A simple subdivision algorithm generates forms of bewildering complexity.

Michael Hansmeyer

New Order

Michael Hansmeyer's subdivided columns are creating a new, process-driven language of form.

Words **Jane Szita**
Photos **courtesy of Michael Hansmeyer**

Michael Hansmeyer is an architect and computer scientist who explores the use of algorithms and computation to generate new architectural forms. He is experimenting with the Doric column using his own software, which involves a subdivision algorithm that generates forms of bewildering complexity, which he assembles as thousands of sliced layers. He currently researches and teaches at the CAAD group of the Swiss Federal Institute of Technology (ETH) in Zürich.

For the sake of argument, Michael, do we even need a new language of form?
Michael Hansmeyer: You could ask, why search for anything new? It's human nature. We're driven by curiosity and we want to push boundaries. Architects have always used the newest techniques and materials, like steel in the 19th century. It's always about finding out what's possible given the tools of our time.

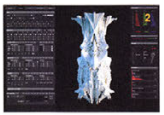
So what's the tool in this case?
It's a procedural approach to design, a system based on an algorithm. It's not about producing an object or a building, but about creating a system that can generate an object or a building. And it means we're no longer talking about single objects but multiples – a species or family of objects.

The hall of columns exemplifies this kind of approach.
Yes, we've just done exactly that for September's Gwangju Design Biennale in Korea, curated by Seung H-sang and Ai Weiwei.

Once the columns are designed, how are they manufactured?
Currently they can't be made in one piece, as they are too large for 3D printing, so I produce them as horizontal sections which are then piled one on top of the other. The first ones I made used layers of 1-mm-thick cardboard to replicate the shapes – 2700 of them. You need a core to align the layers. In early models I used wood, but lately I've switched to steel for more structural strength. You don't need to glue the layers together, because weight keeps them in place. The finished cardboard columns are 2.7 m tall and and weigh 650 kg. The latest columns I've made use ABS plastic, which is nice because it is less opaque than cardboard; light shines through at the edges. I've tried balsa wood, which was ...

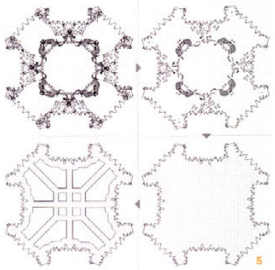
1 Screenshot showing the programme used to generate the column. The input is an abstracted Doric column. The process begins by taking each face of the column and dividing it into four faces. The new faces are subdivided again and again until the final form emerges: an intricate column composed of 16 million faces. Panels are used to control the subdivision process.

2 Screenshot showing the curvature plot of a detail. In this case, the degree of curvature is used to specify subdivision ratios for further steps.



3 Each subdivision step adds further levels of detail to the form. The first steps of the process influence the overall shape and its curvature; the next steps determine the surface development; and the final steps generate a minuscule texture on the broader surfaces.

4 Screenshot showing the programme used to calculate the slicing of the column into 2700 individual layers, which can then be laser-cut or milled from cardboard, balsa wood, plastic or another material.



5 Each layer is laser-cut out of 1-mm-thin cardboard sheets, which are stacked around a common core to produce a 2.7-m-high prototype. Owing to the column's surface features, the lasers travel a cutting path exceeding 19 km in length. Despite being partially hollow on the inside (6), a single prototype weighs an astonishing 880 kg. Further prototypes are being constructed using ABS plastic and other composites.

6 Each column is built up from 2700 1-mm-thin cardboard layers, arranged around a central core.

The system, not the designer, generates the form

... prohibitively expensive, and I've also experimented with different material thicknesses – 2 mm, which gives a less detailed result, and 0.5 mm, which looks wonderful but doubles the time involved.

Do you expect to make the columns using 3D print technology one day?
Absolutely – it may be possible in five or ten years. The slicing and layering approach is a stopgap. A certain aesthetic is achieved by layering, but it is a compromise. Right now, though, 3D printing is limited by speed, size, resolution and price.

What is the future potential of algorithmic design?
The question is: will we use it for optimization and problem solving – to improve circulation in a building, for example – or will we use it on a formal level? Both are possible, but I'm mainly interested in using it as a system to generate forms. Through setting up a simple system, you can generate forms of astonishing complexity – that's very alluring.

Also, algorithmic design will impact the role of the architect or designer of the future, since designing the system and designing the building or object are two different things and could be done by different people. I anticipate that more time and effort will go into the system than into the end products.

Do you anticipate the forms that result from your software?
Not at all – I never have a clue about what I'll end up with. It's an iterative process, and deterministic, yet in so many ways the output is unpredictable.

The columns look like strange natural forms – is there a biological principle behind them?
No. Biologists often comment on their organic look, but I've talked to these scientists, and it's clear that nature works completely differently, although the results may look similar. In any case, I have no interest in mimicking nature. I'm primarily interested in using simple processes to produce complexity. _

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The end result is visually intriguing and alluringly tactile.