Zeitschrift: Trans : Publikationsreihe des Fachvereins der Studierenden am Departement Architektur der ETH Zürich

Herausgeber: Departement Architektur der ETH Zürich

Band: - (2015)

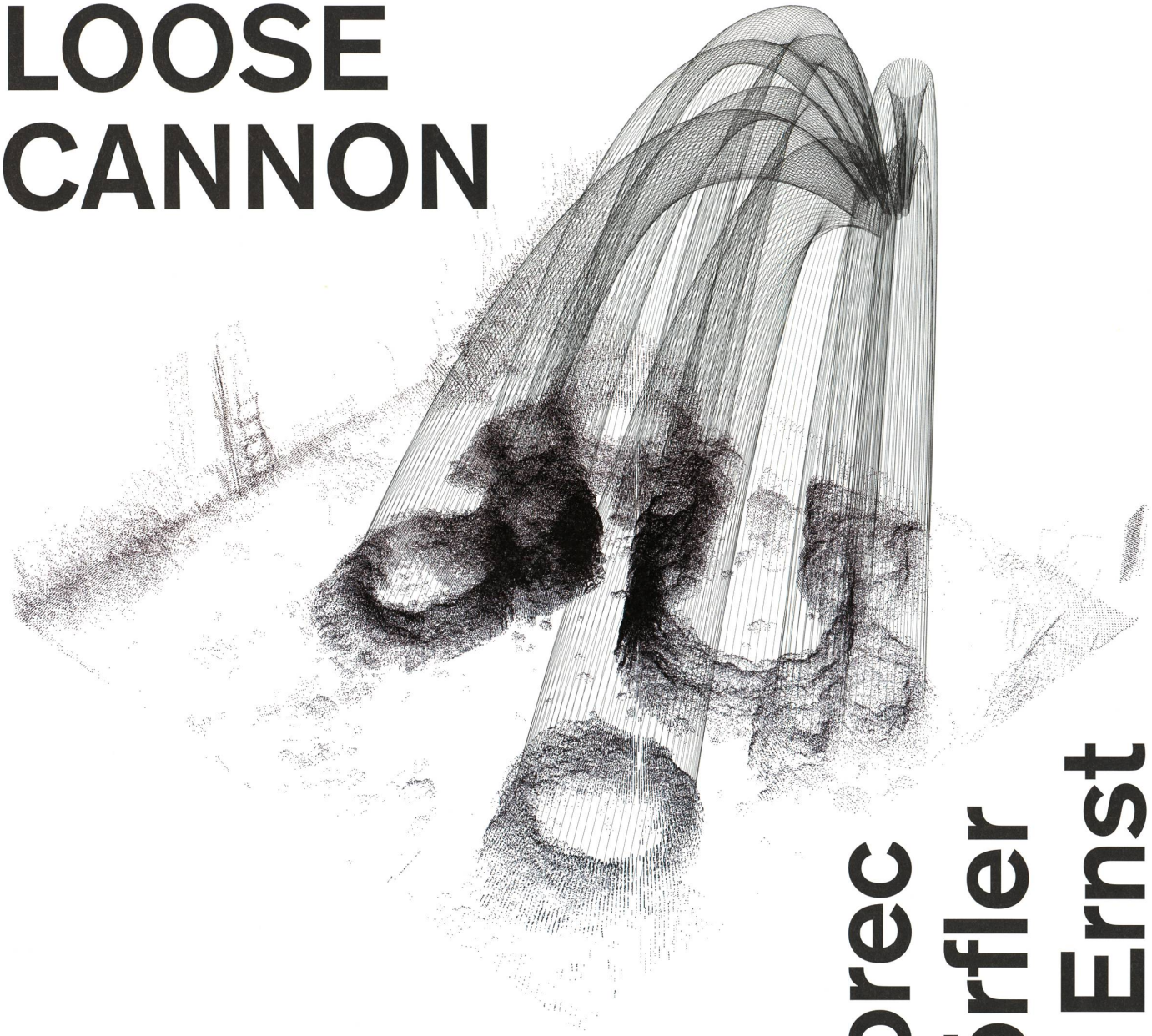
Heft: 26

Artikel: Loose cannon

Autor: Piškorec, Luka / Dörfler, Kathrin / Ernst, Sebastian

DOI: https://doi.org/10.5169/seals-918891

LOOSE CANNON



Luka Pišković
Kathrin Dörfler
Sebastian Ernst

104

«Modern humans are geniuses at manipulating things with hands and fingers. We are guided by an extreme development of the kinesthetic sense invested in that ability. The integrative powers of the brain for the sensations that come from handling objects spills out into all other domains of intelligence.»

