

Thinking **Inside** The Box

SOM's BlackBox Studio optimizes design

By Lara Brown

For a convention center's roof in Tanggu, China, the architects at SOM's BlackBox Studio began their explorations with a shape already created by the firm's design team that met programmatic needs (it covered a single building organized into two distinct programmatic zones with large circulation spaces) and aesthetic needs (the undulations echo some of the curved patterns used throughout). For the wavy roof, they are initially looking to reduce highly loaded pockets of stress.

BlackBox Studio, a four-person team in SOM's Chicago office, spends much of its time finding optimum shapes during the conceptual design phase. Although the team does some strictly theoretical work, when its members contribute to the schematic design of a project, the process begins with the design informing the technology, not the other way around.

"Optimization' is a buzzword we're into," says Keith Besserud, AIA. He describes his group's goal as "finding a set of solutions that are all well performing" and describes the BlackBox team as "architects and designers who are able to bridge—pretty convincingly, I think—the worlds of design and technology."

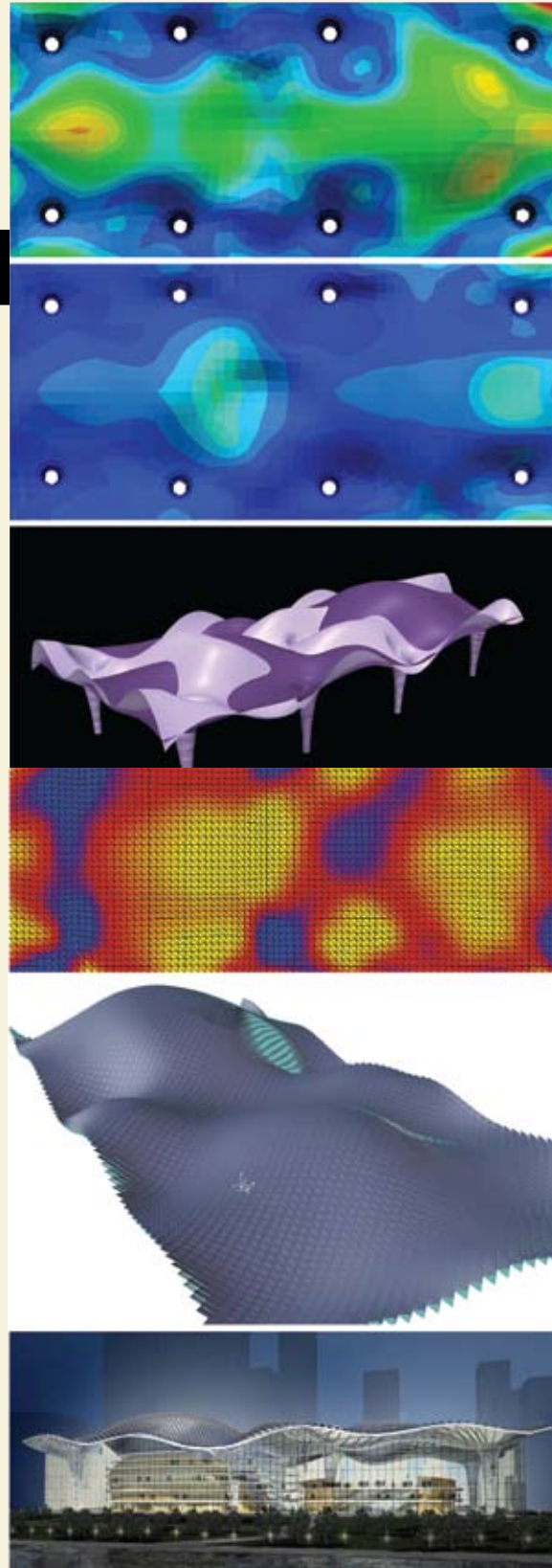
Besserud, who now heads the BlackBox Studio, had been practicing architecture for 20 years when he decided to take two years off to earn a master's degree in product architecture and engineering in an unaccredited program with an emphasis on computer science and programming at Stevens Institute of Technology in New York. All BlackBox team members have a Stevens Institute connection: Besserud and Josh Cotten attended from 2005 to 2007; Justin Nardone, 2006 to 2008, and Neil Katz, AIA, taught there in 2008.

