Freeing Up Architecture

Many of today's most striking buildings are nontraditional *freeform* shapes. A new field of mathematics, discrete differential geometry, makes it possible to construct these complex shapes that begin as designers' digital creations. Since it's impossible to fashion a large structure out of a single piece of glass or metal, the design is realized using smaller pieces that best fit the original smooth surface. Triangles would appear to be a natural choice to represent a shape, but it turns out that using quadrilaterals—which would seem to be more difficult—saves material and money and makes the structure easier to build.

One of the primary goals of researchers is to create an efficient, streamlined process that integrates design and construction parameters so that early on architects can assess the feasibility of a given idea. Currently, implementing a plan involves extensive (and often expensive) interplay on computers between subdivision—breaking up the entire structure into manageable manufacturable pieces—and optimization—solving nonlinear equations in high-dimensional spaces to get as close as possible to the desired shape. Designers and engineers are seeking new mathematics to improve that process. Thus, in what might be characterized as a spiral with each field enriching the other, their needs will lead to new mathematics, which makes the shapes possible in the first place.

Photo courtesy of Viceroy Hotel Group.

For More Information:
"Geometric computing for freeform architecture," J. Wallner and H. Pottmann. *Journal of Mathematics in Industry*, Vol. 1, No. 4, 2011.

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