Edward O. Wilson,
The Social Conquest of Earth

fig. a
Excavation site from where the clay for the project originates.
Photograph: Kathrin Dörfler.

Remote Material Deposition (RMD) started as a feasibility study and intended to explore the idea of extending the building range beyond the immediate reach of a robotic unit (which, as part of our research, has replaced humans in the building process) through digitally controlled ballistic deposition. After promising preliminary studies in a small scale, testing different deposition methods (like controlled throwing and finally making use of linear accelerators using pressurised air as an energy source) the project was extended to include a 30 ton installation, in collaboration with the Sitterwerk St.Gallen. Initially an art factory specialised in casting metal sculptures for the likes of Hans Josephsohn, Sitterwerk now features a diverse range of different production methods. This hub of material expertise and the possibility to work in their guest atelier space gave us the opportunity to demonstrate our technology in a culturally rich and spacious context. While the technocratic nature of RMD is self-evident, we wonder how its disposition could change when seen in the wider context of both traditional and contemporary building traditions. When the ability to control the complex mechanicality of ballistics is combined with the inherently amorphous behaviour of clay, a dialectic is introduced, in which precision is confronted by the nebulous; In this case the amalgamation of sensual aesthetics is achieved by a loss of control.

OF CONTROL AND MEDIATION

Few architects are as synonymous with Modernity as Mies Van der Rohe. In essence, Mies' projects embody the modernist rational ideals, including the use of standardised industrial components to compose geometrically controlled spaces. Before starting his career as an architect, Mies was trained as a stonemason under his father at the Dombauschule in Aachen. Bauhaus, the school he was to lead as an architect-director from 1930 to 1933, aimed to combine the principles of art and craft in unison with industrialised mass production, and thus explored the interplay between mediation and control in the conception of built projects. This consolidation is not just characteristic of modern architecture. Jackson Pollock's action painting demonstrates an unparalleled combination of the anti-figurative aesthetic associated with the Bauhaus, the impression of spontaneity characteristic of abstract expressionism and careful planning, demanded by the large size of his canvases. The use of brushes and painting sticks was consigned to material inherent forces, foremost kinetic propulsion, material friction, viscosity and gravity. As to the industrious scale intrinsic to Mies' work, the mass productive style of the Pop art generation comes to mind. The reprinting, duplication, scaling and resulting deformation of Pop culture images (the conscious misuse of technique to alter or create different realities) became very influential to our project. Often misunderstood, these artists did not ‹let things happen›, but created a set of boundary conditions in which things ‹can happen›, thus allowing a Gestalt to unfold within a clearly defined range.

OF DRAWINGS AND MOVEMENT

Although there is a conceptual difference between the free hand sketch and the technical drawing of an architect, both are still of use for the purpose of building. Apart from the instructions contained by drawings, a certain body of knowledge is always implicit in the craft of a builder, an assumption an architect has to make. While hand drawings leave considerable space for interpretation, technical drawings tend to restrict them, yet both are means of communication. In the realm of digital fabrication methods, this communication does not take place between the architect and the builder, but between an unmediated initial form of material and final articulated architectural space. Nicholas Negroponte, in his text ‹Towards a Humanism Through Machines› from 1969, proposed that the communication between the designer and the machine in a CAD environment should be based on a rudimentary dialogue, similar to the communication between two people that speak different languages: They are capable of developing a crude method of exchanging information based on a ‹common ground›. Ideally, this is how we imagine the communication between an architect and the fabricating machine to be, based on a firm common ground aided by architectural and technical drawings, a set of instructions, bills of quantities etc. But until now, the operation of digitally controlled machines required an architect to simultaneously take on the role of a mechanical engineer and a computer scientist, greatly limiting the potential for productive collaboration between the architect and his machine. What do crea-

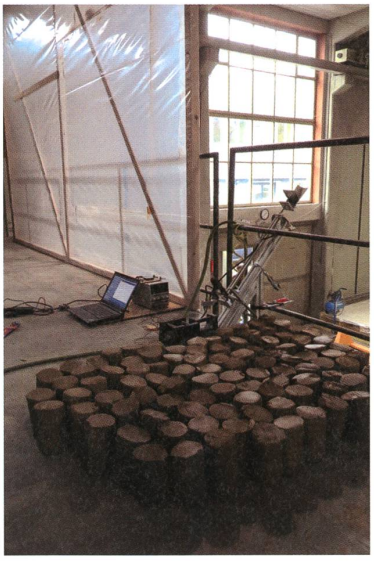


fig. b
Early robotic fabrication setup with a laptop, clay projectiles, and a pneumatic cylinder for shooting.
Photograph: Julia Lütolf.

