Autodesk University 2012

Beyond Massing: Conceptual Design Tools in Autodesk® Revit® Architecture 2013

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AB3555 - In this class, you will learn about the powerful Conceptual Design Tools in Autodesk Revit Architecture 2013. You will learn how to use these tools to create precise, free-form designs quickly and directly. You will also see how these tools integrate into and complement existing workflows and products in the Autodesk portfolio.

About the Speaker:

David Fano is a founding partner of CASE, a virtual design and construction (VDC) and integrated-practice consultancy based in New York City. At CASE, David is primarily responsible for leading technology implementation, knowledge capture and sharing, social media initiatives and business development. He designed a BIM curriculum for Autodesk that incorporates the use of BIM methodology for conceptual design and has provided firmwide BIM support, training and guides to clients such as Woods Bagot, Pelli Clarke Pelli Architects, and Skidmore Owings & Merrill. David has also contributed to the design industry with the development of DesignByMany.com, a challenge-based virtual design community and DesignReform.net, a digital design publication and free tutorial resource for design professionals.

David previously worked at SHoP Architects where he held the position of Director of Technology Research. His responsibilities included managing technology R&D initiatives and developing "direct to fabrication" initiatives with software manufacturers and fabricators through the use of BIM.

Since 2006, David has been an Adjunct Professor at Columbia University's Graduate School of Architecture, Planning, and Preservation where he teaches seminars and workshops focusing on the impact of technology on design processes. David received his Master of Architecture with honors from Columbia University where he was the recipient of the Lucille Smyser Lowenfish Memorial Prize and the Computer Aided Design Honor Award.

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This Class will cover the following topics

Concepts

- **Solid Modeling**
- **Parametric Modeling**

Massing

- **Direct Manipulation**
  - Create form
- **Mass Scheduling**
  - Mass Floors
- **Parametric Mass**
  - Reference planes
  - Parameters
  - Design with controlled variations.
  - Construct an parametric building mass

Surface Modeling

- **Parametric Surfaces**
  - Create form
  - Parameters

Concepts

Solid Modeling

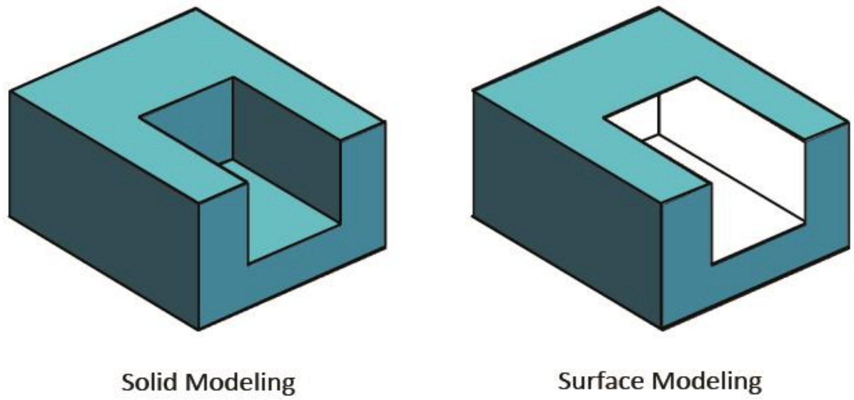

Figure 1: Differentiation between solid modeling and surface modeling

Solid Modeling is a technique in computer-aided design (CAD) that allows for the representation of solid objects. Its primary uses are for fields such as architectural design, engineering analysis, computer graphics, animation, product visualization, and rapid prototyping, among other things. Originally, solid modeling software used one of two methods to define solid shapes, either constructive solid geometry (CSG) or boundary representation (B-REP). CSG uses solid primitives such as rectangular prisms, spheres, cylinders, and cones, and boolean operations such as unions, subtractions, and intersections to create a solid model. B-REP methods, on the other hand, begin with one or more wireframe profiles and generate a solid model through one of various processes such as extrusion, sweeping, revolving, or skinning. Additionally, solids can be constructed through a sewing operation, which is a process of combining surfaces that often have complex shapes. Because each of these solid modeling processes have their own advantages and limitations, it is often most beneficial to generate solid models using a combination of both CSG and B-REP techniques. Autodesk applications use a hybrid of these techniques with AutoCAD® 2013 and Autodesk® Revit® Architecture 2013 providing native support for solid modeling. Models created by sewing surfaces in Autodesk® 3ds Max® 2013 and Autodesk® Maya 2013 can be exported as DWG files and converted to solids using AutoCAD 2013.

