

## cartographic techniques

### Looking Closer: A Guide to Making Bird's-eye Views of National Park Service Cultural and Historical Sites

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For an online gallery of NPS bird's-eye views and Quick-Time VR scenes visit: [www.shadedrelief.com/birds\\_eye/gallery.html](http://www.shadedrelief.com/birds_eye/gallery.html)

#### ABSTRACT

The US National Park Service (NPS) has long used large-scale panoramas, also known as bird's-eye views, to portray park sites where buildings and other human-made features are plentiful. This paper examines these bird's-eye views, most of which were produced by nationally renowned contract illustrators in a wide range of artistic styles. Both their traditional and digital work receive attention. A brief historical review looks at the antecedents of current NPS products dating back to the Renaissance. The practical second half of the paper focuses on how the NPS now designs these bird's-eye views with 3D software, with an eye toward cost savings. Topics include viewing parameters in a 3D scene, preparing DEMs, modeling buildings, designing trees, and creating environmental special effects. Two dozen full-color illustrations supplement the text.

#### INTRODUCTION

On the afternoon of May 31, 1889, following a night of torrential rain and years of poor maintenance, South Fork Dam reached its breaking point. The earthen structure gave way releasing three-kilometer long Lake Conemaugh in a deadly surge of water and debris—trees, houses, barbed wire, and livestock—that swept through Johnstown, Pennsylvania. More than 2,200 people died in the disaster, which ranks as the worst inland flood in US history. The former dam site is now a national memorial managed by the US National Park Service (NPS). To explain to visitors how the flood occurred, the NPS uses a sequence of bird's-eye views showing the dam deteriorating over time, ending with its failure (figure 1). Bird's-eye views such as these are commonly a part of the presentations that the NPS prepares for visitor use. They vividly depict



Figure 1. Johnstown Flood National Memorial, Pennsylvania. The South Fork Dam as it appeared when newly constructed (left), in a state of disrepair (middle), and breaching (right). Art by L. Kenneth Townsend. (see page 96 for full color version)

historical events and settings, and give a panoramic yet intimate view of places in a way that no other graphic, including a traditional map, can. In our fast-paced, distraction-filled modern world, bird's-eye views are a rare commodity for being able to “connect” with park visitors.

In this paper I examine how the NPS designs and produces bird's-eye views for the depiction of cultural and historical sites. The range of products includes artistic illustrations, such as Johnstown Flood—most of the other views deal with cheerier topics—and products with lines and labels that fall within the cartographic fold. The primary emphasis is on the digital 3D design and production methods developed by the NPS in collaboration with our contract illustrators. In the hands of a talented 3D artist, digital production methods yield bird's-eye views every bit as visually appealing as those produced traditionally. How we reached this level of refinement is a story worth telling.

The making of bird's-eye views is a difficult and poorly understood enterprise. Although they portray spatial relationships just as any proper map should, they nevertheless are a niche product on the margins of mainstream cartography. Art, architecture, computer gaming, movie animation, and the new field of urban simulation all have a stake, perhaps more deservedly than cartography, in the ownership of this genre. The conventions that guide cartographers in the making of traditional maps simply do not exist yet for bird's-eye views, although research has begun in this area (Haeberling, 2004). It should come as no surprise then that the people who make NPS bird's-eye views, regardless of their professional backgrounds, are by necessity self-taught.

To begin bridging this knowledge gap, the aim of this paper is to provide practical ideas for those making bird's-eye views, and to serve as a reference for clients needing to have them made. Knowing basic concepts and the right questions to ask is essential for all parties concerned. After beginning with a general discussion of bird's-eye views, the pages that follow look at the many design and production issues that go into the making of a successful view.

## BACKGROUND

The somewhat quaint term bird's-eye view, first coined circa 1600, is apt for describing the obliquely viewed perspective scenes that I discuss in this paper. They are a variant of the landscape panoramas painted by the late Heinrich Berann and others, but with the emphasis on the human environment rather than the natural (Patterson, 2000). Human-made structures on the surface of the land, such as buildings, fences, and dams, appear with three-dimensionality and dominate the scene.

Extremely large-scale depiction is another key trait of bird's-eye views. Notwithstanding an unfortunate Ruppell's Griffon Vulture that once collided with an aircraft 11,278 meters over Africa, most birds fly at altitudes less than 1,000 meters, and usually they stay within a few dozen meters of the ground (Whiteman, see references for URL). This altitude range is similar to the viewing elevation found on NPS bird's-eye views, a point much closer to the ground than that of a typical map. For example, cities and towns often appear on maps as small dots; the sites depicted on a typical bird's-eye view would take up at most a mere pinprick of the area within these dots. At these much larger scales even tiny details, including people and animals, become visible. Keen-eyed readers may have noticed the horse and carriage crossing the South Fork Dam (Figure 1, middle).

The ease in which readers can identify all features on a bird's-eye view is one of their chief advantages over traditional maps. At extremely close range in a scene we recognize the depicted objects based on observations in our everyday lives rather than the learned skill of map reading. As the virtual camera moves closer to the ground and the scale becomes increasingly large, you reach a point where realistic 3D depiction of surface objects becomes the preferred solution rather than abstract 2D depiction. In some cases 2D depiction is never feasible, for showing a horse and carriage on a dam, for instance. Most of the visual cues needed for identifying large objects (things that are bigger than we are) can be found in profile view in the vertical (z) dimension. We identify buildings by the windows, doors, siding, etc, observed on their exterior walls. How many of us know what the roof of the building we are currently in looks like from above? More difficult still, what does the building's footprint look like on a large-scale plan map?

Bird's-eye views also can reveal things that are difficult for a contemporary park visitor to see, such as how a place looked in the past. Possible examples include a crumbling archeological site portrayed as the vital place that it once was, a historic battle recreated on a field that today looks more park-like than bloody, and, as we have seen, simulating a dam break. A special use for NPS bird's-eye views is showing readers

the otherwise hidden interiors of buildings (figure 2). Finally, bird's-eye views go by many names. Among the words commonly mixed and matched together, often only according to whim, are aero, oblique, panoramas, perspective, three-dimensional (3D), renderings, scenes, simulations, views, visualizations, and, last but not least, maps. All are appropriate. In this paper I will attempt to stick with the term bird's-eye views. However, for the sake of variety and brevity I occasionally use the other terms.



Figure 2. Building visualization. (left) The Castillo de San Marcos, St. Augustine, Florida, lifted off its foundation. (middle) Buildings at Apomattox Court House, Virginia, that no longer exist, shown in ghosted form. (right) The interior of a barracks at Manzanar, California, revealed in an "X-ray" or cutaway view. From left to right, art by L. Kenneth Townsend, Chris Casady, and Don Foley, respectively. (see page 96 for full color version)

## Historical perspective

Bird's-eye views have a long history in mapmaking, and those produced by the NPS are a part of this continuum. Despite the predominance of planimetric maps today, up until two centuries ago oblique views were far more common, and the depiction of terrain and cities often revealed the three-dimensional nature of these features. It is only natural that early mapmakers drew cities in this manner; that is what the buildings in which they lived looked like. Perhaps the most famous early bird's-eye view is a 1502 map of Tuscany and the Chiana Valley by Leonardo da Vinci. On this oblique map the hills appear in profile topped with fortified towns. The city maps created in Europe during the Renaissance are the direct stylistic forebears of some bird's-eye views made by the NPS today (figure 3).

