Virtual Campus 101

A Primer for Creating 3D Models in ArcScene

By Suzanne Gross and Patrick J. Kennelly

The C.W. Post College of Long Island University is a 307-acre campus located 25 miles east of Manhattan in the town of Brookville, New York. This article documents the cyber-groundbreaking of the C.W. Post campus. The Department of Earth and Environmental Science has begun building a three-dimensional model of the campus. The project is not a completed virtual world, but it is a work in progress that will provide a framework for encouraging the campus community to interact and learn about GIS.

The three-dimensional model presented in this article was completed during the fall semester of 2004. It resulted from approximately 80 hours of paid student work and eight hours of faculty advising. This three-dimensional model was built on a student accessible PC (Pentium 4, 3.8 GHz, 1 GB RAM) using ArcGIS ArcInfo as well as the ArcGIS Spatial Analyst and ArcGIS 3D Analyst extensions including ArcScene.

Below: A view looking south at the campus. The southern portion of the campus seen in the background is set on a hill. Widths and shapes of sidewalks and roads on campus are highly variable, lending these features to being represented as polygons.

Gathering Data

Before the campus features could be rendered in ArcScene, shapefiles of these features had to be created. Data for these features was gathered from several sources—AutoCAD files, orthophotos, and scanned paper maps; some data was also collected directly in the field using a handheld GPS receiver.

The AutoCAD files, from an architectural plan for the campus that was previously created by an outside firm, were submitted to Brookville with permit applications for new buildings. Three detailed DXF files of the campus included locations of buildings, roads, parking lots, sidewalks, forested areas, individual trees and hedges, fences, light poles, fire hydrants, and contour lines at two-foot intervals. These files were originally in a local coordinate system but were projected into North American Datum of 1983 (NAD83) New York State Plane Long Island coordinates.

The second data source is 1' x 1' color orthophotography from 2000. This imagery, part of the New York State Statewide Digital Orthoimagery Program, can be downloaded at no cost from the New York State GIS Clearinghouse (www.nysgis.state.ny.us/). These images were used to locate features absent from the AutoCAD files, such as bus stops; orient and properly size transitory features, such as cars parked in lots;

Shapefile Name	Type
Campus boundary	polygon
Roads	polygon
Sidewalks	polygon
Parking lots	polygon
Buildings	polygon
Forested areas	polygon
Trees and hedges	point
Fences	line
Contour lines	line
Bus stops	point
Fire hydrants	point
Light poles	point

Table 1: Shapefiles.

Part of one of three detailed AutoCAD drawings of the C.W. Post campus used as a data source.

A digital orthophotograph, showing a portion of the C.W. Post campus, that can be downloaded from the New York State GIS Clearinghouse.

and verify features from the AutoCAD files. The data was separated into the 12 shapefiles listed in Table 1.

Making a Virtual Campus

The two-foot interval contour lines provided detailed base elevation information for the entire campus. The contours were converted into a triangulated irregular network (TIN) to create a smooth, continuous surface across the campus. To create the TIN, the contours were used as mass points and the campus boundary polygon was used as a hard clip line in the triangulation process. The resulting TIN honors z-values on the contour lines; uses spot elevations (that were represented as two short, crossed line segments on the contour layer in the AutoCAD drawings); and does not extrapolate z-values outside the edge of campus where detailed elevation data was not available.

Roads and sidewalks were mapped as polygons rather than lines to control the width of the roads. This also allowed surface textures, such as asphalt and concrete, to be applied in ArcScene.

Parking lots, buildings, and forested areas were also mapped as polygons. Initially, these five polygon layers were symbolized with appropriate textures and colors and overlaid on the TIN on which a grass texture had been applied. However, when using this method, portions of the grass-textured TIN bled through the other polygon layers that obtained base height from the TIN. The result was that odd patches of grass appeared in places such as in the middle of a parking lot where they were not actually present.

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This occurred even if the parking lot polygons were offset from or extruded above the TIN.

Because nearly every feature that wasn't road, parking lot, sidewalk, forested area, or building on the campus was grassy lawn, a land use/land cover layer was created that assigned all areas on campus to one of these six categories. This eliminated the display of random, phantom grass. Also, sharp edges could be displayed between adjacent features by offsetting one feature type with respect to another. For example, the roads and parking lots were offset by 0.3 meter (or approximately 1 foot) from the sidewalks, grassy areas, and forested areas to create a discrete white break between the two. In essence, this process created a virtual curb one foot high.