Parametric Modeling

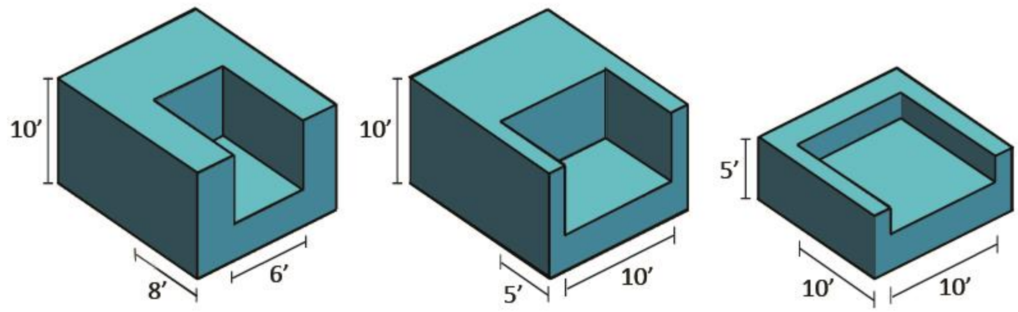

Figure 2: Precisely controlled modification of a parametric geometry

A parameter, in its most general sense, defines a system and determines the limits and performance of the system. A feature of some CAD applications is the ability to construct a model parametrically. Within a parametric model, each entity such as a primitive solid, a line, or fillet operation possesses associated parameters. These parameters control the various geometric properties of the entity such as its length, width, height, radius, and so on. They also control the locations of these entities within the model and how entities relate to one another. For example, geometric entities can be located at the origin of a curve, the midpoint of a line, or the vertex of a face. Additionally, the parameters can be adjusted by the operator as necessary to create the desired geometry. This process is known as *parameterization* and is essentially the specification of a point, curve, or surface by means of one or more variables that take on values in a user-specified range. Parametric modeling is significant for conceptual design because it enables designs to be modified and controlled precisely, as long as these modifications are within the limits of the system. Revit Architecture provides a comprehensive set of parametric modeling tools, while both Maya and 3ds Max implement parametric behavior based on construction history. AutoCAD provides a new parametric drawing environment that allows for the creation of 2D geometric and dimensional constraints and relationships, in addition to dynamic blocks.