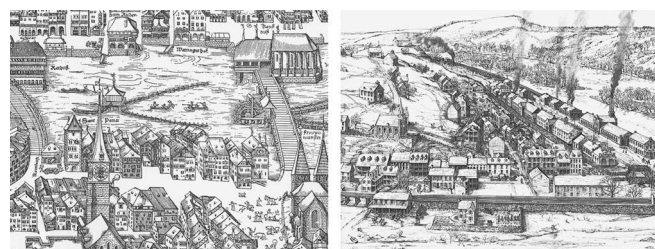


Figure 3. (left) A 1576 map of Zurich, Switzerland, by Jos Murer. (right) A map showing Harpers Ferry, West Virginia in 1860, drawn by Richard Schlect circa 1980. Zurich map source: Imhof, 1963. (see page 96 for full color version)

The decades from the late 19<sup>th</sup> to early 20<sup>th</sup> century were the golden era of bird's-eye views in the US. As towns and cities grew and became prosperous thanks to industrialization, it became fashionable and a matter of civic pride to advertise this newfound economic vitality in the form of oblique panoramic maps. Itinerant panoramists traveled from town to town primarily in the Northeast and northern Midwest mapping furiously as they went. Notable panoramists include Thaddeus Mortimer Fowler, who in his 54-year career generated more than 400 views, and Albert Ruger who published 60 views in 1869 alone (Hébert, 1984).

Fowler and Ruger did not go up in hot air balloons or strap miniature cameras to pigeons or kites to gather information for their panoramas. Instead, they stayed firmly on the ground drafting a street map in perspective based on a grid. Next, they walked through the town sketching the facades of buildings that would appear from the viewing direction that they had chosen. Finally, they drafted the final panorama, filling in detail from the building sketches they made in the field. As we shall see later in this paper, the techniques used by Messrs. Fowler and Ruger, overlooking the primitive technology of the day, have similarities to those of the NPS today. The US Library of Congress maintains an online collection containing some 1,500 bird's-eye views of cities in the US and Canada made during the Victorian and Edwardian eras (see references for URL).

As industry in the American heartland waned in the mid-20<sup>th</sup> century, so too did the making of classic bird's-eye views. This relatively quiet period of time, however, did see the publication of several notable pieces, including an axonometric view of Manhattan published in 1962 by Bollmann Bildkarten of Germany (see references for URL); David Greenspan's detailed battle maps for the American Heritage Picture History of the Civil War (Catton, 1960); and, artistic illustrations appearing in National Geographic magazine. The pieces by Greenspan and various National Geographic artists, which depicted past events and thematic subjects in oblique views, point toward the type of bird's-eye views that the NPS would produce in the coming decades.

Today, bird's-eye views are once again in vogue. If the industrial economy spurred their production a century ago, the burgeoning tourist economy drives it now. The prevalence of 3D maps of ski areas and summer resorts highlights this trend. Just as 19<sup>th</sup>-century bird's-eye views were a tool for economic boosterism, we find today that many chambers of commerce distribute 3D maps (ranging in appearance from cartoonish to glitzy to elegantly refined) of downtown restaurant and entertainment districts in a bid to attract more tourist dollars. Bird's-eye views are also growing in popularity online. The recent launch of Google Earth

now allows users to interactively explore 25 major cities in the US from any direction and viewing elevation with buildings appearing as blocky 3D forms. Rival online mapping service MSN Virtual Earth has plans to depict buildings in urban areas with oblique aerial photographs taken from multiple directions (see references for URLs).

Whether 3D maps are really better than 2D maps for helping people find things and get around is not certain and is a topic of current cartographic research (Freundschuh, 2001). Marketers, however, are more decided about the usefulness of bird's-eye views. When selling things, looking good matters. The NPS uses bird's-eye views for promotion of a different sort: to foster appreciation of the cultural and historical heritage of the United States.

### TRADITIONAL NPS BIRD'S-EYE VIEWS

The Harpers Ferry Center (see references for URL) is the NPS facility responsible for making bird's-eye views, a side product of a much broader mission. The Center creates interpretive media—a catchall term that includes brochures, indoor and outdoor exhibits, movies, and multi-media—for the 388 units of the National Park System. Art plays an important role in this effort. Since its creation in 1970, Harpers Ferry Center has commissioned nearly 10,000 pieces from hundreds of commercial artists and illustrators, many with national reputations. The subject matter portrayed by this commissioned art is as broad as the National Park System itself. In the art collection at Harpers Ferry Center you can find ink sketches of prehistoric artifacts, a watercolor of a determined John Brown holding a pike, and an acrylic collage of the plants and animals found in the Everglades. It is amidst this visual bounty that one also finds the 200 or so pieces that qualify as bird's-eye views.

#### Traditional art

Many of these artistic works strain even the broadest "big tent" definitions of what a map is. On some pieces the viewing angle is high and map-like, but on most the angle is considerably shallower, making spatial relationships difficult to judge. Not that it matters much. Views of this type are not intended to help visitors get around but to convey an impression of how a place looked in the past. Non-spatial issues—who, what, and how—take precedence over where. The most successful of the illustrative views recreate historical events with vibrant realism. For example, the view of Fort McHenry, Maryland, depicts the familiar battle imagery contained in the lyrics of the US national anthem (figure 4, left). A comparison with a stirring martial tune is a tall order for any graphic, which the bird's-eye view by L. Kenneth Townsend manages to accomplish, notably.



Figure 4. Some of the varying artistic styles found in illustrative NPS bird's-eye views. (left) Fort McHenry, Maryland, by L. Kenneth Townsend. (middle) Fort Bowie, Arizona, by Richard Schlect. (right) Oxon Hill Farm, Maryland, by Greg Harlin. (see page 97 for full color version)

Depending on the artist and the type of medium used, the style of a bird's-eye view can vary considerably, a choice that the NPS makes carefully. Often these styles relate to a particular genre of art. For example, the luminous and detailed quality of Townsend's "Fort McHenry" is reminiscent of countless paintings of heroic battles hanging in museums throughout the world (figure 4, left). In the muted ink and watercolor renderings of Richard Schlect it is not too difficult to see parallels with the 19<sup>th</sup>-century expeditionary art (figure 4, middle). And the soft watercolors of Greg Harlin strike a chord of nostalgia for our simpler arcadian past (figure 4, right). We see this style of art on the cover of catalogues issued by a vendor of outdoor apparel and gear based at latitude 43° 51' N, longitude 70° 06' W.

The staff at Harpers Ferry Center provides art direction to the artists who transform a blank sheet of paper into a lavishly rendered bird's-eye view. To learn more about how this is done I visited Wood Ronsaville Harlin, Inc. in Annapolis, Maryland, an illustration studio which does contract work for the NPS (see references for URL). There I met with Pam Ronsaville, president of the firm, and senior illustrators Rob Wood and Greg Harlin. Like our other contract illustrators, they do not specialize exclusively in the making of bird's-eye views but create a range of products that includes natural science, historical, infographic, and children's illustrations. Recently they have also begun creating cover art for popular fiction. Belying these pieces that stir the reader's imagination, however, careful research and preparation goes into all of the art that they create with little left to their own imagination. For example, even an artistic book cover derives from direct visual references, typically photographs taken in the controlled environment of their studio and composited as a mosaic in Adobe Photoshop. It should come as no surprise then that when making bird's-eye views the need for good visual references is even more important.

Oblique aerial photography is the reference material of choice for making bird's-eye views. Greg Harlin photographed Oxon Hill Farm, Maryland, from a helicopter to obtain the base map he needed to paint the final art (figure 4, right). He supplemented the

aerial photographs with others taken from the ground. When Rob Wood painted a view of Herbert Hoover National Historic Site, Iowa, obtaining helicopter photography was not possible so he had to rely instead on an aerial photograph draped on a DEM and viewed obliquely in a 3D application. Because buildings in 2D aerial photographs do not appear with three-dimensionality when viewed in a 3D application, Wood had difficulty visualizing how the final scene should look. He nevertheless managed to pull this off in the end in his usual polished style.

The actual rendering of the bird's-eye view takes place in three steps: a rough pencil sketch, a final pencil sketch, and, finally, the painted art. At all stages of production the art undergoes review by staff at Harpers Ferry and at the park portrayed in the art. The entire process progresses in fits and starts and can take more than a year to complete. Both Harlin and Wood emphasized the importance of visiting a site to "absorb the natural beauty and history of the area" as an important factor in producing top-notch views. Deciding just how much or, more importantly, how little texture to put in a scene is key to a successful project. According to Harlin "I spend a lot of time making it look like I didn't spend a lot of time painting the illustration." Both artists try to imagine themselves "in the scene" as they paint. When rendering final art they also pay considerable attention to lighting to accentuate small details and give the overall scene interest and drama.

