Computational Design Culture

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Computational Design Culture - Scripting, Simulation, and the Making of Architecture.

(conference report on behalf of the organizer)

The 1.5-day international conference, conceptualized, and organized by Nicole Stöcklmayr (MECS Institute for Advanced Study on Media Cultures of Computer Simulation, Leuphana University Lüneburg, Germany), focused on how parametric methods, computer simulation, and scripting techniques change the design and thinking of architecture, particularly regarding the effects of code-controlled design and fabrication. The conference brought together professional architects, engineers, and software developers with scholars of architectural history and theory, philosophy of science and media studies. Crucial to the discussion of the term Computational Design Culture was the joint understanding of the difference between computation and computerization as contrasted by Kostas Terzidis: Whereas computerization is seen as “the act of entering, processing, or storing information in a computer or a computer system”, which “is about automation, mechanization, digitization, and conversion”, computation stands for “the procedure of calculating, i.e. determining something by mathematical or logical methods” itself. Due to its exploratory mode, computation deals with “the exploration of indeterminate, vague, unclear, and often ill-defined processes” and “aims at emulating or extending the human intellect” by “rationalization, reasoning, logic, algorithm, deduction, induction, extrapolation, exploration, and estimation”. Thus, Computational Design does not refer to mere digitalization or simply to computer equipment, but rather includes “problem solving, mental structures, cognition, simulation, and rule-based intelligence” [1].

Biomimetic research: Materiality, performativity, and learning from the living
The first part of the conference was devoted to biomimetic and integrative design strategies investigated at the University of Stuttgart [2]: The concept of “material agency“ introduced by Achim Menges aims at embedding the logics of materiality into design processes by using organisms as biological role models, whose bionic principles and performance are extended to geometric structures, which are tested, analyzed, evaluated, and finally transferred into an architectural prototype. By this means, adapting the integrative methods of natural morphogenesis and material differentiation requires the exploitation of the interrelation between internal capacities of the system’s material and structure itself as well as of external forces and influencing constraints. Likewise, Jan Knippers exemplified the use of computational strategies for biomimetic research by connecting morphology and functional mechanisms, inter alia in terms of implementing the elastic ben-

ding logic of blossoms into a performative kinematic model applicable to facade systems. Both talks illustrated that, as biology demonstrates, materiality is not given, but constructible by rediscovering the structure and the potential that lies in the matter (Menges), which can only be done with the help of computational tools and thinking. Moreover, Computation Design Culture changes the perspective on technology: according to Knippers, computational environments show that simple structures adapted from natural evolution and implementing heterogeneous and anisotropic materials, hierarchy, redundancy, and multi-functionality are much more efficient than constructions that base on mono-functional components, isotropic materials, and hypercomplex inlays. Even in space architecture computational methods deal with a certain curiosity about the living: the GrAB project introduced by space architect Barbara Imhof follows the notion that natural growth patterns and processes can be applied to building, for example by transferring genetically controlled growing processes of self-organizing organisms into living architecture [3]. In addition, Gabriele Gramelsberger gave an insight into how the parametric ideas of variation, repeatable elements, and building systems are implemented into the computer-aided design of useful organisms in synthetic biology using the principle of "brickification". Reflecting the ethical horizon of such undertakings should also be part of the discourse on Computational Design Culture, since it does not end with the optimization of things, but reconfigures the ideas of life, design, and matter.