Massing

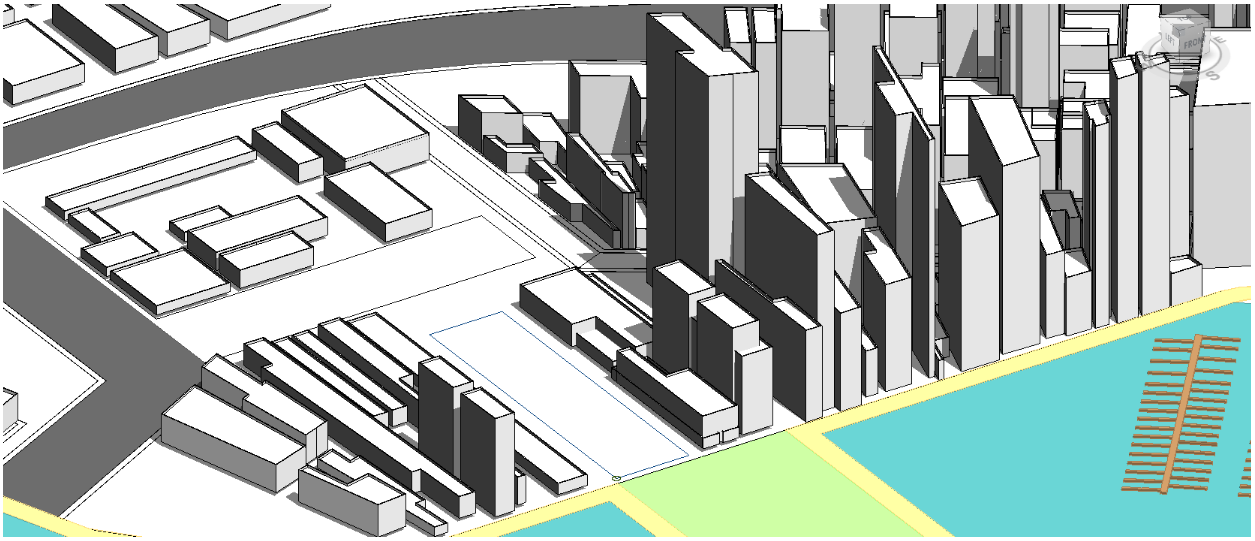

Figure 3: Revit project model

The site for this demonstration is a waterfront property located along the boardwalk of a coastal city. The existing architecture of the area is composed of many mid to high-rise commercial and residential buildings. We will design and model a water front complex to act as an iconic structure among its urban surroundings.

