designtoproduction

brings together the practical experience of Arnold Walz as "geometry consultant" and the academic research of the former *caad.designtoproduction* team founded by Fabian Scheurer, Christoph Schindler and Markus Braach at Prof. Ludger Hovestadt's Chair of CAAD at ETH Zürich. designtoproduction implements digital process chains based on parametric CAD-models and offers consulting services for parametric planning, detailing, optimization, and digital manufacturing. **www.designtoproduction.com**

The Whole and its Parts

All architectural structures—unless dug into the earth—have this one thing in common: they are assemblies of numerous parts joined together. This statement is based upon the simple fact that no single material, be it natural or manufactured, is as large as a building. In architecture, the whole easily consists of thousands of parts. And if the architect used contemporary digital-modeling tools to generate a complex form, each element of the design is probably different.

In today's building process it seems that the introduction of digital design and fabrication tools leads to a continuous flow of information from conception into production. In the architect's practice, computer-aided design (CAD) software helps to define surfaces by pulling control points or adding and subtracting volumes like a virtual sculptor. Via standard data formats the design is forwarded to computer-aided manufacturing (CAM) software in the workshop, which in turn controls the computerized tools that produce the various components. Does 'CAD/CAM' mean that architectural design is reduced to pulling control points, exporting the result and leaning back to watch the production?

This method indeed is applicable to small-scale prototype design or mold fabrication where the whole consists of just one part. In architecture however, the whole and its parts are not identical: CAD modeling-tools help to define the whole, while a CNC-machine fabricates parts. And even worse, the building material at disposal within the budget often does not match the desired shape: plain sheets and straight bars and profiles confront curvilinear designs.

How to translate the shape of the whole into parts made from standardized material? Here in fact, between the modeling tool and the fabrication tool, lies the complete architectural planning process including the breakdown into parts, the optimization according to various constraints, the detailing, and the preparation for fabrication. There is neither a generic software tool to automate this process from the whole to its parts. Building designs are too different for a generally applicable solution. Nor is the manual processing of thousands of different parts advisable, because it is laborious and hard to get a grip on it. Approaching a digital architectural planning process means establishing project-specific algorithmic relations between the whole and its parts.

designtoproduction researches and realizes automated solutions for the intermediate steps between digital design and digital fabrication. Those steps are interconnected: they influence each other from the whole to the parts and from the parts to the whole until the information and material flow is harmonized.

ion between the whole and its parts:
›dels

the breakdown from the whole to the parts, we implement
nodels on the basis of professional CAD packages.
atially difficult to comprehend. The intertwining forms of
enz Museum for instance can hardly be described in plans
:ontractors needed exact documents with information
ə whole was still in the process of development.
se amount of information in a parametric three-dimen-
thousand detailed plans could be generated automatically
sign chosen by the architect.
numbers. They think in relations. Standard CAD
:ions. They store numbers. Numbers that change while
able. Parametric CAD models capture those persistent
ing form, reducing thousands of coordinates to a handful

cribing thousands of different parts with a few
l of 'parametric standardization': Individuality is expressed

depending on the interrelations among its parts:
›n tools

tifies relations among the parts to develop advanced
natch design ideas to the best constructive, structural, and

ne basement of KCAP's Groningen Stadsbalkon have
oncrete slab, get out of the way, minimize resources, and
random forest. Such conflicting demands are hard to
approach. With an optimization software based on arti-
chitects were enabled to "grow" alternative solutions on
ed all constraints—far quicker than a real forest.
vith regular grids and uniform modules the optimum is easy
mplex geometry, where dimensions change and angles
find any answer at all—let alone a good one. With state-
ools that exploit the power of bottom-up methods like
Swarm Intelligence it is possible to find good solutions for
taining the non-regular form instead of falling back on a