When BlackBox team members set out in search of an optimal form, they are often evaluating forms in terms of structural, environmental or daylighting performance. For the Tanggu project, they will test the roof's form—in this case, they are testing it initially from a structural perspective—to determine the optimum shape. The roof's materials are not yet defined. So that the roof's form adheres to the designers' original concept, the parameters are set so that the numbers selected for generations of genetic algorithms stay within plus or minus five meters of the original number.

"Genetic algorithms robustly look for a solution," Besserud explains. "[Using them] allows you to iterate much more quickly through ideas."

Genetic algorithms—GAs for short—have been used since the 1950s to

In the images at right, BlackBox Studio explores the conceptual design for a convention center roof in Tanggu, China. The green areas in the first and second images represent the roof's higher stress loads (as viewed in Strand, a structural analysis program). The second image shows a form with reduced pockets of stress. The fourth image shows the roof's performance (in Ecotect) once solar fins are added. Solutions created by genetic algorithms are transferred to Digital Project (third and fifth images) that show the form created by each solution, or genome. The bottom image is a rendering of the conceptual design of the convention center.



Images courtesy of SOM

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search for the best solutions in the fields of engineering, biology and mathematics. GAs are computer-generated, randomly assigned sets of data that are created to solve a user-defined optimum solution.

For the BlackBox team, the process of creating genetic algorithms involves entering the initial data points in the scripting—for the roof that means a total of 70 numbers representing points along the roof's seven splines; assigning parameters—suggested solutions should stay within plus or minus five meters of the original points; and letting the computer scripting search for optimal forms.

"The images show the progression—how it was resolving itself," Besserud says. Their explorations result in a shape that looks similar to the initial design but performs better from a structural perspective. In collaboration with the design team, an optimal form is selected and agreed upon, and the BlackBox team then investigates adding tilted solar panels to the roof, using genetic algorithms to test for the optimal shape of the panels.

Besserud counters the argument that this type of technology could minimize the authorship of architects by explaining the collaborative process and decision-making that goes into conceptual designs. For a military academy's windows in Kuwait, the designers knew that scalloped walls around the windows would reduce direct radiation from the sun; however, windows that were mostly shrouded would likely make for an unhappy client, as well.

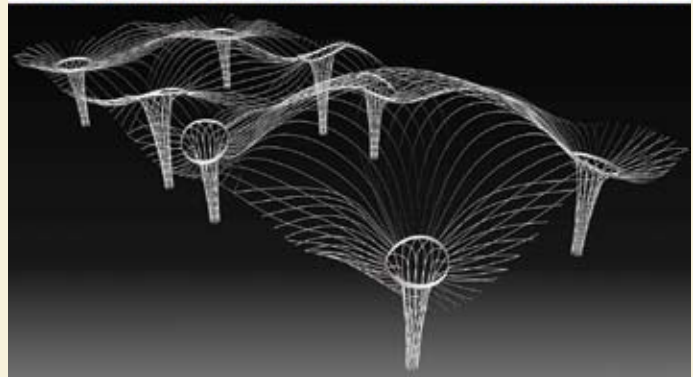
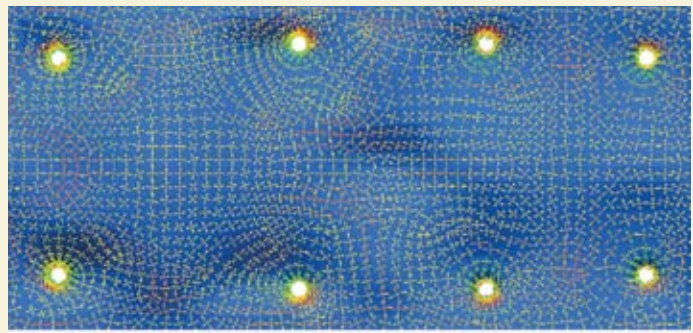
The BlackBox team incorporates a project's programmatic and site parameters into its scripting, so that, in the case of the military academy windows, no more than 10 percent of the window could be shrouded, thereby ensuring that functionality, common sense and good design are aligned. In this way, the BlackBox team acts as editor, and not author, of the original design.

