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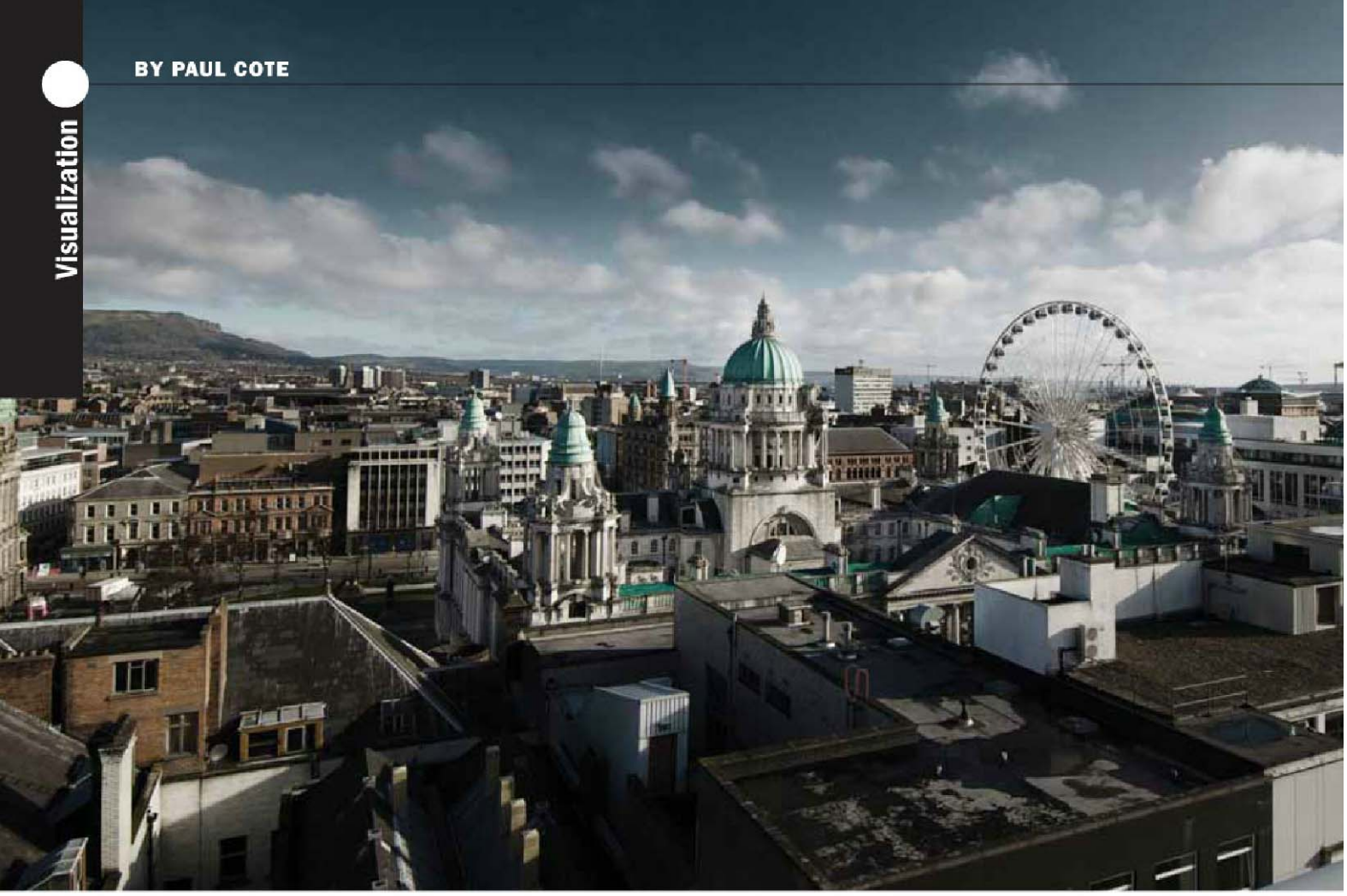
BY PAUL COTE



Where Are Samson AND Goliath?

3-D Experiments Model the Belfast Skyline

Belfast, a port city on the northeast shore of Northern Ireland, is undergoing a stage of renewal after years of paralyzing sectarian conflicts. Progress on the political front has brought about a renaissance of interest in using architecture and urban design to propel the city forward.

Predominantly composed of two- and three-story structures, Belfast provides many opportunities for planning landmark buildings that may be visible from many directions. A multidisciplinary team from the University of Ulster and Harvard University investigated how a GIS-based 3-D city model could be used to evaluate building proposals with regard to their visual consequences.