### Map-like views

In addition to this commercial art, over the past 35 years the NPS staff has made about one dozen map-like bird's-eye views that are utilitarian in appearance and function. They serve primarily as devices for orienting visitors and site navigation—where is the visitor center and how do I get there. To produce these views we traced over oblique aerial photographs in ink, leaving a framework of casing lines for roads, pathways, trees, and buildings that were filled with flat colors photomechanically. They look similar to the 3D maps of college campuses that are so common today. Depending on the availability of suitable oblique aerial photographs, these products were relatively inexpensive and quick to make. Moving now to the digital part of this paper, we will see that they are no longer made with ink at the NPS.

### DIGITAL NPS BIRD'S-EYE VIEWS

As elsewhere in the cartographic community, at the NPS the transition from traditional to digital mapping has been our focus for much of the past dozen years. Having started with small inset maps first, we now make all of our products digitally, including large visitor-use maps, shaded relief, and even landscape pan-

oramas. We also make map-like bird's-eye views—like the inked versions discussed above—digitally. Using Adobe Illustrator software instead of Rapidograph pens, the NPS has replaced all of these inked pieces with vector files, also comprised of lines and flat tones. I discuss a variant of this technique in the upcoming section on budget bird's-eye views.

Making artistic bird's-eye views with digital tools that are comparable in quality to our best traditional pieces has proven to be a difficult challenge. Vector drawing applications like Adobe Illustrator can take you only so far in depicting scenes with artistic refinement and natural realism. For these we have turned to 3D software, the same tools used to create blockbuster animated movies and popular computer games. Scenes created with 3D software can contain dappled lighting, soft shadows, reflective water bodies, atmospheric haze, and organic textures that appear, for some types of work, completely real to all but the most discriminating viewers. Nevertheless, 3D software has a major downside compared with other digital techniques; it is an order of magnitude more difficult to use. Big and complex, these are not the sorts of applications with which you can occasionally dabble and expect to gain proficiency. Consider Maya, the 3D application used to create many of the special effects in Hollywood movies. In the large production shops it is common for the animation professionals who use Maya to have a single specialty, like modeling, texturing, lighting, motion, etc (Casady, 2004). Creating 3D special effects is a collaborative effort, as long film credits show.

As though using difficult-to-use software were not enough, the creation of a bird's-eye view in 3D software requires the user literally to build a virtual model of the entire site in painstaking detail. If you want to see it, you have to model it: scratch beneath any surface in a 3D scene and you will find a wireframe object. The effort is similar in scope to the elaborate sound stages built for filming movies or the museum dioramas with displays of wild animals (of the stuffed variety) placed in front of painted natural backdrops. On a bird's-eye view, to distinguish between two buildings—one, say, with a gable roof and the other with a hip roof—requires building separate models of each building. Depending on the complexity of the buildings, each may take anywhere from 15 minutes to several hours to create. Multiply this by perhaps dozens of buildings in a given scene, and the production quickly becomes arduous.

The creation of bird's-eye views at the NPS with 3D software occurs both in-house, mostly for simpler projects, and with the assistance of outside contractors whom we art direct for larger and more complex projects. Our contractors include notables like Chuck Carter, best known for his work on the computer game

*Myst*; Don Foley, author of two books on 3D animation and a frequent contributor to National Geographic; and, Chris Casady, who worked on the movie *Star Wars* (see references for URLs). If the output from 3D software has a visual fault it is the tendency for it to look hyper-realistic—too smooth, shiny, and simulated. Although this look is desirable for depicting space stations and sleek new automobiles, it is out of character for historic park sites. Of the NPS contractors, the work of Chris Casady, despite, or maybe because of his impeccable credentials on science fiction movies, achieves the painterly look that the NPS seeks in bird's-eye views. Through patient hard work, mastery of his preferred software (Bryce), and an artistic eye, Casady manages to combine human-made and natural features into thoroughly convincing final scenes. You will see many examples of his work throughout this paper.

Today one finds many 3D software applications sold to a relatively small pool of users. Consequently the prices of these applications are generally high, although not as expensive as they were a few years ago. Nevertheless, Maya Unlimited, a product of Alias, and one of the pricier 3D applications, will cost you US \$6,999. The artists who provide services to the NPS use a variety of 3D modeling and rendering applications. If the need arises, sometimes they will use multiple applications on the same project. Subscribing to the belief that using software creatively is as important as what brand (or price) it is, I use Bryce 5.0, a \$100 application from Daz Productions. There is, however one software application used by everyone. The raster art rendered by all 3D programs inevitably finds its way into Adobe Photoshop for final image enhancement. Additionally, at the outset of a project, data are prepared in Photoshop for later use in 3D applications. For the rest of this paper I attempt to be software agnostic as much as possible. If you should happen to prefer a software application other than the one that I am discussing, I invite you to make a mental substitution.

### Planning

The design of bird's-eye views requires considerably more care and interaction with clients than does the design of a traditional 2D map. A point is reached soon after production begins at which making even a small change to the basic scene parameters, for example, shifting the direction of view 10 degrees to the west, means much wasted work. An analogous situation would be for an architect to give new plans to a builder after construction has begun. To safeguard against this, the Harpers Ferry Center provides the park staff with several mockups of a bird's-eye view to review. A base map loaded into a 3D application allows easy changes to the viewing parameters should the need arise. The park staff then decides, with coaching from

Harpers Ferry Center, which preliminary scene best meets their needs—consensus is essential. Work on the final scene begins only after Harpers Ferry receives written approval to proceed from a person in authority at the park (figure 5). Occasionally I encounter a park site that for a variety of reasons is not ideally suited for depiction as a bird's-eye view. My advice based on hard-learned experience is not to force the issue but instead to use conventional 2D mapping. In fact, some projects are undeserving of any type of cartographic depiction—for example, showing the path from a parking lot to a nearby visitor center. In this case, people can more easily follow signs on the ground pointing to the visitor center.



Figure 5. A portion of Eisenhower National Historic Site, Pennsylvania. (left) A plan map draped on a DEM and viewed obliquely in Bryce. The park approved this view as the basis for final production. (right) The final bird's-eye view. Art at right by Chris Casady. (see page 97 for full color version)

### Budget bird's-eye views

A few words are in order about the fiscal realities of making bird's-eye views. Although 3D modeling software creates the most elegant bird's-eye views, the downsides are production times and costs that are significantly higher than other digital options. Hollywood studios can afford the expense of 3D production because of the potentially enormous revenues that films generate. The same applies to computer games. In late 2004 the release of the computer game *Halo2* generated US \$124 million in sales for Microsoft in 24 hours. Because production budgets at the taxpayer-funded NPS are smaller by a factor of several zeros compared to these commercial entertainment ventures, we use 3D techniques with any eye toward both quality and cost management. A complex bird's-eye view created by 3D software costs about the same as an equivalent view painted traditionally, somewhere between \$12,000 and \$20,000. One advantage of 3D modeling is the potential for repurposing work as animations or QuickTime Virtual Reality (QTVR) scenes, which spreads costs over several projects. Nevertheless, until more economical 3D production methods become available, as they undoubtedly will, for much of our work we will continue to seek less expensive

alternatives, including simply tracing vector art from oblique aerial photographs. Two less expensive methods of producing bird's-eye views deserve mention here.

### Hybrid method

This involves combining 3D modeling with vector drawing software for production. The "flying carpet" view of Marsh-Billings-Rockefeller National Historical Park, Vermont, is an example of such a merger of methods (figure 6, middle). The foundation of the scene was a square-shaped digital elevation model (DEM) representing terrain viewed obliquely with 3D software. A rasterized map draped on the DEM, much like a decal on an automobile bumper, shows roads, trails, and building footprints. The next steps include rendering the oblique 3D scene, saving it as a 2D Photoshop file, and placing it as background art in Illustrator. Finally, in Illustrator, the trickiest step was drafting simulated 3D buildings on top of the building footprints visible on the raster art placed on the layer below. Even with the aid of reference photographs and perspective grids as a guide, drawing angled rooflines presents visualization challenges. Ultimately, one must rely on intuition to accomplish the task.