Direct Manipulation

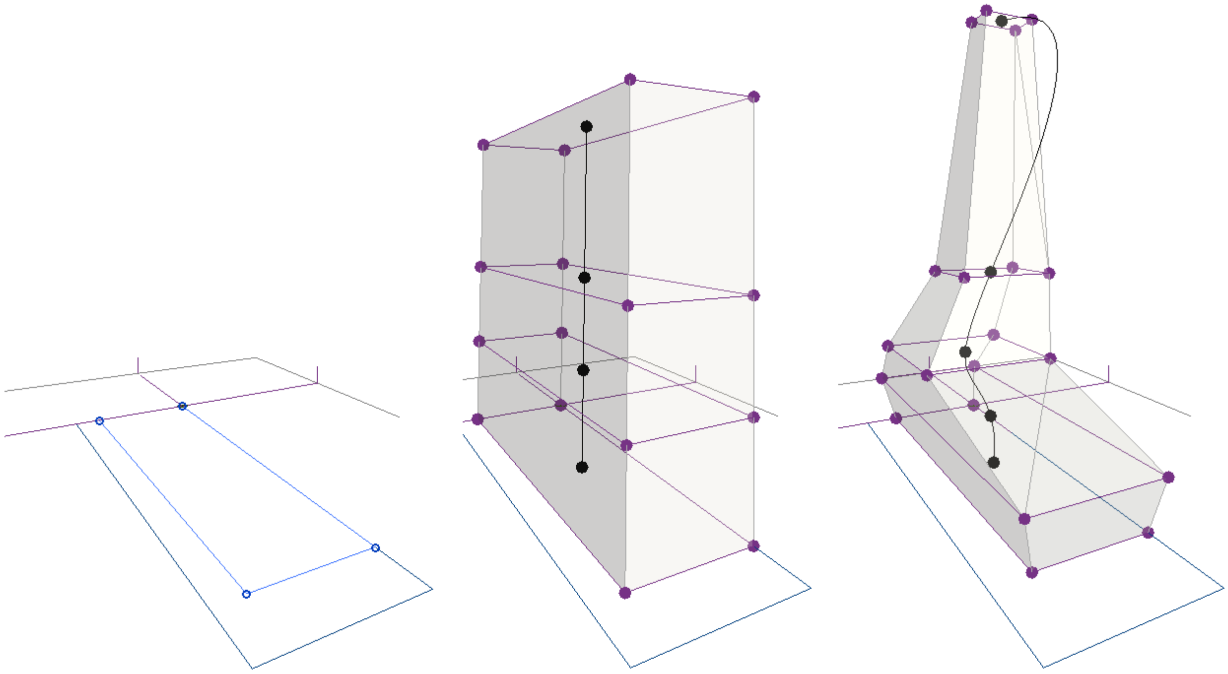

Figure 4: Revit mass family

The new Conceptual Mass environment supports both surface and solid modeling workflows. The solid modeling workflow maintains the benefits of working with mass families, such as the use of the Building Maker tools, while also providing new direct manipulation tools that significantly enhance the ability to create quick, iterative design models. In addition, now surfaces can be created and manipulated using the same tools and thickened to create solid masses

We will begin with a Mass family and create the outline of the site. Importing a CAD file as a basis can also work to ensure that your models (family and project) are aligned. One you have a profile, extrude it to create the base of the building mass. To manipulate the mass extrusion, you can adjust the positioning of vertices, edges, or faces, as well as insert edges and profiles to add additional detail. Here we can perform a series of explicit modeling operations to the mass in order to sketch out the overall form, and then begin to control variations of the mass by adding parameters.

Mass Scheduling

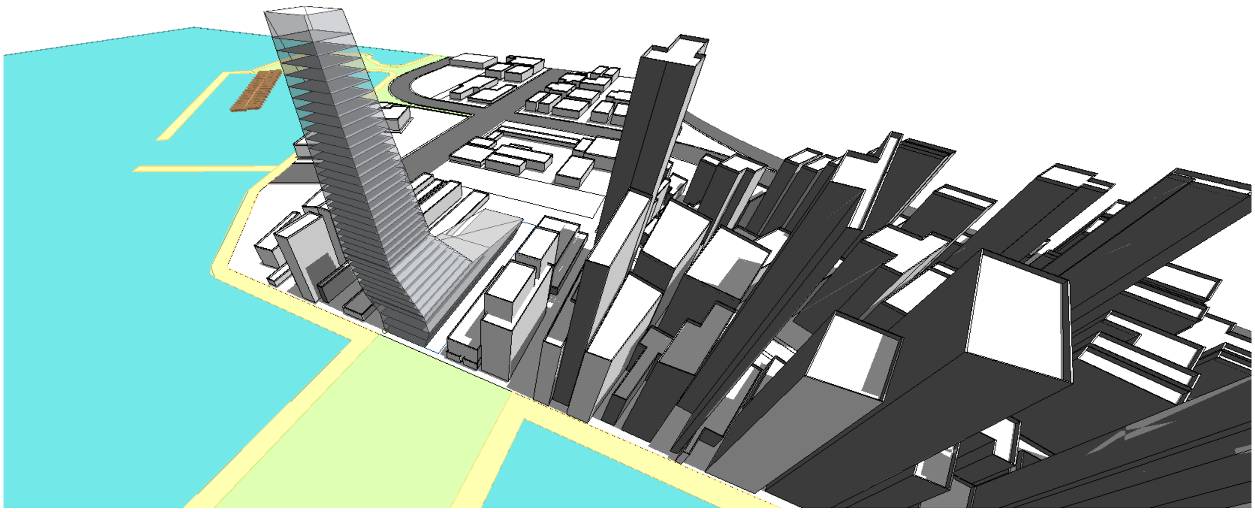

Figure 5: Revit mass within the project with mass floors

In order to understand the impact that our urban design decisions will have on the programmatic requirements, we load the mass into our Revit Project. Once in the project we will create mass floors and calculate the building area with a mass floor schedule. Switching back to the conceptual mass editor, we can modify our design changes numerically by adding reference planes and parameters.