Modifications of working methods and the architect's self-conception
As many of the speakers emphasized, a Computation Design Culture requires and supports not only highly interdisciplinary collaborations but also the convergence of disciplines. In so far as integrative design not only focuses on the integration of form and function but also of the disciplines, the historical distinction between architects and engineers no longer can be maintained (Knippers) and architects tend to become programmers and vice versa. Therefore, one of the central threads running through the conference concerned the motif that a Computational Design Culture dispenses with the traditional concept of the architect as an author-subject that brings design-objects into being. Instead, the exchange of information becomes the linchpin of work and architectural design becomes increasingly aware of its own media conditions. Furthermore, Knippers pointed out that, while model thinking means dynamic process thinking, it involves both technologically conditioned top-down and biologically derived bottom-up principles [4]. But Computation Design also shows analogies to ancient methods of operating: Stefan Rutzinger argued that similar to 16th century alchemists, who dealt with the unknown through passionate search and experimentation, contemporary architects play with parametric design strategies and discover the new through simulation. In terms of the relevant technological procedures, Moritz Heimrath demonstrated by means of examples how the software karamba3d deforms and reconfigures a 3-dimensional model according to the changing of its parameters and how it controls the responding structural and material behavior by algorithms. He also made comprehensible the representation of the series of modeled versions and calculated results of the structural analysis via 3d-grids.

Robotic fabrication and new aesthetics
Computational techniques become essentially productive in terms of fabrication, as in the programming of robotic interaction by which self-expression of (synthetic fiber) material is supported. Matias del Campo and Sandra Manninger's approach to contemporary "mood architecture" is closely linked to questions of fabrication: While throughout the history of architecture atmospheric spaces were primarily created through columns, openings, and the use of light and shadow, today autonomous robotic construction enables creating non-Euclidian objects that influence the

spatial experience and establishing a new way of mood generation via form finding. Whereas casting and molding need a formwork to shape the material, autonomous fabrication bases on a small set of rules that cause the robotic system to behave responsively in order to construct a spatial figuration out of the material [5]. In recent tests dealing with gravity as the main forming force and working with thermodynamic material, “moody objects” emerge in the form building process and by nature itself. Their specific aesthetic can be described as fuzzy, imprecise and, to some extent, monstrous, because, as Gramelsberger explained, they arise from organic recursion and permutation [6]. By arguing that a philosophy of parametric thinking has to take up the convergence of numerical variation (as in parametric design rooted in systems dynamics modeling) and geometric repetition of simple forms (as observable in the generative designs presented by Knippers), Gramelsberger stressed that bringing both aspects together leads to non-strict iterativity – a principle belonging to natural morphology and even fractal geometry. Within repetitive processes, such as feedback loops, the optimal solution of a problem is developed during several iterations of responsively varied, but simple design operations. Parametric design therefore overcomes geometric constructive symmetry by creating self-referential objects, whose form results from non-strict iterative operations. Thus, parametric design converts uniform objects into naturalistic non-uniform ones. Another approach towards creating atmospheric spaces suggested by Andrea Graser refers to light and its impact on the emotional experience of spatial quality. She contextualized the generating of individual light spaces as part of the paradigm shift from light as the medium of visualization to light as a phenomenon that is visual by itself and therefore can be discovered via visual coding. In a project implemented at a geriatric center in Vienna, Graser contributes to prototyping translucent light panels, which display light scenes due to different parameters such as movement, speed, color or brightness. This and similar projects are supposed to elaborate light as architecture in the long run. A vigorous debate was launched by Stefan Rutzinger’s discussion on re-thinking the term “form": The Temporary Art Pavilion in Salzburg and the installation The Art of ReCreation in Vienna both consist of simple repetitive elements aggregated according to a small set of rules, which is why the pavilions create the impression of irregular, mass-like conglomerates as if they were objects without contour. Their vague formation indicates that, according to Rutzinger, the deeper parametric methods are implemented, the more formless becomes the result. While the classical understanding of architecture assumes the distinction between content and its physical appearance, he proposed the term “formless“ in order to address the unknown, multilayered, and inconsistent, which can only be achieved approximately [7].