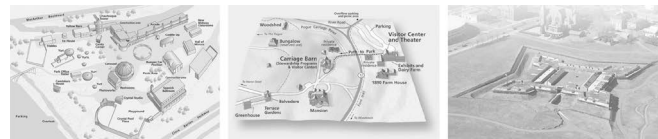


Figure 6. (left) Glen Echo, Maryland, was sketched in Adobe Illustrator using an older inked map as a guide. (middle) Marsh-Billings-Rockefeller National Historical Park, Vermont, was made from a 3D terrain base upon which buildings were drawn in 2D in Adobe Illustrator to appear three-dimensional. (right) Fort Stanwix National Monument, New York, derives from an oblique aerial photograph artistically filtered in Adobe Photoshop. (see page 97 for full color version)

### Photo method

Occasionally an oblique aerial photograph by itself can serve as the final art. The NPS used this method for making the bird's-eye views of Fort Stanwix National Monument, New York (figure 6, right). Faced with spending \$15,000 and waiting several months to have the scene developed using 3D software, we instead hired a photographer and helicopter to take dozens of high-resolution digital photographs from the air. One of these shots had the viewing direction, viewing angle, and illumination that we sought. Including the in-house time spent planning the project, writing contracts, and applying watercolor artistic filters to the image in Photoshop, the job took only days to complete and cost just \$1,400.

Not every park site lends itself to this production method, however. Fort Stanwix, which sits in an open field, is not obscured by the large numbers of trees that are typically found in parks and, more troublesome still, often grow next to buildings. Wintertime photography when the leaves are off the trees helps but only so much. The decision to use aerial photography depends on the suitability of the site, access to oblique aerial photographs, and tolerance for image editing in Photoshop. On the plus side performing touchups in Photoshop is much faster than modeling 3D scenes completely from scratch. In the case of Fort Stanwix the NPS was fortunate and only had to remove a few lingering snow drifts (the photograph was taken in early April) with the Clone (rubber stamp) Tool in Photoshop.

### 3D DESIGN AND PRODUCTION

This final section covers some of the many design and production factors influencing the making of bird's-eye views in a 3D software application. Given the great variety of software used for creating 3D scenes, and how generally difficult they are to use, the discussion that follows gives an overview of the issues—what you should be doing, more so than the particulars of how you might do it. I introduce subjects generally in the same order in which they come up when building a 3D scene. Several of the illustrations compare examples of good and bad design—a check mark at the top indicates the good examples.

I will begin this section with a discussion of the viewing parameters that determine the basic appearance of a 3D scene. Appropriately enough the first step in designing a successful bird's-eye view is choosing a good view.

#### View direction (orientation)

All bird's-eye views look at sites from a certain direction, for example from southwest to northeast. Picking the best view direction is a critical concern because, compared to planimetric maps, bird's-eye views are less flexible for on-site navigation. As you walk the winding paths of a park with a printed bird's-eye view to guide you, the piece cannot be rotated to the direction you are facing as is possible with a plan map. Try turning upside down any of the illustrations of a bird's-eye view that accompany this article. They just don't work. What this tells us is that whatever view direction you choose for a bird's-eye view—the possible choices span 360 degrees—had better meet the orientation needs of most park visitors most of the time.

For maps of large-scale sites the NPS has a long-standing convention of using an orientation that matches the direction from which visitors enter the site (figure 7). For example, when Metro riders emerge squinting from underground onto The Mall in Wash-

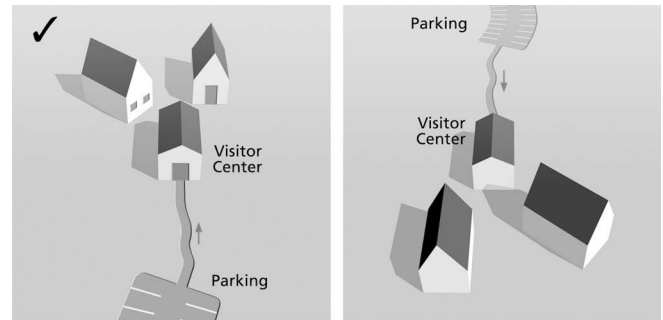


Figure 7. Direction of view. (left) A bird's-eye view should approximate, from a raised vantage point, what a visitor sees when entering a site. (right) A view from the opposing direction makes it harder for visitors to orient themselves because left and right, and, front and back, no longer corresponds to what they see on the ground. (see page 98 for full color version)

ington, DC, they see an outdoor map exhibit oriented in the direction that they are facing. People glance at the map, get their bearings, and then set off. Knowing which way is north is less important than the immediate concern of getting from point A to B quickly. This same user-centric orientation also applies to large-scale bird's-eye views.

For park sites with a single point of entry and a primary visitor destination, determining the best viewing direction is simple. In these cases the alignment of the view direction should generally follow the path that a visitor takes into the site. However, not all park sites are so simple, and choosing the best direction of view is less obvious. For bird's-eye views at smaller scales, with multiple points of entry, and with multiple visitor destinations, conventional orientation from south to north may be the best option. In addition, the view direction should show the front facades of important buildings—visitors do not care about the delivery docks and service entrances found around back. The foreground and background inherent in all bird's-eye views provide a powerful way to establish an information hierarchy. Try to choose a view that places important features in the foreground (the visitor center and historic buildings) and less important features (the picnic area and restrooms) in the background.

#### Viewing angle

The viewing angle, sometimes called camera pitch or inclination angle, determines how oblique a scene appears when viewed from above. Shallow viewing angles create highly oblique scenes complete with a horizon and sky that can appear strikingly realistic. Higher viewing angles create map-like scenes that better portray spatial relationships and are better for site navigation. As a general rule the viewing angle should be somewhere between these two extremes, perhaps slightly favoring the higher angles (figure 8). If the an-

gle is too high, however, it places undue emphasis on the roofs of buildings at the expense of their distinctive facades. Go higher still and eventually the bird's-eye view for all intents and purposes becomes a plan map, which defeats the reason for using an oblique view in the first place.

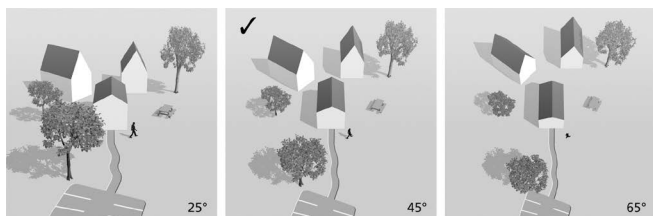


Figure 8. Viewing angle. (left) When the viewing angle is too low, tall objects in the foreground obscure lower objects in the background and spatial relationships are difficult to judge. (middle) An angle between 40 and 60 degrees generally works well. (right) Higher angles of view place too much emphasis on the tops of buildings and trees. (see page 98 for full color version)

In perspective scenes the apparent viewing angle varies according to where you are in the scene, becoming steeper from background to foreground. Three-dimensional objects in the background appear more in profile than similar objects in the foreground, where their tops become more evident. What this means, as counterintuitive as this may sound, is that buildings in the foreground of a scene may not be as recognizable as those farther back because their sides are not as visible.

The viewing angle also influences visual foreshortening, the front-to-back (top-to-bottom) compression that you see on obliquely viewed scenes (figure 9). There are both advantages and disadvantages to this. Foreshortened bird's-eye views occupy much less space than plan maps, allowing their placement into cramped layouts. On sites with widely scattered features, the effect is to pull the foreground and background closer together, making them appear more

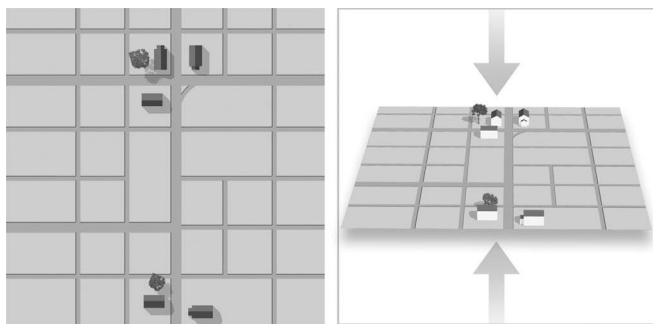


Figure 9. (left) A plan map. (right) Because of foreshortening a bird's-eye view needs less space to show the same area. (see page 98 for full color version)

compact. The opposite holds true on scenes with dense information, which become even more congested and less legible because of foreshortening.