Additionally, one solution may score as a high-performer, but be eliminated as an option if the design is cost-prohibitive, unattractive or inconsistent with the design intent.

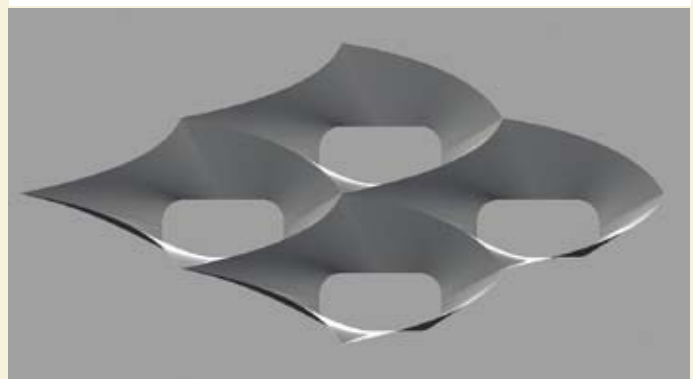
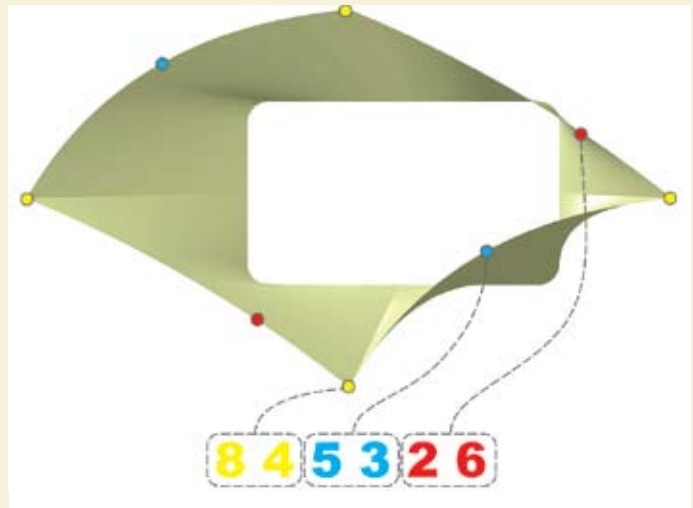
Although some of BlackBox Studio's work gets highly theoretical and experimental (ask Besserud about what makes a "happy building"), he is quick to point out, "It's an SOM tradition—we don't just do things for the hell of it. Even if we don't have all of the rules defined [for some concepts], we have created a framework for rules."

The group has contributed to projects in SOM's New York and Chicago offices. The military academy and convention center projects are, like so many other firms' projects, now on hold. Besserud acknowledges that even if the projects don't come to fruition, "we're increasing our knowledge bank, and the designers develop a better understanding of form to performance."

Besserud expects the profession to see more architects armed with computer "scripting as part of their design methodology." Asked if he considers himself something other than an architect, he flatly says, "No, I'm just an architect," and his computer programming capabilities are "just tools." CA



The image in blue shows the roof's stress trajectories, as depicted in Strand. The black and white image shows that same form in Digital Project.



For a military academy's windows in Kuwait, eight numbers represent points along the windows' geometry. Genetic algorithms will create new forms by randomly changing these eight data points. Scripting parameters keep the design on track and in search of a user-defined optimum solution. A spreadsheet or database maintains the results and the genomes' performance scores. High performers go on to start the second generation. Each generation usually has 100 genomes, and the computer will run through 200-300 generations in search of the optimal form. The generations are scripted to explore mutations (randomly changing one value of a genome) and cross-breeding (randomly using half the data from one genome and half the data from another). This process takes days to complete.