AEC News

I want my Bilbao:
Architects and the Secret Move to 3D NURBS

By Siani Jones

During SIGGRAPH 2004, I found myself in the company of old friends—the solid modeling software developers for Rhinoceros known as Robert McNeel & Associates. Oddly, the Rhinoceros people were hosting architects during the event, and I couldn't keep my curiosity in check.

I say 'oddly'. I have known the Rhinoceros people for a long time and *kno*w that their activity is in 3D mechanical CAD by providing superb NURBS-based (Non-Uniform Rational BSpline surfaces) modeling for manufactured products. But I soon got re-educated. According to the Rhinoceros crew, construction projects of a style and type never feasible before are becoming possible with the use of 3D. It's the 'Bilbao' in every architect's dreams. And according to Eric Owen Moss Architects, Rhino makes it possible.

Before I get into depth about the use of Rhinoceros in architecture, I want to mention that I was told, by several authorities on the subject over the last year, that architectural firms are 'simply not interested in using 3D'. But they, and I by default, are proven wrong. Following various discussions, I believe that architects want to use 3D in a way that suits them—not as dictated by a specific software vendor. I believe there is a 'pull' process going on where architects are selecting their software of choice, rather than a 'push' process where software vendors dictate what their clients should use. And Rhinoceros is the beneficiary. Furthermore there is a general increase in interest for the use of solid modeling in construction: as evidenced by fledgling companies such as StructureWorks, a civil engineering product based on SolidWorks, and Digital Project from Gehry Technologies, based on CATIA. Both of the core products are solid modeling systems focused on manufacturing. This is definitely an underground movement, and only time will tell where this trend will lead, but the general feeling is positive.
Eric Owen Moss Architects is well-known: With more than 50 major design awards under its belt, the company works all over the world, but is possibly best-known for its careful renovation work in parts of Culver City, California. Most striking about its designs is the creative use of glass within the structure. According to Eric McNevin, an architect at the firm, this has been enabled by Rhino3D.

In Eric McNevin's words, "All 2D detailing at our firm is a product of AutoCAD. All 3D modeling is performed in Rhinoceros. We use the Flamingo plug-in (to Rhino3D) for rendering. We used to use AutoCAD exclusively for the 3D work but we entered into a phase of projects that required such complex #D modeling that it simply couldn't cope. We tried 3D Studio but we needed to be able to model complex and non-conforming shapes. It simply did not meet our needs. The first software that worked with any accuracy was Rhinoceros, and we have been using it exclusively for 3D for three years now."

McNevin made clear that Rhinoceros has developed two defined roles in their architectural practice. First, Rhinoceros is highly involved during the design and testing phases, in combination with physical models, to ensure that a design is feasible, that it meets the clients' needs and that it receives the appropriate approvals. Second, Rhinoceros data is able to seamlessly communicate the 3D information into a system like AutoCAD for 2D detailing "The integration between Rhinoceros and AutoCAD is almost seamless," he said. "We do highly accurate modeling in Rhinoceros and can then pass it directly into AutoCAD for detail creation. This has been very important."

During the design and testing phase, Rhinoceros has also added some benefits to Eric Owen Moss: its ability to work directly with desktop milling machines to assist with the creation of 3D physical models has been exploited by the company. Using Rhinoceros and the milling machines, creation times for physical models are being shortened by rapidly milling parts of the model directly from Rhino.

Another benefit noticed by the company has been the ability of the 3D model to improve the pricing and manufacture of specialty parts within the construction. "All the vendors we work with are now plugged into Rhinoceros and are able to use the 3D models. This has meant that constructions that used to be very, very difficult have become feasible – challenging yes! But with the level of detail and accuracy we can now get, these creations are workable," said McNevins. It also means that costs associated with complex-shaped buildings are becoming more manageable, since the suppliers can very accurately and quickly manufacture exactly the right part.

Talking to Scott Davidson at Robert McNeel, I asked him why Rhinoceros' NURBS-based architecture is providing what these architects want. "Rhinoceros is actually a hybrid modeler that uses both surfaces and solids to create exactly what shapes you want," explained Davidson. "Because of the way it is built, it is highly accurate and this differentiates it from a mesh-modeler that is less precise. In addition, mesh modelers cannot create accurate crosssections—something that is critical in any construction project, and more so when the shape of the building becomes non-conforming."

Mesh modelers use a large amount of tiny, flat surfaces (polygons), or facets, to approximate a surface. If the intended surface is planar, the representation can be perfect. If the intended surface is curved, however, that curved surface can only be estimated, because the amount of applied facets is finite. Increasing the amount of facets can raise the approximation quality but perfection can never be reached. By contrast, NURBS-based modeling uses a series of coordinates and mathematical equations to define a curve in 3D. This curve can be perfectly represented using this method. The same curves can also be accurately represented in a full solid model (as opposed to a hollow model made up of surfaces alone) which allows cross sections to be created accurately.

According to Davidson, Rhinoceros was not built with any sole vertical industry in mind. It was designed to provide accurate and easy-to-learn solid modeling. The initial market for Rhinoceros was the product design market, but the software has seen a keen uptake by architects and others in the construction industry. In addition, the software has benefited from

several plug-ins and integrated applications that enable high-end rendering (Flamingo and Brazil), site survey data integration (EasySite), Cabinet design (Butterfly3D), and Tensile structure Form Finding (For-Nurbs.)

What Rhinoceros does not have are the utilities and tools that are generally available in other architecture-focused CAD products, such as window generation, parametric doors, cavity walls and so on. "Rhinoceros was designed to be a great free-form modeler with highly accurate design," stated Davidson. "It works great as a complement to the traditional architectural CAD systems at a price that architects can deal with." Pricing for Rhinoceros is $895. Plug-ins are extra.

I still want my Bilbao

"The second CAD revolution is upon us," stated Malcolm Davies, COO, Gehry Technologies during an interview. "We are now approaching the 'tipping point' when sufficient numbers of designers want more. They want to have the ability to create and model whatever forms they can imagine. And they want to be able to automatically extract drawings."

Davies contends that the concept of building information modeling (BIM) has been widely discussed and yet has only gained a little traction. However, leaders in design and construction are beginning to see that there is really something they need and are responding by finding the solutions that suit them.

"By utilizing powerful data-driven solids modeling systems from the aerospace and automotive industries and by extending the BIM concept through to construction and fabrication and by using innovative digital contracts, the reality and benefits of digital contracting are now available. Fewer errors, fewer change orders, lower risk, lower bids, faster construction, and a higher quality end product," Davies said.

"We are witnessing an anthropomorphic movement here with the use of solid and NURBS modeling in construction," stated Davidson at Robert McNeel. "Ever since the opening of Bilbao (the Guggenheim Museum in Bilbao, Spain), it seems every city, municipality and owner wants their own version. Everyone wants their Bilbao."

It is obvious that the drumbeat of technology is affecting architects. But they are not going to be dictated to, or driven towards a technology concept such as BIM that does not seem to inspire. While we could spend some time dissecting the BIM message, I am further tempted to extend the entire BIM conversation to cover PLM (BIM for the manufacturing industry if you like) but this will result in a horrible mess of emotions and angst. No. I am much happier to sit back and observe as more people find ways to get their Bilbao.

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