

SmartGeometry Conference 2009

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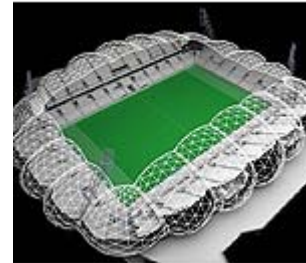
"Computers give us a huge new opportunity to change the way we think about design," said Lars Hesselgren, director of research and development in the London office of [Kohn Pedersen Fox](#) and a leader of the SmartGeometry Group. "What we want to do is to make the computer our partner, not an opposition, and not just a very simple method of recording and communicating, but actually actively helping us design things."

For some, what the SmartGeometry Group proposes might be too radical. For others, it's the beginning of a new architectural vocabulary. Its root is the architect's ideas and parameters, but the algorithmic grammar employed by the software is so complex that the outcome might be something the architect hasn't anticipated.

GenerativeComponents

Bentley Systems, the principal sponsor of the conference, has a vested interest in promoting the SmartGeometry Group's approach to design. Bentley developed its [GenerativeComponents](#) (GC) software in collaboration with the SmartGeometry user community, and GC has played a crucial role in several SmartGeometry projects.

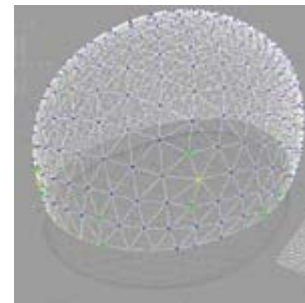
"This unique generative design software captures and exploits the critical relationships between design intent and geometry," according to Bentley's announcement of the conference. "Designs can be refined by either dynamically modeling and directly manipulating geometry, by applying rules and capturing relationships among building



SUBSCRIPTION SAMPLE

The roof structure of the Melbourne Rectangular Stadium by [Arup Sport](#) was defined using Bentley's [GenerativeComponents](#) software.

Image: © John Gollings, Cox Architects and Planners, MPV, and MOPT



In abstract topology explorations using an application they developed, Jonathan Rabagliati and Przemysław Jaworski of [Foster + Partners](#) sought to balance symmetry and asymmetry.

Image: Courtesy Jonathan Rabagliati and Przemysław Jaworski/ Foster + Partners



elements, or by defining complex building forms and systems through concisely expressed algorithms."

GC is available as a standalone product via subscription (\$250 a year in the United States). It can be operated with or without Bentley's flagship architecture package, MicroStation.

New Shapes on the Rise

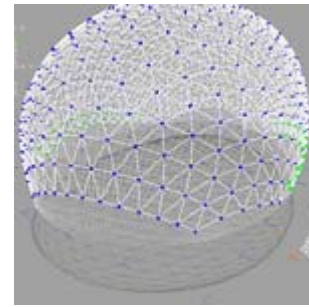
On Olympia Boulevard in Melbourne, Australia, a series of eggshell-shaped roofs with interlacing frames are going up. Still in its embryonic stage, the Melbourne Rectangular Stadium (20,000 seats, AU \$268 million) is an ambitious project, set to open three days before Christmas 2009. It's the work of Arup Sport, a division of the global design firm [Arup](#) that specializes in designing sports arenas.

Even if you have no interest in the rugby and soccer games that the stadium is slated to host, you'll marvel at the roof structure, which comprises a series of blossoming geometric shapes. John Legge-Wilkinson, Arup's CAD (computer-aided design) guru, explained, "To generate the stadium roof geometry, a 3D model of the stadium structure was created using building information modeling (BIM) software. Since the roof geometry was subject to a variety of changes throughout its life cycle, optimization studies of the stadium roof were undertaken that led to the development of the final geometric and structural design."

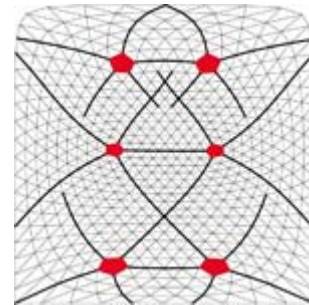
Tangible Geometry

For some of the attendees, one of the attractions was the 3D printer, a Z450 from Z Corp, that allowed the presenters to produce three-dimensional scale models of the complex designs envisioned in Bentley's

In this project, GC was driven by two scripts. The first involved variables to define the base geometry and test alternative geometric configurations to find the best structure; the



This topology exploration resembles [Buckminster Fuller's](#) classic geodesic dome, with variable element lengths. Image: Courtesy Jonathan Rabagliati and Przemysław Jaworski/ Foster + Partners



A 2D foldout of Rabagliati's automatic pattern generator, driven by embedded formulas. The application is programmed so that changes to the real-time 2D pattern formation are instantly reflected in the 3D sphere.

Image: Courtesy Jonathan Rabagliati and Przemysław Jaworski/ Foster + Partners [Extra Large Image](#)



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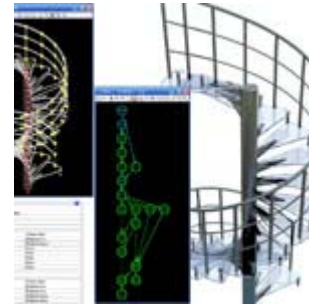
GenerativeComponents software. The digital geometric model can be exported to the 3D printer software as VRML (color-enabled) or STL (monochrome), then automatically constructed in the printer's build chamber.

second one was written to generate the lacing configuration for each individual roof segment.