Parametric Mass

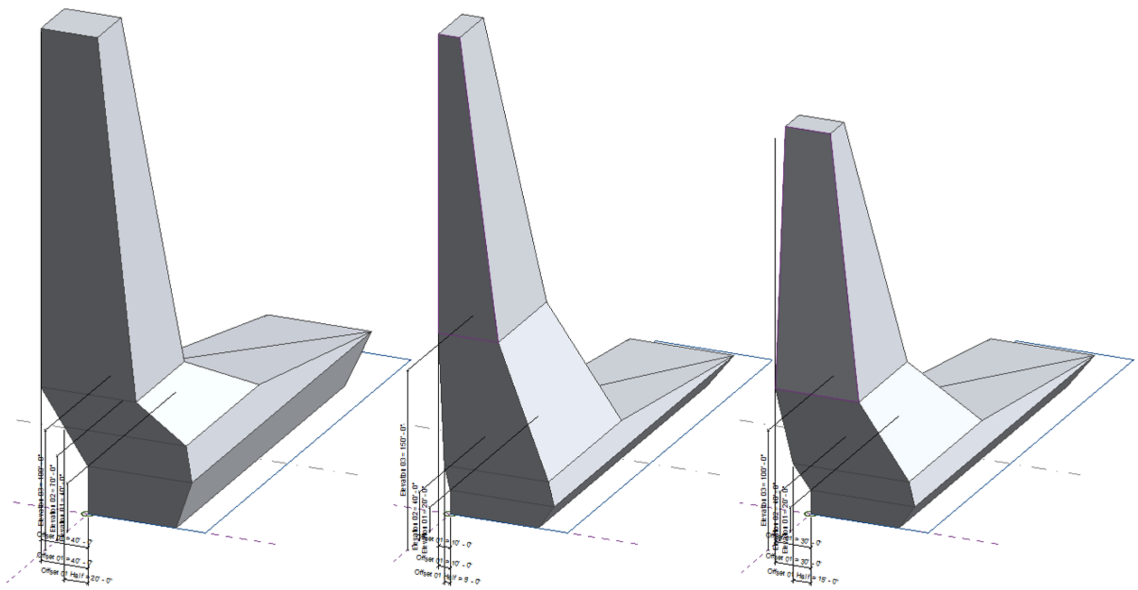

Figure 6: Process and development of instantiating a component onto a surface of a parametric system

The transformations made to the building mass until this stage was through processes of direct manipulation. In order to more precisely explore variation, you will add dimensional parameters, enabling increased degrees of control through numeric input. With the introduction of these dimensional parameters, the model can be modified using both numerical and graphical means. The first dimensional parameter that you apply to the building mass is a height constraint, which you use to control the overall height of the mass. Once this constraint has been applied and changed, you will see the building mass update, affecting the initial form. From here, you can implement additional dimensional parameters as you find necessary to control the mass. In addition to the height parameter, you add a width constraint, as well as a constraint to control the proportion of the sectional profile. To ensure that the parameters are referentially linked and working together to create an associative system, you can defined the parametric formula of the width and sectional constraints using proportions based on the building's height. Rather than using a single numeric value, you use existing parameters and mathematical operations to create relationships between different elements. Defining parameters in this way ensures associativity between all parameters that describe the building mass and can assist in arriving at a more cohesive final product. Using parameters give us the ability to make changes directly from within the Project environment, so that we can get instant feedback on our area schedules.

Surface

Parametric Surface

Figure 7: Process and development of instantiating a component onto a surface of a parametric system

Here we will use a series of parametric arc on reference plane to build a parametric surface that will serve as the enclosure for a small pavilion structure. Once we have the arcs we will create a loft with the create form tool. It's important to note that we will be using reference lines and not model lines, this will maintain the parametric control of the curves and not allow them to be consumed by the create form tool. To modify the system, within the massing environment you can either adjust the reference planes to change the length of the pavilion or change the dimensions of the arc to increase the radius of the pavilion sections. This ability gives you increased opportunity for design exploration within the system. It is also characteristic of a top-down approach to design, as adjustments are made at a global level, affecting the entire system at once.