing designs with the logic of physical materials and vice versa, we opened a research laboratory at ETH Zurich for the digital fabrication of full-scale prototypes and non-standard building parts. For our first experiments, we chose a standard industrial robot. Its extreme flexibility, both in terms of the software that controls it and its physical capacities, allows us to program its movements and design the actual construction tools it selects for operations. The resultant projects confirm that digital logic, both in design and fabrication, will lead to profound changes in architecture, blurring and ultimately dissolving the boundaries between analogue and digital realities.
本项目要求学生设计3x2m的砖墙，由砖块和混凝土构件构成。他们可以将每个构件作为不同的单元。学生开发了算法设计工具，该设计工具可以将程序化逻辑编译成墙面参数。采用这种方法他们就能对墙面作出描绘。设定完成墙体的400块砖中的每一块的空间位置和定位。这个工作室的成果既包括新的材料的呈现，也包括了程序设计的分化特性。

The students were asked to design a 3 x 2 m brick wall, to be produced by an industrial robot which could position every brick differently. The students developed algorithmic design tools that informed each single brick of its spatial disposition according to a procedural logic. In this way they were able to describe a brick wall in which each of its 400 individual members had a specified rotation and position in space. The results of this workshop contained both the archaic presence of the material, as well as the differentiated qualities of their procedural design.

本项目以木板为基本建筑元素，与先前的项目形成鲜明对比的是，通过对每块木板所需的长度，使每块木板在空间上具有灵活性。在计算长度之后，机器人将木板放在其最终的固定位置上。此项目灵活性之外，其他的参数如承重能力、耐候性能、天气保护等参数也要考虑。目标就是将性能作为构造过程的动力和整体不可分割的部分。墙的功能与外观审美直接相关并且互相影响。

This project uses wood slats as the basic building element. In contrast to previous projects the module becomes flexible in one dimension through defining the desired length of each slat. After cutting the lengths, the robot places each slat in its final position in space. In addition to this flexibility, parameters like load bearing capacity and insulation values as well as weather protection had to be addressed. The goal was to see performance criteria as a driver and integral part of the configuration. Functional aspects of the walls and their aesthetic appearance are directly related and influence each other.

使用不拘泥于重复或单一化的数字采集方式，可以产生出高度分化的多孔形元素。基于墙体穿孔的角度，可以从独特的方向形成模块，通过几个开口的不同方向，墙体上产生了可以穿透的区域。其形式和透明度将随着观察者的运动持续改变，由此获得了视觉和深度效果。自主开发的算法工具，为学生提供了进入设计范畴的直接路径，并采用其自身的分布和方向发展的算法化进行补充。

Using digital fabrication methods that do not depend on repetition or a uniform grid, highly differentiated perforated wall elements can be produced. Depending on the angle at which the holes penetrate the wall, the perspective is steered in a particular direction. Through the differing orientations of several openings, permeable areas are created in the wall, their form and transparency changing continuously and gently along with the movement of the observer. The wall thus gains in visual presence and the effect of depth. Algorithmic tools, developed internally, offered students an intuitive route into design, and were used to complement the programming of their own logics of distribution and orientation.

本项目研究采用聚氨酯结构设计并制作样品的策略。结合数字制作技术探索上述附加材料的方法的吸引力以及创建泡沫形成过程中的虚实模型的不可比性，我们用上述理解为重新定义材料特性与数字工具之间关系的机会。评价设计特性只能通过脚本的迭代博弃和作品才能实现，这包含了对泡沫的材料特性的显微和泡沫形成性的微分析。项目中的第二部分研究了如何使用上述方法设计声墙。

This project investigated strategies for designing and fabricating panels out of polyurethane. The fascination of researching this additive material process in combination with digital fabrication technologies stemmed from the impossibility of creating a virtual model of a process like foaming. This constraint was seen as an opportunity to redefine the relation between material properties and digital tools. The evaluation of design properties became only possible through an iterative loop of scripting and production. This involved analyzing the material properties of foam and its behaviour during the foaming process. In the second part of the project we examined how to use the process to design acoustic wall panels.