By mapping the forested areas as polygons, points representing individual trees could be generated at random locations within the polygons. In this model, points were generated using a dot density display in ArcMap and exported as a point shapefile using a script obtained from the ESRI knowledge base. Virtual forests for this campus were created using four different point files, each with a different dot density. This resulted in random point placement and the ability to use four different types of trees that produced forests with more variety: different species, sizes, and colors of trees.

It was important for some point features to be oriented in a particular direction. For example, the bus stops had to face the street. To achieve this, a rotation field was added to the attribute table, using 0 to 360 degrees as the value range. Rotation values were entered for each feature that needed adjustment and used to rotate the objects in ArcScene.

To give the buildings height, they were extruded based on height values from the attribute table. To capture the varying colors of the exterior walls, trim, and roofs of the buildings, two more copies of the buildings shapefile were added to the ArcScene project. The three identical building layers were then offset vertically so they would be layered on top of each other. The extrusion values for each copy of the shapefile were also adjusted so the buildings would retain their correct height. The polygons were then symbolized with colors, based on exterior color values from the attribute table. The resulting variations of colors match the general exterior colors for each building on campus.

Right: Three copies of the buildings shapefile were added to the display and assigned colors to represent walls, trim, and roofs. Heights were extruded so that the three building layers are stacked on each other and take into account the height of each building.

Adding More Realism

To add even more realism to the virtual campus, two additional shapefiles were created—one for cars and one for horses. Cars were placed in the parking lots, and horses were placed in the horse stables located on the campus. ArcScene includes an array of three-dimensional objects, such as cars, trees, light posts, fire hydrants, and bus stops, that were used in this model. In this rendering, five different makes, models, and colors of cars (available in ArcScene) were used to add variety and detail to the model. All cars were oriented based on parking spaces on campus, with the necessary degree of rotation stored in the Rotation field of the attribute table.

Importing three-dimensional objects is simple. To add horses, points in a new shapefile were scattered around the stables. These points were given various orientations specified in a Rotation field in the attribute table. A free three-dimensional horse model was downloaded from the Internet and added as a 3D marker symbol. Fences in the stables area are numerous, but were easily included by saving line features on the fence layer from the AutoCAD drawing as a shapefile and then applying a 3D texture line symbol representing a rail fence from the ArcScene 3D symbols.

Right: A portion of the 3D campus model that shows different land use/land cover features in close proximity. The roads and parking lots are offset one foot below the grassy areas, forested areas, and sidewalks. A rotation value is assigned to the bus stop to properly orient it with respect to the road.

Where to Go from Here

Additions and refinements can be made to any virtual model. However, it is possible the C.W. Post campus model may generate more interest and foster more participation on campus in its current state rather than a more realistic version. Nonetheless, there is a long wish list of enhancements for this model. The use of three-di-