Finally, the slope of the terrain is a factor when choosing an viewing angle (and also the view direction). In a bird's-eye view, terrain that slopes uphill towards the back of the scene is preferable to terrain that slopes downhill. On downhill views, as the terrain falls away from the reader the exaggerated foreshortening reduces the visible terrain surface appreciably and makes relative elevation differences difficult to judge. For the many cultural sites that occupy nearly level ground, however, slope is a moot consideration.

### Field of View

This seemingly esoteric camera setting greatly influences the appearance of bird's-eye views. Most 3D applications use central perspective (sometimes called central projection) because of how it mimics what the human eye sees (Jenny, 2004). The average human with binocular vision who gazes toward the horizon takes in a view shaped as a flattened cone and spanning 140 degrees from side to side. In 3D applications this area of visibility, called the Field of View (FOV), assumes the shape of a symmetrical four-sided pyramid with the camera at the apex. The FOV in 3D applications ranges anywhere from 1 to 180 degrees and even wider if you count 360-degree QTVR scenes.

FOV relates directly to the focal length in cameras. As the name suggests, wide-angle lenses have a wide FOV and telephoto lenses have a narrow FOV. Moderately telephoto FOV angles (10°–50°) produce more useful results than those that are wide-angle (figure 10). Displaying too broad of an area within the confined rectangular space that bounds a bird's-eye view leads to undesirable distortions. If the FOV angle is too wide the perspective convergence becomes extreme—background areas pinch toward the vanishing point, and foreground areas become too enlarged. On the sides of the scene away from the central axis of view, tall 3D objects splay outward at unnatural angles. In the opposite situation, as the FOV angle becomes lower a scene loses its perspective qualities and becomes

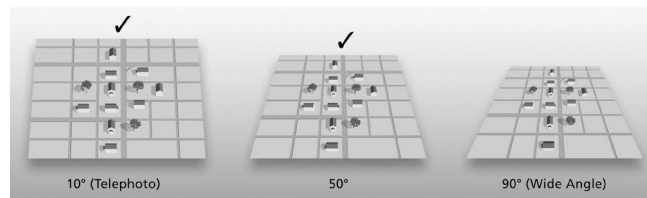


Figure 10. Adjusting the Field of View (FOV), which is a camera setting in 3D applications, controls the amount of perspective in a scene. From right to left the examples become increasingly orthogonal. (see page 99 for full color version)



more orthogonal, albeit in an oblique view. The advantage of oblique orthogonal views is that similarly sized objects in foreground and background are comparable. The disadvantage of having less perspective is the lack of visual depth in such a scene. However, as we shall see in the upcoming discussion of environmental effects, adding background haze can effectively remedy this deficiency.

### DEMs—Beneath it All

Digital Elevation Models (DEMs), which show topographic surfaces when rendered in a 3D application, serve as a foundation for building even the largest-scale bird's-eye views. In addition to the usual mountains and valleys, large-scale DEMs contain micro topography, much of which is the result of human activity, such as graded roadbeds and leveled land around buildings. Without these subtle but important details cultural features on the surface would appear divorced from the terrain below.

Finding DEMs at a fine enough resolution for making large-scale bird's-eye views is a problem. The finest resolution DEMs commonly available from the USGS have elevation samples every 10 meters on the ground, much too coarse to serve as a base for a cultural site where many buildings would be less than 10 meters in length. In recent years LIDAR (Light Detection and Ranging) DEMs at one-meter resolution have offered promise, but they are all but impossible to find for NPS sites and are prohibitively expensive to have produced. LIDAR  $x, y, z$  point data at 2 to 3 meter height postings costs US \$1,000 – \$2,000 per square mile (2.6 square kilometers), a price that does not include final DEM processing (NOAA, see references for URL). This leaves the user little choice: either modify existing 10-meter DEMs to show more detail, or make a new higher-resolution DEM from scratch using specialized software. Both options are difficult and involved, and I will discuss them only briefly here.

Modifying an existing DEM is the faster of the two options and, not surprisingly, it yields less accurate results. At the NPS we modify existing DEMs in Adobe Photoshop after importing them as 16-bit grayscale images. DEMs in this format appear with dark pixels representing lower areas and light pixels higher areas. Raising and lowering the pixels for selected parts of the DEM with the image editing tools in Photoshop transforms the DEM and produces an altered landscape surface when rendered in a 3D application (figure 11). For example, applying a large amount of Gaussian blur to the area on a DEM that falls directly under the draped image of a road creates a graded surface with cuts and fills similar to the real thing (Patterson, 2003).

Making custom DEMs from scratch requires that you have a dense network of contour lines or spot

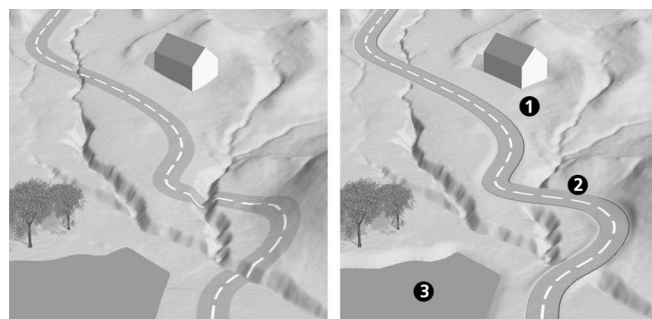


Figure 11. (left) A scene created from a DEM without supplemental modification. (right) The same scene with modifications, which include (1) building site leveling; (2) road cuts and fills; and, (3) pond lowering. (see page 99 for full color version)

elevations from which to start. These can take the form of digital data or paper map sources. If neither is available the only recourse is to survey the site yourself or have someone do it for you, adding significantly to the cost of a project. Fortunately, at most park sites large-scale contour maps are available for the built-up areas—finding them often involves rummaging through drawers.

From digitized contours you create a DEM by either of two methods. The proper method is to use an application like ArcGIS or Surfer to assign elevation attributes to each of the contours, interpolate a Triangulated Irregular Network (TIN) from the contours, and, lastly, output a DEM. With technical help from GIS staff, the NPS created a custom 3-meter resolution DEM from contours in ArcGIS for the bird's-eye view of Huffman Prairie Flying Field (figure 12).

The second method—the “DEMs for dummies” method, as I sometimes call it—is easier to accomplish and more logical for those who work primarily with graphical software. It also yields far less accurate results. This is how it works. First, you trace contour lines from a map in a drawing software application like Adobe Illustrator. Next, you fill the zones between the contours with gray tones progressing in consistent increments from dark to light as you go higher. The result is a gray Illustrator file with terraced elevation zones. Then, the Illustrator file is rasterized in Photoshop and blurred liberally to create a smooth image with no evidence of the terraces. Finally, you import the blurred grayscale image into a 3D application and extrude it to represent the terrain surface (Foley, 1997). The amount of blurring applied is key to success. With too much blurring, the terrain looks overly smooth and generalized, and with too little blurring, more details become visible, including the unwanted terraced edges. Complicating matters is the fact that widely spaced elevation zones require more blurring to appear smooth than do tightly spaced zones. Producing optimal landscape surfaces depends on trial and error.



Figure 12. This scene shows the counter-clockwise flight of the Wright Flyer in 1908 over the Huffman Prairie Flying Field, Dayton, Ohio. The foundation of the scene is a custom DEM at 3-meter resolution derived from contour lines processed in ArcGIS software. A second hand-made DEM with a bumpy dark-green texture extrudes upwards through the surface of the first DEM to depict background trees. Art by Chris Casady. (see page 100 for full color version)

The view of Marsh-Billings-Rockefeller National Historical Park, Vermont, uses a primitive DEM created with this method (figure 5, middle).