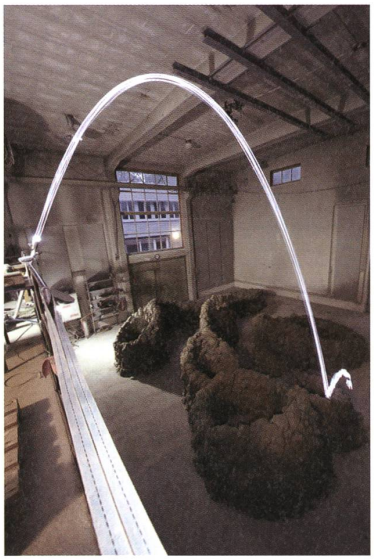


fig. c
Long exposure of a light projectile being shot out, forming a calculable parabolic projectile path.
Photograph: Mike Lyrenmann.

tors and their machines have in ‹common›? Perhaps, if the body of architecture is understood as an assembly of material and mass, differentiating space into volumes and voids, density and openness, light and shadow, we could perceive the building culture as a choreography of moving materials through space and time. Then it is the movement of this spatio-temporal nature that is the common ground, movement previously enabled by hands and limbs, now translated into axes and joints.

OF STONE WALLS AND PROPELLED CLAY

The thesis that movement could be the common ground in all building endeavours regardless of who executes them, humans or machines, can only be tested on a real building project and in full scale. Clay became our material of choice, as its properties are ideal for ballistic deposition (unlike concrete it retains its mouldable shape for longer but still stiffens after a period of drying). An indirect inspiration for the design of the exhibition piece was Su Nuraxi, a Nuragic archaeological site in Barumini in Sardinia, dating back to the seventeenth century BC. It is a settlement consisting of a Nuraghe, a bastion of four corner towers surrounding a central one, and an enveloping village. Although they seem superficial at first, after close comparison it becomes evident that design characteristics that apply to building with clay are the same as those used to stack dry stonewalls. Drawing from this parallel between the two materials, both ancient in their own right, we solved a contemporary problem with knowledge passed down by our ancestors. Self-supporting walls stiffened by curvature and spatial buttressing was the optimal solution for building with rough stone (used for smaller buildings while taller ones used more regular, but time-consuming cut stone) or clay. The critical problem during the ballistic deposition of material (the stability of wall segments during construction) is also solved by the same approach – curving the wall to add stiffness. Our ballistically deposited structure grows concentrically from the centre outwards, as clusters of similar shapes, enabling the continuous addition of spaces. Walls were designed to be stable closed shapes, circular or oval, and to lean on each other to provide mutual stability. Space development is articulated through open and closed wall forms that can intertwine, creating a dense array of spaces to meander around. And finally, structural walls increase in height according to stability criteria as well as to avoid ‹ballistic shadowing›. Linking this advanced technological building process to proto-architectural forms from the Late Bronze Age is not merely ironic, but reveals an odyssey through millennia of human constructive endeavours.

OF FORCES AND HANDS

The composition of the clay structure corresponds to the physical formula of the ballistic trajectory as well as the capacity of the projectile machine. The form of the clay brick was tested over a month and was eventually scaled to the diameter of the used clay mixer. The length of the cylinder was determined by the maximum weight the cylinder was able to accelerate, just as the dimensions of bricks are tightly linked to the physique of the builder. Comparable to 3D printing the fabrication is carried out in layers, and therefore avoids ‹ballistic shadowing› explored and quantified in so many artillery manuals: a ballistic shadow is the area which is unreachable by ballistic projectiles, a place used to protect people, equipment and, well, other guns. The individual clay projectiles, although robotically guided through a digitally controlled launching mechanism, behave to their own accord and display a consistent ‹spread›, which is just another way to quantify the unpredictable nature of the local behaviour of building elements. In order to accommodate for this inherent unpredictability, it was necessary to employ visual and tactile senses for the building machines (3D sensors, digital scales, etc.). What could not be automated digitally, was instigated in manual processes: to keep the texture consistent, clay mixtures were modified according to weather conditions on site; wet clay was compensated with less water or longer mixing times; every batch of projectiles was evaluated by three pairs of hands before approval. Parameters which could not be assessed by digital measurement devices needed to remain consistent, crucial to the precision of the overall remote material deposition. Therefore, production and launching schedules were adjusted to ensure similar conditions regarding the freshness of the material used. Due to the lack of an African sun (which made clay building methods so popular in the Cradle Continent), different drying regimes were employed by day and night to harden the structure, preparing it for the subsequent tons of clay that were to follow.