Rationalizing the parts to realize the design

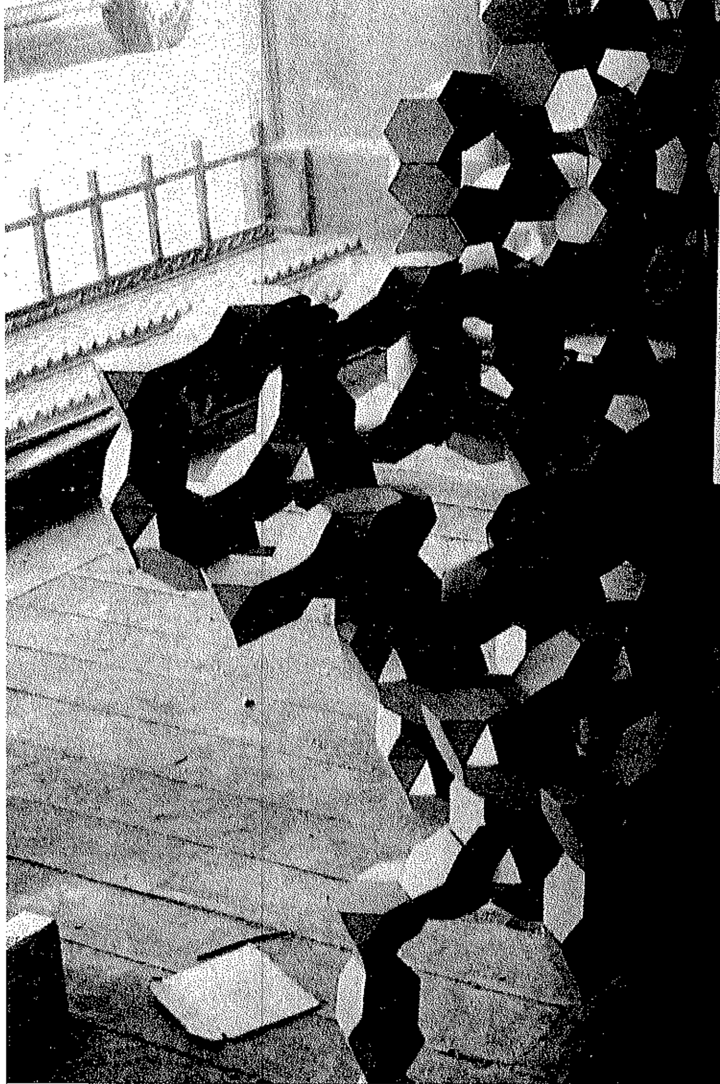
Architectural construction is all about the assembly of parts.
And complex architecture consists of large numbers of individual parts.
One of our favorite details is a little extruded aluminum dovetail profile that we used for several constructions. While the little profile is a standard invariable industrial product, the grooved counterpart on the component is a parametric detail. More than three thousand of them are needed to connect the 2164 pieces of Daniel Libeskind's sculpture Futuropolis. And besides looking good each of them saved a few minutes of labor time, because they make it unnecessary to clamp the pieces during the hardening of the glue.
Integrating thorough knowledge about fabrication technologies, materials and joints into the detailing leads to smarter, leaner, and more rational production processes—and to a result that comes close to the intention of the original design without busting the budget. We attempt to produce detailing strategies that reflect a deep understanding of the methods and constraints of existing fabrication processes. In fact, most of the conditions for breaking down the whole into parts are determined by machines' dimensions, its tools and scope of movement. We seek for constructive solutions to cover systematically the range of individual, parametric details.

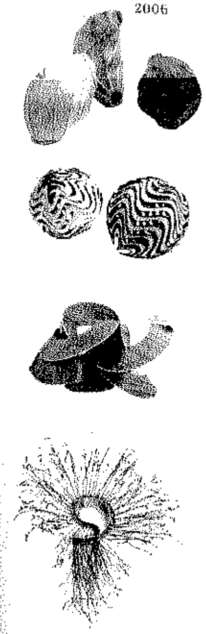
4. MATERIALIZE information:
Production data for the parts

Non-standard geometries are built from non-standard parts. In a workshop, every single part has to be edited for the computer-aided machine—nesting parts on raw material, selecting tools, configuring the tool path and generating the machine code.
The doubly curved glass panels on Zaha Hadid's Hungerburg Funicular Stations are held in place by some 2500 individually shaped profiles. Each of them is cut from polyethylene boards with a computer controlled five-axis router. Manually nesting a couple of thousand pieces and translating their geometry into NC-programs for the router would have been a heavy burden for any building budget. Therefore, the complete machine code was directly generated from a parametric 3D-model —including stickers with unique part-IDs that help allocate the pieces.
While software solutions offer to perform many of those steps automatically, still every single part has to be imported and treated with CAM software tools —an enduring process that has to be repeated any time a condition changes.
Automating the planning from detailing to machine code is the final step of organizing the relations between the whole and its parts, but is adding most value to the processing chain.

Aranda/Lasch

is a New York-based architectural studio founded by Benjamin Aranda and Christopher Lasch in 2003 after graduating from Columbia University. They think of their practice as a way of putting together craft and computation through geometry, mathematics and pattern. Their research on physical processes and biological systems is illustrated in the Brooklyn Pigeon Project (an investigation of pigeon swarms) and the Pamphlet Architecture publication *Tooling*. www.terraswarm.com





Baskets 2006

What is parametric to us?

We once built some baskets with a Native-American basket weaver named Terrol Johnson, and learned we have much in common. Before Terrol, we had always described our approach to design as *computational*, since we preferred to create our own design tools rather than purchase them. This meant we could use a very fundamental type of language, computer code, to build up our concepts, whatever these may have been. Our exchanges with Terrol taught us something else: that with any technique—whether one calls it craft or computation—there exists a certain disengagement from the object being formed; the process becomes more about the *relations* around that object.

Terrol spoke of basket-making as a process that brings people together, both those around him and the ancestors through which he continues a tradition. He spoke of many voices in that object, as if each basket was, in essence, a conversation. So too, we began to think of making architecture as a conversation between themes of universal significance, such as geometry and matter, with the actual experiences through which these themes become manifest. It is a boundless and inspiring conversation, one that reminds us that designing can be about communing between two worlds: one entirely abstract and coded, the other very real and alive, like what we find through our interactions every day with people, communities, and cities. In the end, like those baskets, the truly inspired moment of design comes with the realization that neither of these worlds is of our own making—both were always there, and somehow discovered along the way.