I will finish this section by stating the need for an inexpensive and easy-to-use application for making DEMs from contour lines saved in Adobe Illustrator format, which would produce DEMs of higher quality than the technique discussed above.

### Landscape textures

DEM look better when they are not bare. At large scales even the most detailed DEM rendered in a 3D application without any textural covering looks artificial, like molten plastic. An aerial photograph precisely registered to the DEM and draped onto its surface goes a long way toward making the final rendered terrain look more presentable. At other times, such as when aerial photographs are too noisy or have dark and conflicting shadows, custom-made textures comprised of colors and embossed textures, known as bump maps, are the better solution. Custom-made textures can derive from multiple sources, often used in combination with one another, including rasterized vector art, fractal textures generated in Photoshop and other graphical applications, hand painting in Photoshop with a Wacom stylus and tablet, and photographs of all kinds. To produce a grassland texture for the bird's-eye view of Fort Larned, Kansas, NPS contractor Don Foley shot a digital photograph of his front lawn from an upstairs window. He then tiled this small photograph as a larger seamless texture and draped it on the DEM.

The following will help you make effective landscape textures:

- Avoid flat unvarying textures at all costs even if the landscape you are portraying is that way. Subtle modulations in light and shadow bring a level of realism and visual interest to even the most boring features. For example, the bird's-eye view of Appomattox Court House, Virginia, is comprised largely of empty fields. Instead of representing these areas with flat green Chris Casady created an image texture that emphasized subtle natural variations in tone (figure 13).
- Do not over apply landscape textures so that they become noisy and distract from more important information in the bird's-eye view. Be especially careful when applying bump mapping, which can easily become too dark and contrasting.
- Readers can't help but take notice of overly symmetrical, geometric, and repetitive textures, especially in natural areas. Use them sparingly.
- Clean bright colors may look fine on a traditional map but they are less applicable to realistic bird's-eye views. Instead select a color palette comprised of the slightly impure colors typically found in nature and, if possible, refer to photographs of the site for greater accuracy. And if most park visitation occurs at a certain time of the year, say, late summer, the selected colors should reflect that season.

### Buildings—assembly required

Like their brick and mortar counterparts, buildings in a bird's-eye view take a long time to construct. The meticulous modeling of small but important architectural details—eaves, gables, porticos, and the like—accounts for the slow pace. Given the unavoidable detail,

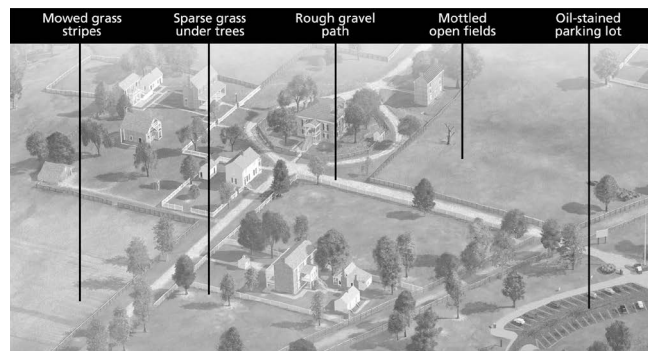


Figure 13. Custom landscape textures bring subtle realism to the bird's-eye view of Appomattox Court House, Virginia. Art by Chris Casady. (see page 100 for full color version)

this section looks at how to create building models as efficiently as possible.

Generalization is a logical place to start. Depending on the scale of the scene and its purpose, not every architectural detail deserves portrayal, thereby saving valuable production time. One must evaluate all components of a building for what it is they contribute to our visual understanding of the building in a bird's-eye view. For example, does including the rain gutters and downspouts better allow readers to identify a building? Image resolution is also a factor when generalizing buildings. On buildings that will appear at thumbnail size, why go to the trouble of modeling the dozens of sub-pixel-sized porch railings that are below the threshold of visibility? Because only two sides of buildings (plus the roof) are visible in any given view, a simple way to decrease modeling time is to keep the obscured backsides of buildings blank, much like a movie set. To do this you must be completely decided about the viewing direction and have no plans to use the buildings for a virtual reality scene that will be viewable from every which way. The NPS used this method to decrease costs on the bird's-eye view of Eisenhower National Historic Site (figure 24).

The options for generalizing buildings range from simple 2D footprints all the way to complex 3D models with realistic textures (figure 14). Like the stylized recreational symbols (camping, hiking etc.) used on NPS visitor-use maps, a building can be distilled to a much simpler 3D form and still be recognizable to readers. The problem is that, being the primary information on a bird's-eye view, buildings demand detailed depiction. The detail attracts a reader's eye and subconsciously informs them that these are indeed places worthy of attention, more so than, say, the parking lot. Sometimes it makes design sense to show both detailed and generalized buildings in the same

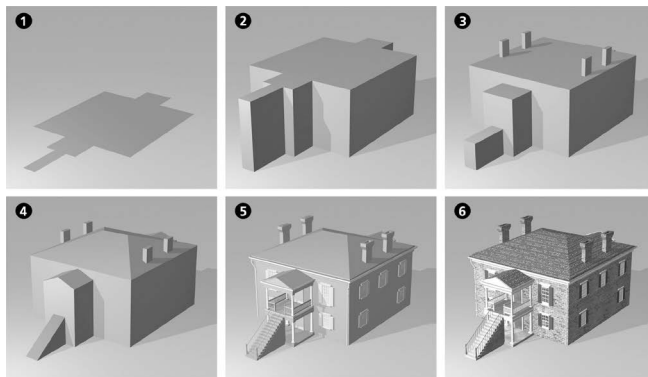


Figure 14. Starting with a simple footprint (1), building depiction becomes more realistic with each successive image. The most critical steps are going from a blocky "prismatic" model (3) to a model with angled roofs and flat-shaded detail (5). Building model by Chris Casady. (see page 101 for full color version)

scene. For example, for a park site within an urban setting, depicting the park buildings with more detail than non-park buildings focuses the reader's attention on the park. This also spares you hours of unnecessary labor.

The NPS is continually on the lookout for new software to more easily produce models. Photogrammetric modeling software is one of the intriguing methods that we have tried (we have tested Canoma 1.0, now discontinued, and ImageModeler 4.0). With this software, which uses oblique aerial or terrestrial photographs of buildings as a guide, the user carefully constructs 3D wireframe models over the building shapes seen in the photographs below. Identifying common points on a building on multiple photographs increases the accuracy of the resulting 3D model. When the model is complete the software then "maps" the photographic textures to the surfaces of the building providing realistic detail (figure 15).

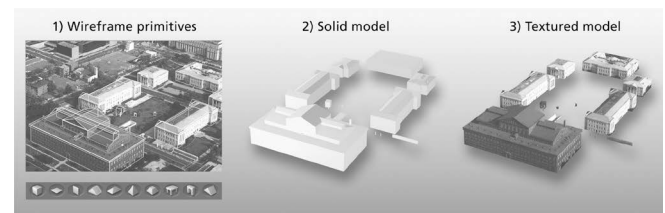


Figure 15. Canoma 1.0 software uses photogrammetric methods to create 3D models from oblique aerial and terrestrial photographs. (see page 101 for full color version)

Photogrammetric modeling software is widely used in the related field of urban simulation to model entire cities. When used in conjunction with LIDAR DEMs (to determine heights), rectified aerial photographs (to determine locations), terrestrial video (to obtain facade detail), and semi-automated procedures (to reduce production time), this software can model thousands of buildings. These are big-budget productions for big-time cities—London, New York, and Tokyo are among the notable projects (Shiode, 2001). The best-known urban simulation is perhaps *Virtual Los Angeles*, created by the Urban Simulation Team, University of California at Los Angeles. They have modeled large swaths of Los Angeles in sections (see references for URL).