Right: The stables on campus with a 3D model of a horse included at several locations. The complex pattern of fences was easily imported from the AutoCAD drawing of the campus. These fences can be displayed with 3D texture line symbols so gaps between the fence rails are transparent.
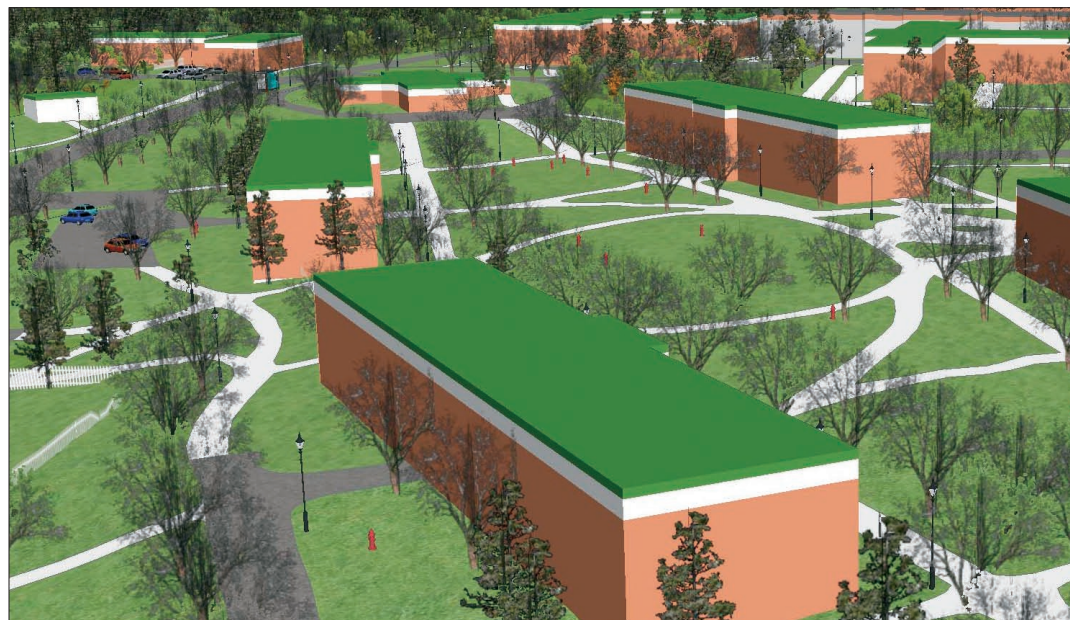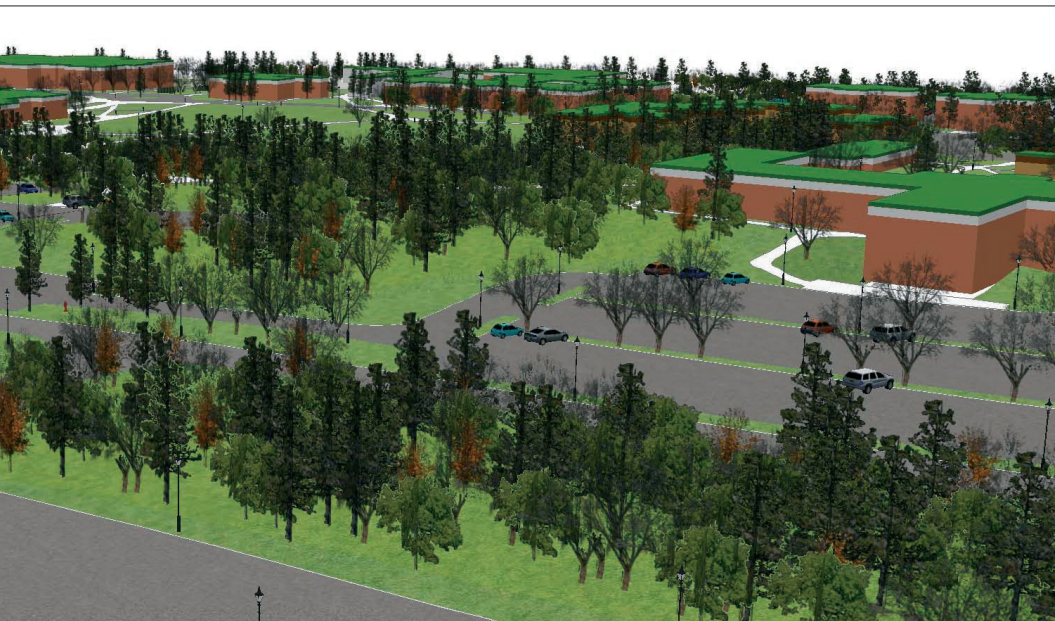
to create and render three-dimensional models, they do not use a geospatial format. Participation by students from the College of Visual and Performing Arts would undoubtedly lead to interesting visualizations that could include creating photorealistic buildings and incorporating them into the ArcScene model.

Conclusion

It is impossible to capture every detail from the real world in a three-dimensional model; however, that shouldn't stop GIS users from getting started. ArcScene, with its capabilities to display smooth surfaces, includes true three-dimensional symbols and textures and can extrude and offset two-dimensional features into three dimensions. ArcScene offers all the functionality necessary for anyone to begin the fun of creating a three-dimensional virtual world. For more information, contact

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mensional tree models based on actual species and the creation of three-dimensional buildings draped with images of the actual structures are two changes that would make the model more photorealistic.

C.W. Post's campus contains an arboretum with a large variety of trees. Images of these trees have not been captured digitally. After documenting the location of arboretum trees, more of the different 3D markers for tree species from ArcScene could be used to represent them. Such an assignment could prove to be an interesting and fun field exercise for students in the Biology Department and would introduce students outside the Department of Earth and Environmental Science to the power of three-dimensional display using GIS.

In addition to the College of Liberal Arts and Sciences, C.W. Post has a dynamic and vibrant College of Visual and Performing Arts. While students studying computer graphics learn how