Epistemological consequences of the Computation Design Culture

The keynote held by Mario Carpo focused on the epistemological impact of big data analysis and simulation on sciences and design. Inasmuch, even in architecture, customized mass production of variations supersedes the mechanical reproduction of identical copies that was characteristic for industrial fabrication in the modern age [8], mathematical data compression via formulas (as in CAD software) not only makes physical data compression by descriptive geometry (i.e. blueprints) superfluous but also allows the prediction of the future at the smallest scale. By presuming that for every future event one can find a precedent and relying on the assumption that the same conditions will always produce the same result, big data not only leads to a “new science of singularity“ driven by infinite granularity, but also raises the question of how innovation can be addressed. At that point, simulation goes much further than big data analysis, because it liberates the designer from the (recorded) past by predicting scenarios for which no precedent exists. In terms of providing an additional test of truth beyond material reality simulation does not depend on the understanding of the abstract laws determining the world and even the principle of trial and error is brought forward into virtual reality. Thus, simulation in accordance with Friedrich Kittler stands for the affirmation of the non-existent [9]. Whereas calculating splines (as “small data”) means to simplify complexity, big data analysis at least tends to deal with complexity itself and complies better with the discreteness, randomness, and irregularity of nature as it is – apart from the paradox of measuring and copying the totality of an event. Accordingly, the style of big data appears fragmentary and disconnected compared to the elegant and continuous spline curves notated as mathematical functions, which were dominant in the early 1990s [10]. Corresponding to Carpo, del Campo and Manninger suggested that their “moody objects” explore the “ontographic qualities” inherent to Computational Design technologies and represent a virtually post-human epistemology, in which (aesthetic) knowledge emerges autonomously within the process, just as Rutzinger outlined concerning the “formless”.

Conclusion

The fact that most of the contributions focused on particular (avant-garde) design projects should not disguise the consequent entitlement to conceptual perspectivation and theoretical connectivity that was pivotal in the problem-oriented talks and critical discussions. The practically orientated approach complied with a methodological program for reflecting the subject from a decidedly media theoretical perspective: it is apparent that the whole conference executed the Nietzschean catchphrase that our writing tools are also working on our thoughts [11]. Hence, the conference implicitly refuted the separation of academic theory and practice.

Although scripting at first glance seems to become secondary while hidden behind the software (which is a well-known idiosyncrasy of media, too), it allows to handle high-level complexity of systems on variable scales and with numerous variations. Thus, computational tools open up the exploration of new aesthetics by approaching the formless or the monstrous, by focusing on the interrelation of form, function, fabrication, and of materiality itself. Hence, they push the reflection on primary concepts such as form, matter, structure, and ornamentation [12]. By sharpening two different meanings of the term simulation, Carpo initiated probably the most concise synopsis that could have been drawn from the lectures: whereas simulation on the one hand refers to imitating artifacts, it can be understood as a methodological tool for prediction and optimization on the other hand. As identified by Carpo, the conference contributions clearly applied to the overlapping of both, the representational and the technological aspect of simulation. By dispensing the traditional architect-subject, Computational Design Culture admits an own operative agency and epistemological autonomy to the design itself and to the technologies and methods it arises from. Questioning dichotomies such as form/matter or inanimated/living contributes to this very shift [13]. To what extent Computational Design is moving towards a relativization of opposites or actually to their extensive suspension, remains to be seen in the future. As it turned out, the transdisciplinary approach of the conference resulted in a very productive, informed, and lively debate about the characteristics of what can be conceptualized as Computational Design Culture, and, thus, prepared the ground for further research on this topic [14].

Notes:

[1] Kostas Terzidis: Expressive Form: A Conceptual Approach to Computational Design, London, New York 2003, p. 69; see also: Algorithmic Architecture, Jordan Hill 2006.

[2] For further details of the design research at the ICD/ITKE Stuttgart see i.e.: Moritz Dörstelmann, Stefana Parascho, Marshall Prado, Achim Menges, Jan Knippers: "Integrative Computational Design Methodologies for Modular Architectural Fiber Composite Morphologies", in: Design Agency [Proceedings of the 34th Annual Conference of the Association for Computer Aided Design in Architecture (ACADIA)], Los Angeles 2014, pp. 219-228, DOI: 10.13140/2.1.5186.0485.