"The optimization studies would not have been feasible without the ability

of GC to quickly regenerate the different geometric configurations and to export the data in a format that could be linked to the analysis software," said Legge-Wilkinson.

A steel ladder generated using the parametric interface of GenerativeComponents. Image: Jens Sauer/ Courtesy Bentley Systems



POPQUIZ

Sound Design and Play Space

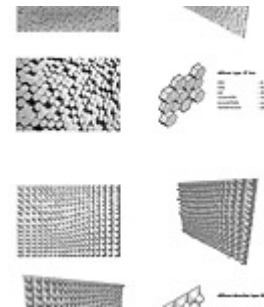
Brady Peters, an architect and Ph.D. student at the Royal Danish Academy of Fine Arts, spoke about "Parametric Acoustic Surfaces." Peters outlined how he investigated new interfaces between acoustical science and architectural design. "This project focuses on integrating computer-based acoustic simulation with new parametric computer-aided modeling techniques to develop complex surfaces that, through their shape and material, can be part of an acoustically well-balanced space," he explained.

His surfaces comprised complex patterns, built using variations of a base module developed to reduce vibration. "By investigating how architectural surfaces such as walls, floors and ceilings can be designed and detailed to be acoustically regulating, the project aims to develop integrated design solutions for sound in architecture," he said.

Another presenter, Jonathan Rabagliati, described his principal domain as "the generation, evolving, and analysis of 3D foam structures." For him, algorithm-driven forms and patterns are playgrounds to stretch his imagination. In their talk entitled "Playing with the Rules," Rabagliati and co-presenter Przemyslaw Jaworski, both from [Foster + Partners](#), demonstrated a software interface for real-time visualization of mesh patterns

Spiral stairs can be specified in Bentley's GenerativeComponents software.

Image: Jens Sauer/ Courtesy Bentley Systems [Extra Large Image](#)



Brady Peters of the Royal Danish Academy of Fine Arts generated acoustic walls patterned with modules designed to control sound.

Image: Brady Peters/ Courtesy Royal Danish Academy of Fine Arts [Extra Large Image](#)

automatically generated using computer scripts.

Not content to simply watch the automated process, Rabagliati and Jaworski developed a few tools to influence the geometric dynamic relaxation by introducing forced changes in topology. For instance, they could, at any given moment, execute a command to flip or collapse a series of triangles. The aim, Rabagliati explained, is to "find the balance that exists somewhere between symmetry and asymmetry."

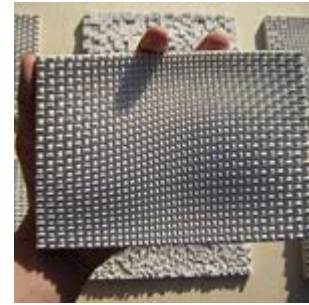
Pushing Sustainability to New Heights

When the geometric forms get smarter, they also get better at predicting their impact on the environment. In a group presentation entitled "Sustainably Tall," Judit Kimpian and Josh Mason from [Aedas](#); Jeroen Coenders from [Arup](#); Dan Jestico from [Hilson Moran](#); and Steve Watts, Brian Smith, and Neal Kalita from [Davis Langdon](#) tried to address an important question: are tall buildings sustainable?

Kimpian pointed out that, by simulating the traffic, parking, and developments a tall building would attract in an urban setting, Aedas's research and development team was able to demonstrate how a high-rise might change the character of the environment. By the same token, Aedas was also able to show that strategically erecting tall buildings near mass transit routes could minimize the towers' impact on the cityscape.

The analysis model developed by Kimpian and her colleagues could be used to examine correlations between energy use, carbon dioxide emissions, number of occupants, hours of operations, and other factors, for instance.

"Some of what we found was quite surprising to us," said Kimpian. "For example, [we found] that user energy, like computers, can account for over 50 percent of energy use in an office building, or that adding daylight



Peters's acoustic design permutations were fabricated using a 3D printer.

*Image: Brady Peters/
Courtesy Royal Danish
Academy of Fine Arts
[Extra Large Image](#)*

Click on thumbnail
images
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sensors can save as much energy as high-performance cladding systems."

Shaped by Rules

Simply put, SmartGeometry is about taking advantage of the computer's number-crunching capacity to generate designs based on parametric formulas. So part of those formulas could be rules aimed at minimizing energy costs, maximizing the use of natural light, and reducing carbon emission throughout the building's life cycle.

Developing such rules so as to apply reliably in the context of parametric geometry could be an emerging research trend in the near future.

Rabagliati said, "Architects and engineers are no longer restricted to pushing around an inert mass with a mouse or calculating dead loads with a pencil; they now are engaged in grappling with dynamic systems of positive and negative feedback loops."

"The new generation of architects are now more inclined to be modeling relationships," he continued. "They are now playing with the rules, negotiating and re-negotiating, generating and re-generating, finding new forms of organization and dynamic equilibrium at the threshold of order and chaos."

The 2009 [SmartGeometry Conference](#) took place March 27 to April 1 in the Palace Hotel in San Francisco, California.

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Kenneth Wong, a freelance writer based in San Francisco, has been covering the architecture software industry for nearly nine years. His writings have appeared in Cadalyst, Computer Graphics World, and Desktop Engineering, among others.



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