Some cities, such as Washington, D.C., were designed to visually connect distant neighborhoods and squares with a network of view corridors. In Belfast, the urban fabric has evolved without a conscious focus on visual connectivity. Nevertheless, the incidental location of landmarks has resulted in iconic views such as the cranes, Samson and Goliath, that stand where the ship Titanic was built (Goliath is visible at the right side of Figure 1).

Although the cranes no longer are used, they're protected and maintained because of their role as familiar and commemorative focal points on the Belfast skyline.

As Belfast develops more tall buildings, people may ask how a specific proposal may enhance or interfere with important views of landmarks such as Samson and Goliath. In this project, the team was particularly interested in exploring how a 3-D model might be used to evaluate the various aspects of site selection for landmark buildings and view-corridor protection.

A Virtual 3-D Model

To understand how places in Belfast are visually connected, it's worthwhile (and enjoyable) to explore the city on foot or by bicycle. The task is more difficult if the goal is to understand the impacts of proposed buildings:

- How would a particular building design be seen from a distance?
- Would it or block views of other landmarks?
- What would the views be from the building's upper floors?
- How would the demolition of existing buildings create new view corridors?
- How can Belfast take measure of important view corridors that are worth protecting?

These questions and experiments with alternative futures are much easier to explore with a virtual 3-D model.

The University of Belfast virtual model was created with two datasets obtained from the Ordinance Survey of Northern Ireland: a raster terrain model at 10-meter resolution and a planimetric layer that included building footprints.

A research assistant estimated and recorded the height of each building by visual inspection of oblique photos of the city from Pictometry Inc. In addition, the model incorporates an aerial photograph from Terrametrics Inc. exported from Google Earth Pro. These layers are brought together in ESRI ArcMap, which provides a database architecture that integrates large collections of geometric objects with raster terrain data and imagery. And the ESRI ArcGlobe application provides capabilities for 3-D visualization.

To test the applicability of the 3-D model, the team chose to study a building project in the initial phases of site excavation. The Obel Tower is conceived by its developer, the Lagenside Corp., as an "Obelisk set in Old Belfast." The 28-story tower will sit on the west bank of the Lagan River, at the eastern edge of downtown Belfast.

Expected to be completed in 2010, the Obel Tower will be the tallest building in Northern Ireland. The model of the Obel Tower (Figure 2) was created in Sketchup and made available through Google's 3-D Warehouse. The model was exported from Sketchup as a 3-D Studio format model and incorporated as a multipatch object in an ArcGIS geodatabase.

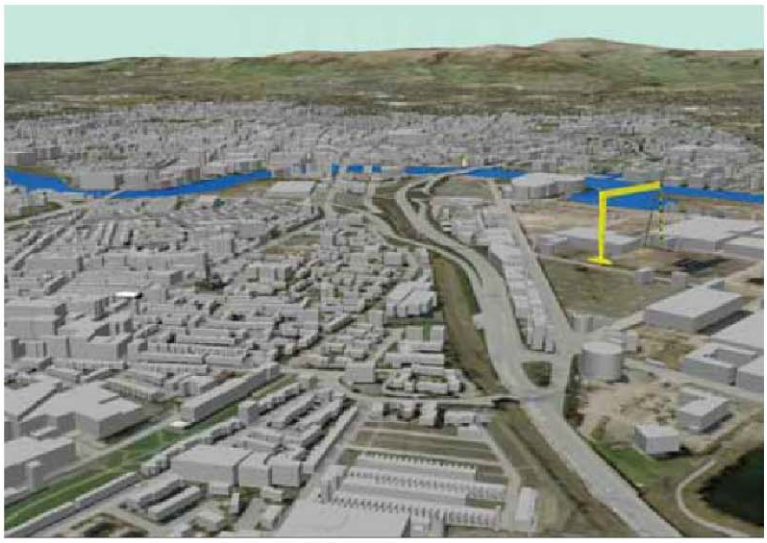


Figure 1. Belfast is bisected by the River Lagan and overlooked by two large gantry cranes, Sampson and Goliath.