[3] Imhof also presented another two futuristic projects realized at the trans-disciplinary platform of Liquifer Systems Group, which deal significantly with computational issues: The design of an autonomous self--deployable habitat applicable to extreme terrestrial environments and to near-term space missions (SHEE) needs to integrate parameters related to cost reduction, to optimization of capacities, but also to human factors. Secondly, Imhof outlined the undertaking of sending a mobile robotic 3d-printer to the moon that receives digital 3d-files from earth and produces complex structures without the help of human assistance on site. For this purpose the printer uses only the material given at the place of action, so that producing easily on demand allows a self-sufficient supply within the extraterrestrial environment. Although these projects are still in their exploration and testing phase, they show the potentials of robotics, biomimetics, and simulation for tackling highly complex challenges that involve many parameters and process a huge amount of data to be exchanged. For more information about the projects of the Liquifer Systems Group see: <http://www.liquifer.com>.

[4] See: Jan Knippers: "From Model Thinking to Process Design", in: Architectural Design (Special Issue Computation Works: The Building of Algorithmic Thought), Vol. 83, Issue 2, pp. 74-81, March/April 2013, DOI: 10.1002/ad.1558.

[5] For additional explanation on autonomous robotic fabrication see: Matias del Campo: "Autonomous Tectonics II", in: Paradigms in Computing: Making, Machines, and Models for Design Agency in Architecture, eds. David Jason Gerber, Mariana Ibanez, Los Angeles 2014, pp. 298-306.

[6] See: Gabriele Gramelsberger: "Schrift auf den Punkt gebracht - Extrapolation, Rekursion, Simulation", in: Schriftbildlichkeit. Wahrnehmbarkeit, Materialität und Operativität von Notationen, eds. Eva Cancik-Kirschbaum, Sybille Krämer, Rainer Totzke, Berlin 2012, pp. 389-400.

[7] See the description of The Art of ReCreation in Vienna by Emilia Margaretha: "Gezielte Formlosigkeit: Pavillon in Wien", in: Detail – Das Architekturportal (7.07.2014)
<http://www.detail.de/architektur/themen/gezielte-formlosigkeit-pavillon-in-wien-023455.html>.

[8] See: Mario Carpo: Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory, Cambridge/Mass. 2001; The Alphabet and the Algorithm, Cambridge/Mass. 2011.

[9] See: Friedrich Kittler: "Fiktion und Simulation I", in: Kanalarbeit. Medienstrategien im Kulturwandel, ed. Hans Ulrich Reck, Basel, Frankfurt a. M. 1988, pp. 269-274.

[10] See: Mario Carpo: „Breaking the curve", in: Artforum (February 2014), pp. 169-173.

[11] See: Friedrich Nietzsche: Letter to Peter Gast (Heinrich Köselitz) of 16. February 1882, in: Friedrich Nietzsche: Sämtliche Briefe. Kritische Studienausgabe in 8 Bänden, pt. 6, Januar 1880 - Dezember 1884, eds. Giorgio Colli, Mazzino Montinari, Munich, Berlin, New York 1986, pp. 171-172; Friedrich Kittler: "Unser Schreibzeug, unsere Liebe - im Nachhinein", in: Friedrich Nietzsche: Schreibmaschinentexte, eds. Stephan Günzel, Rüdiger Schmidt-Grépály, Weimar 2009, pp. 102-104.

[12] By comparing the sculptures by Michelangelo with artifacts that were made by a 3d-printer, such as the Grotesque Grotto by Michael Hansmeyer and Benjamin Dillenburger, Carpo mentioned that additive fabrication is not only cheaper and produces less waste than subtractive fabrication, but also revaluates the aesthetic status of decoration and ornamentation, which was degraded to the representation of wasted labor and ruined material by Adolf Loos in the early 20th century and translated into the frequent absence of ornaments in modern architecture.

[13] According to Carpo, even the duality of past and future converges within simulation, because by creating the missing historical corpora of cases on demand, the past as reference horizon turns out to be superfluous.

[14] An edited volume based on the conference proceedings is forthcoming.

The conference program can be accessed here:
<http://www.leuphana.de/zentren/mecs/veranstaltungen/vergangene-veranstaltungen/computational-design-culture.html>

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