At the NPS, photogrammetric modeling applications have not proven to be the panacea that we had hoped for. Considering the small size of park sites, which provide little economy of scale, creating building models with these applications has offered no time savings. The dense tree growth often found next to buildings in parks also presents problems. Without unobstructed photographs of buildings from the proper angles, photogrammetric modeling is next to impossi-

ble to use. Finally, there is the highly subjective matter of aesthetics. Buildings created with photogrammetric modeling software tend to look like computer simulations rather than the artistic renderings desired by the NPS

The most detailed and artistic building models produced by the NPS so far have come from the least sophisticated and most time-consuming techniques. Analogous to the “stick built” techniques used in real-world construction, this method of modeling involves assembling sometimes hundreds of 3D objects of various sizes and shapes piece by piece (figure 16). Building footprints draped on a DEM serve as a guide for positioning and sizing the assembled buildings in the 3D scene. Borrowing a technique from the 19<sup>th</sup>-century

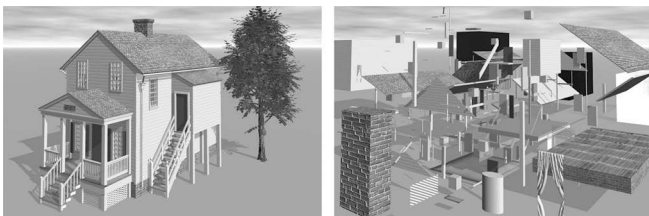


Figure 16. (left) Meeks Store is one of 55 buildings, scores of trees, and perhaps a mile of fence found in the bird's-eye view of Appomattox Court House National Historical Park, Virginia. (right) The exploded view of Meeks Store reveals that it is comprised of 308 separate objects. Building model by Chris Casady. (see page 102 for full color version)

city panoramists, we use digital photographs taken of the buildings from the ground as an indispensable reference for filling in details on the facades. When imported into 3D software, the photographs also serve as templates for gauging the relative sizes of buildings. Strict accuracy, however, is not the intent; our aim is to create buildings that look realistic and recognizable to readers. In fact, the NPS occasionally exaggerates the size of the buildings in scenes to improve legibility. For example, at park sites where the buildings are scattered across expansive tracts of land, at true scale they are barely noticeable. Exaggerating the size of the buildings—the smaller the scale, the more exaggeration needed—helps to focus the readers' attention on them.

The depiction of buildings involves more than modeling their forms. Exterior textures are essential for bringing believable realism to buildings, transforming even the most sterile 3D forms into an organic entity. With 3D software, applying exterior textures—shingles, bricks, stonework, reflective glass, etc.—is often as easy as clicking a mouse in the libraries of preset textures that come with most 3D applications. If the right texture is not available in a library, you can create custom textures from photographs and by other means (figure 17). You may need to accentuate fine textures

to make them noticeable depending on the size and resolution of the depicted building. Bump mapping, a type of 3D embossment, when used in moderation, is an essential technique for giving textures a more realistic look.

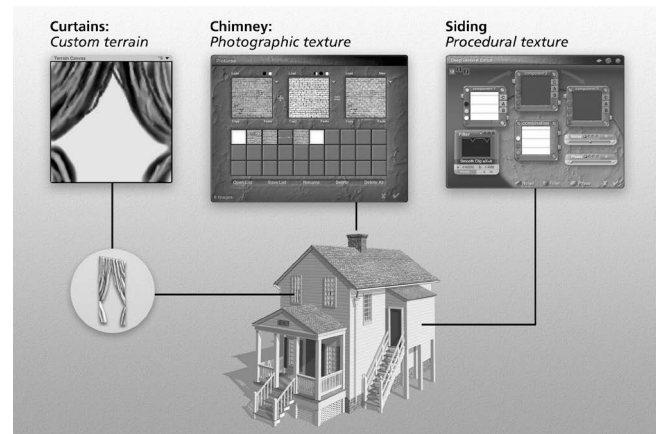


Figure 17. The custom textures applied to a model of Meeks Store. Building model by Chris Casady. (see page 102 for full color version)

Recently the NPS has found a simpler, cheaper, and faster way to model 3D buildings in Sketchup 5.0, an architectural application that offers user-friendly tools for rapidly creating 3D buildings. We learned more about the benefits of Sketchup from NPS contractor, Steven Patricia, an accomplished water colorist who is also a registered architect. Says Patricia of bird's-eye views “an artist has to make choices about what is to be truth and what is to be distortion.” To depict buildings “truthfully” he uses wireframe models created in Sketchup as a visual reference for painting traditional art. Building models made in Sketchup are also applicable for an entirely digital workflow. The models are exportable in common 3D formats (3DS Studio, AutoCAD DXF, and VRML), complete with attached image textures. File sizes are small, which is an important consideration when working on projects with many buildings. In a 3D rendering application like Bryce, the textures on imported Sketchup models are editable, and realistic bump mapping is easily applied. The NPS has great hopes for Sketchup and intends to use it for the next appropriate project that comes along.

### Trees

Like props on a stage, trees in bird's-eye views play a secondary role and should be treated accordingly. When designing a view you soon discover that trees are more abundant than you ever imagined and grow where you least want them, typically in front of the most important buildings, hiding their distinctive facades. There are several options for managing this

arboreal profusion: delete, shrink, move, or prune the trees. Visitors to historical and cultural parks usually go there for reasons other than the trees and chances are good that they will never notice a few missing *Quercus alba* or *Acer rubrum* in your 3D scene. At many older sites the trees have now grown taller than the buildings, obscuring them from above. Shrinking the trees to the same height or slightly lower than the buildings improves visibility and still keeps the leafy ambience. Nudging a problematic tree to a new location a few millimeters to the side (in the 3D scene) can reveal just enough of an obscured building to permit readers to recognize it. The same applies to pruning unwanted branches. On the other hand, you should not be overzealous in removing trees or the scene will look too empty and manicured. The occasional tree that obscures non-essential parts of buildings imparts a sense of depth and natural randomness. Lastly, while it is permissible to delete the odd tree here and there to improve visibility, never plant trees where they do not exist.

Thanks to the capable software available today, dotting your scene with highly realistic trees is an accomplishable, if not easy task (figure 18). When designing trees you have the liberty to exercise some artistic license—for once. Viewed from an elevated and distant vantage point, trees all tend to look alike, particularly if they are entirely deciduous or coniferous. Getting the foliage color and tree shape approximately correct will do in most cases, unless, of course, you are depicting a site known for its famous trees. In the background and margins of a scene trees depicted as impressionistic green textures often will suffice. Trees that are too detailed may distract the readers' attention from more relevant information.



Figure 18. 3D tree models created in Bryce's Tree Lab. (see page 103 for full color version)

A problem with 3D trees is the computational overhead that they demand from even the most capable computer hardware. Because every leaf, twig, and branch adds to the size and complexity of a 3D scene, computer performance lags. For example, imported wireframe models of trees in DXF format are especially susceptible to "high polygon counts," which bloat file sizes and slow rendering times. Some applications, such as World Construction Set and Virtual Nature Studio, handle floristically rich scenes with comparative ease. With others, including Bryce, users must develop strategies to reduce file sizes. Eliminating complex bark textures, which are invisible to readers at small scales, is one way. Creating trees with fewer but larger leaves also reduces file sizes while keeping their crowns full. Going even further, Chris Casady breaks up his scenes into overlapping sections maintained as separate files. Once all of the sections are complete he renders them and stitches them together in Photoshop to create the final bird's-eye view. A technique to avoid is inserting 2D pictures of trees into 3D scenes. The 2D trees, which are planar, are all but impossible to see at steep viewing angles typically found on bird's-eye views. By comparison, 3D trees reveal their broad crowns as you would expect. (figure 19).

### Environment

Warm light, soft shadows, background haze, and water reflections are some of the environmental effects that give an appealing ambience to bird's-eye views (figure 20). Although some environmental effects in 3D software are frivolous, others, such as lighting, are essential to the design of a successful scene.