Evaluating Landmark Potential

How well a building performs as a landmark is a matter of how well it can be recognized from other locations in the city. A direct way of exploring a proposed building's view impacts is to create street-level renderings of the building as viewed from far away. The GIS-based city model provides a means

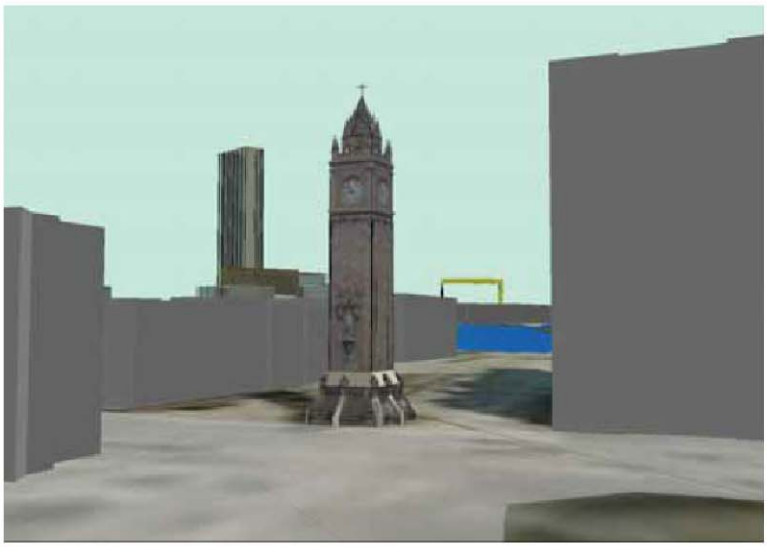


Figure 2. A model shows a pedestrian's view of the Obel Tower from in front of the Albert Clock.

to create eye-level renderings for studying potential views from specific places.

Figure 2 represents such a view of the yet-to-be-built Obel Tower as it would appear to a pedestrian on the plaza in front of another Belfast landmark, the Albert Clock (model courtesy of Inshore Surveys Ltd.). About two thirds of the Obel Tower is visible, including the base's southern end. The tower is certainly recognizable from this viewpoint. Recognizing a building from a distance may depend on how much of the building people can see and also may be determined by whether specific parts of the building are visible.

Evaluating specific views from a street-level perspective is useful, but it isn't likely to discover unexpected opportunities. The experiment's next stage was to develop a data model in which all views of the tower could be evaluated from a cartographic perspective.

The core of this method is the Viewshed tool in ArcGIS 3-D Analyst Extension, which can evaluate the visibility (from eye level) of an elevated point or set of points. A raster elevation model is provided to the Viewshed tool to provide the visibility obstacles or the clear space that views extend into.

To evaluate views of the Obel Tower, building polygons were rasterized and their heights added to the terrain model. Six view points were placed on The Obel Tower, dividing it into two parts vertically and three horizontal slices (see Figure 3). By casting a viewshed from each of these points, an estimate can be made of how well the tower might be recognized from any point in the city.

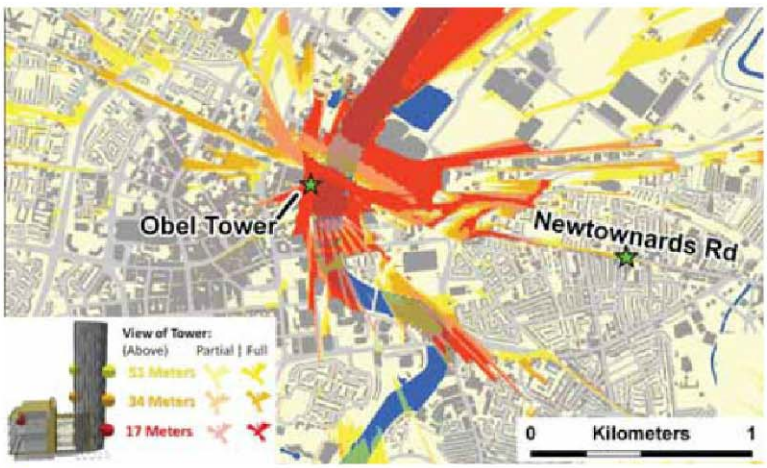


Figure 3. Six key points on the tower were chosen to evaluate view conditions that may be partially obscured.

Figure 4. The 3-D model indicates the view of Obel Tower from the Newtownards Road view corridor.

The cartographic rendering of Obel Tower view corridors (Figure 3) shows in dark red those places from which both sides of the tower base can be seen. From places colored dark orange, both sides of the tower above 34 meters may be seen. This map shows that the tower will be recognizable from distant locations along Newtownards Road to the east and along several other corridors created by roads, the river and elevated places quite distant from the tower.

Because the extruded representations of buildings are based on the footprint and don't include the stepbacks that many buildings have at higher levels, the estimation of visibility through the model is likely to be pessimistic (i.e., buildings in the blocky city model are more likely to obscure views than the real buildings would). Of course, the view corridors discovered through this process can be checked in the field and verified with photographs—even if the subject of the view hasn't been built. It's the gaps through the current landscape that are in question.