Apart from possessing crucial properties that makes it suitable for ballistic deposition, clay holds a profound cultural

fig. d
Detail of the final structure with deformed clay projectiles forming the wall texture. Photograph: Yves Roth.

meaning. Unfired clay was the basis for one of the oldest building modules, the brick. But long before it was used by humans for building shelter and physical structures of power, it was a vital ingredient in formation of life on our planet, as clay minerals only form in the presence of water. When used in construction, this material is mostly shaped from outside by various forming forces, a fact that – like concrete – strengthens our perception of it as an amorphous material. By giving it shape beforehand and then applying a concentrated force (in our case, using it as a ballistic projectile) clay cylinders retain enough of their original shape that certain parameters can be recognised in the finished structure: Their original size, their shape, consistency, direction of flight, the impact force with which they hit the structure. All of this is preserved in the final texture of the surface, telling the story of its own creation as read by a perceptive observer. As Peter Zumthor explains in his book ‹Architektur Denken›, a building should be able to tell its story without the help of its creator.

OF INTUITION AND RATIONAL MIND-SET

Working with a material in the scale of objects (the first objects made by man were indeed tools and utilitarian objects) as well as in an architectural dimension (the first inhabitable spaces were not made by a man at all, they were appropriated by him from nature) required inventing through doing and experimenting rather than planning. Both the builder and the craftsman do not think of material in its abstract qualities, but with knowledge gained by following their hands. Similar to this way of working, we developed RMD as a mechanism to create form following our sketched input, enriched by the unique properties of material expression, the beauty of forces at play. Although conceptually already predicted by Alberti in his ‹De re aedificatoria›, the significant separation of the architect and the builder was brought about through centuries of industrialization of the building sector. This is, for now, a seemingly irreversible process. Especially in the realm of advanced technologies there is room, if not to say necessity, for closer integration of design methodologies, material evaluation techniques and building processes. These integrative powers were developed long ago through the manipulation of objects with our own hands, and have huge potential to be rediscovered with the use of digital fabrication methods. But in order to facilitate that integration, architects need to do the exact opposite of what they have done in the past. They have to let go of their desire to fully control the design process, and rather embrace the unpredictable ‹tailspin›. ‹Ad hoc› and experimental approaches can lead to innovation which is driven not despite, but exactly because of this uncertainty. Intuition, implicit knowledge and kinesthetic sense resist and enrich the rational mind-set. Instead of excluding the one or the other, we should embrace the friction between the two. That is where the future of building lies.

‹Gramazio Kohler Research› in cooperation with: Sitterwerk Kunst und Produktion – Felix Lehner, Julia Lütolf, Ariane Roth, Laurin Schaub

Collaborators:
Sebastian Ernst (project manager), Kathrin Dörfler, Luka Piškorec

Sponsors:
Festo AG, Schweiz
Hans und Wilma Stutz Stiftung, Herisau
IKEA-Stiftung (Schweiz), Basel

Students:
Ralph Benker, Bo Cheng, Roberto Naboni, Pascal Ruckstuhl, Ivana Stiperski, Simone Stünzi, Anna Szabo, Andreas Thoma, Martin Thoma, Alexander Nikolas Walzer, James Yeo

Kathrin Dörfler, born 1983, studied architecture at the TU Graz and TU Vienna, and Digital Art at the University of Applied Arts Vienna. Since 2013, she is a PhD student at Gramazio Kohler Research at ETH Zürich and joined the NCCR Digital Fabrication in 2014.

Luka Piškorec, born 1986, studied architecture at the University of Zagreb in Croatia and attained his master's degree from ETH Zürich in 2011. Since then he's been working as a research assistant at Gramazio Kohler Research at ETH Zürich.

Sebastian Ernst, born 1987, studied architecture at the TU Berlin till 2009 and did his Master Thesis at ETH Zürich in 2013. In 2014 he worked at Gramazio Kohler Research as research assistant and project manager for Remote Material Deposition.