The perspective rendering depicted in Figure 4 simulates the view of an inbound motorist on Newtownards Road 1.5 kilometers east of downtown. This rendering shows how recognition of Obel Tower may provide the first visual cue that one is about to reach the central business district of Belfast.

It's not known to the modeling team whether the designers of Obel Tower chose their site or building design with creation of view corridors as a goal,

although this would be in keeping with their stated Obelisk concept. With the benefit of a GIS-based 3-D model, it would be easy to evaluate other site choices and variations of building placement in terms of how a site and building may enhance or detract from the city's visual character.

View Corridor Vulnerability and Protection

Quality of view may be a factor in a property's value. In most cases, the focus is on views from the property (e.g., views of water, open space or monuments). But when developing iconic buildings, a premium may be paid for a site that's highly visible from other locations.

If substantial investments are made based on view potential, it will be useful to evaluate the risks that today's view will be blocked by a future development. Steps then may be taken to restrict heights in a view corridor or buy or trade an owner's rights to build beyond a certain height within the specified corridor.

Figure 5 illustrates how the virtual model is used to construct a 3-D view corridor for the Newtownards Road prospect. The view-corridor model reveals the properties of concern with regard to view protection. The specific height limits that would need to be applied may be measured from this model.

Future of the Belfast Model

This pilot project created a snapshot of the city of Belfast. The project's next phase will be to develop a strategy for the model's routine update and enhancement, and it will be useful to develop guidelines for formatting and submitting georeferenced digital models. Many people may participate in this, and there already are several nice-looking models of buildings being submitted through the Google 3-D Warehouse.

Submitting digital models may become a requirement of the development-review process for tall buildings or buildings in sensitive corridors. An encouraging note in this regard is the recent addition of georeferencing to the Khronos Group Collada exchange specification for digital 3-D assets.

A simple relational database framework is under development that will form a scalable repository with virtually unlimited numbers of models of different levels of detail (a paper on this subject will be forthcoming at the GeoWeb conference in July 2009). It will be useful for future architectural historians to be able to review the many proposals that were made and their trajectory of revisions.

Models of proposals that are eventually approved can be incorporated into the virtual model as part of the existing condition. To ensure that the model's basic fabric doesn't become outdated, its custodians will require strategies for integrating data updates that originate with local GIS agencies.

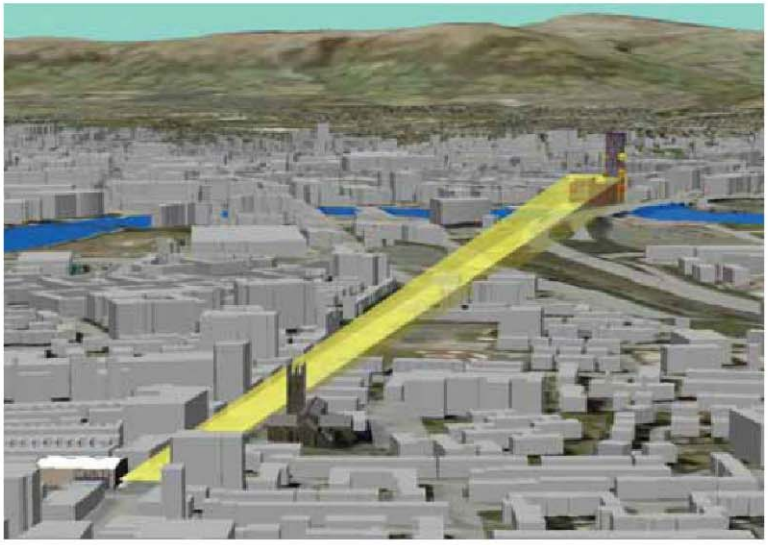


Figure 5. A 3-D view corridor reveals that only a few properties have the potential to encroach on the tower's view.

On this front, the Open Geospatial Consortium's recent adoption of CityGML as a versatile, stable and non-proprietary specification for exchange of city models is encouraging. Part of this strategy will be the extension of the model schema to include the temporal extent for each building, so the city model may be used to retrieve views of past and future scenarios.

Author's Note: *The project to develop a virtual model of the city of Belfast is being directed by Richard Sommer, associate professor of Architecture and Urban Design at Harvard University Graduate School of Design, and Visiting American Scholar at University of Ulster. Colleagues at University of Ulster assisting with the development and funding of this project include Alastair Adair, pro vice chancellor; Hisham Elkadi, head of Architecture and Design; and Abeer Shahhen, research assistant. Thanks also to Shane O'Brien of Inshore Surveys for the Albert Clock Model and Peter Ram for his model of the Obel Tower.*

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