Lighting behaves differently in bird's-eye views than it does on 2D shaded relief maps. On a north-oriented relief map the illumination invariably originates from the northwest or upper left, a direction that minimizes the occurrence of relief inversion. In a large-scale bird's-eye view relief inversion is not a concern, however. Here upper left lighting would throw shadows on the sides of buildings and terrain surfaces facing the viewer, darkening the scene and diminishing legibility. Placing the light source at the lower left or lower right side of a 3D scene is a better solution. Whether you choose a lower left or right placement depends on the orientation of the buildings. Ideally the light should illuminate as many important building faces as possible. Some 3D applications allow the light source (sun position) to be set according to the date and time of day, which rarely places the light where you want it to be. Selecting the light direction is ultimately a graphical decision.

In addition to the global lighting discussed above, 3D applications allow you to place other light sources in a scene. The effect is similar to a room illuminated by multiple lamps. But unlike the lamps, 3D lights



Figure 19. *Slimming down.* Clones of a 2D tree picture and 3D tree model arranged from background (top) to foreground (bottom) in a perspective scene. The 2D tree becomes less visible in the foreground because of the steeper viewing angle and its lack of volume. (see page 104 for full color version)

have options that allow them to behave in unusual ways. For example, a light source can be invisible while still emitting illumination, and the shadows that it casts are suppressible. Like virtual track lights, these 3D lights permit you subconsciously to direct the attention of readers to selected places within a scene, such as a building (Foley, 1995). In Figure 14, a secondary light source placed at the lower left emphasizes the front of the buildings. Secondary lights can also project colors into a scene. A favorite trick of Chris Casady's is using a supplemental blue light to tint shadowed surfaces blue-gray; this complements the warm illumination on opposing surfaces (figure 20). Bird's-eye views and shaded relief maps also depart from one



Figure 20. (left) A simple scene rendered without environmental special effects. (right) The same scene with exaggerated special effects, which include (1) background haze; (2) pale yellow illumination coming from the lower right; (3) soft cast shadows; (4) reflective water surface; and, (5) secondary blue light coming from the left. Environmental special effects come at a price; the scene on the left took 12 minutes to render compared to 2 hours and 18 minutes for the scene on the right. (see page 105 for full color version)

another in the use of cast shadows. Cast shadows are highly inappropriate on shaded relief maps because they cause drainages to appear misregistered with the topographic shading. By comparison, on large-scale bird's-eye views cast shadows serve a useful purpose by anchoring buildings and trees to the ground below. Without cast shadows surface objects would appear to be floating in the air (figure 21).

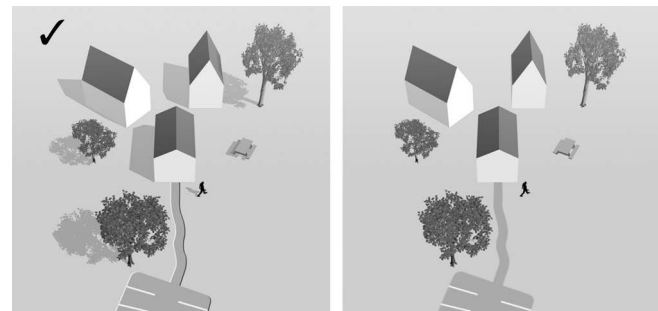


Figure 21. (left) A bird's-eye view with cast shadows. (right) The same view without cast shadows. (see page 105 for full color version)

What you do not see in a bird's-eye view is perhaps as important as what you do see. Adding haze to a scene diminishes unimportant information often occupying the background of a scene. Most 3D applications permit you to add haze of any color and density, also bringing a sense of depth to a final rendered image. Bird's-eye views generally need slightly more haze than occurs naturally (in reasonably non-polluted environments), although it is hard to over-apply background haze to a scene. Lastly, borrowing from the techniques of classical painters, foreground darkening can help guide the reader's eye deeper into the scene. For example, the bird's-eye view of Appomattox Court

House applies supplemental shadowing in the foreground to lessen the visual prominence of the parking area (figure 22).



Figure 22. Appomattox Court House, Virginia, without (left) and with (right) environmental effects. The effects include background haze (1) and foreground darkening (2). Art by Chris Casady. (see page 105 for full color version)

**Finishing work**

When making a bird’s-eye view, the time eventually comes when one must exit the magical world of 3D and finish the job with ordinary graphical tools. Although you can make a complex bird’s-eye view entirely within 3D software, this approach is not the most efficient way to work. For example, with 3D software, replacing a tree in the background of a scene that doesn’t look right would involve replacing it with a new tree model and re-rendering the entire scene, which could take hours to accomplish (one NPS scene took 40 hours to render). Or you could simply use the Clone Tool in Photoshop to obliterate the offending tree in seconds on the rendered image. Knowing when and when not to use 3D software is key to keeping production costs down.

Adobe Photoshop is the final destination for all of the 3D scenes created by the NPS. In 3D software, we typically render a bird’s-eye view multiple times, creating multiple images for final compositing in Photoshop. Because all of the images were rendered at the same size, when they are copied and pasted into a Photoshop document they register perfectly with one another. Some of the images are simple grayscale masks useful for making quick edits (figure 23). For example, inserting a grayscale distance mask into a layer mask in Photoshop permits easy changes to the background haze without having to re-render the entire 3D scene. Should an art director unexpectedly decide that beige haze is more desirable than blue haze, this change would take only moments to do in Photoshop. Full disclosure: I used Photoshop to add the background haze and foreground shadowing shown in Figure 22.

I will end with some advice about labeling bird’s-eye views with Adobe Illustrator. Having spent a great amount of time creating beautiful art, labeling it in a less than effective manner would be a pity. Labels

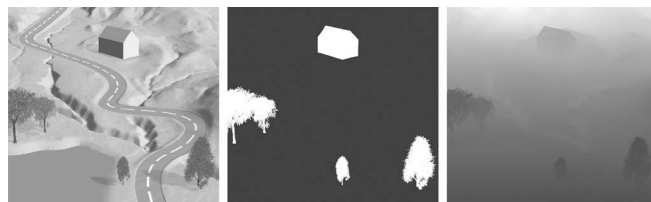


Figure 23. Multiple renders. (left) A simple scene rendered in 3D. (middle) A high-contrast object mask of the building and trees used for selective color edits. (right) A grayscale distance mask used for adding background haze. (see page 106 for full color version)

give bird’s-eye views meaning and transform them from the realm of art to that of maps. In general the NPS prefers to label buildings directly rather than use numbers that readers must identify in a key. The noisy textures, dark shadows, and contrast often found in bird’s-eye views interfere with the legibility of labels. In these situations, instead of traditional black labels, I have found that light-colored semi-bold fonts coupled with dark drop shadows are most legible (figure 24). Whether the drop shadows beneath text should fall to the lower right, as is the graphical standard, or coordinate with the shadows embedded in the art below, I leave for you to decide.



Figure 24. A portion of the bird’s-eye view for Eisenhower National Historic Site, Pennsylvania. Note that the view contains a north arrow but not a scale, which would be inappropriate because of the perspective view. Art by Chris Casady. (see page 106 for full color version)

**CONCLUSION**

Bird’s-eye views are far and away the most difficult “map-like” product that the NPS has attempted to make with digital tools. Although making beautiful artistic pieces is possible with 3D software, doing so requires considerable effort and outside assistance. You might say that it takes a village to make a village, of the 3D variety at least. Mapper, modeler, arborist, illustrator—few, if any, people possesses all the skills needed for making a complex bird’s-eye view. On any given NPS project potential contributors might include

GIS staff for creating the DEM; Harpers Ferry staff for cartographic support and art direction; park staff for content review; and, most importantly, our contract illustrators for the 3D artistry that they bring to the final product.

So how do traditional and digital techniques for making bird's-eye views compare? Both require the assistance of a talented illustrator and considerable time and money. Deciding whether to use traditional or digital techniques may depend on the graphical look that you want. Another factor is the availability of data and map resources. If a site is unmapped at a large scale how then can you proceed with 3D software without a DEM, building footprints, and road alignments? Hiring a helicopter and taking oblique aerial photography would be the expedient alternative in this situation. An advantage of 3D production is the ease with which one can make edits. For example, if in a couple of years all of the elms at a site should die from Dutch elm disease, removing these trees takes only a click of the mouse in the 3D scene file. Scenes made from 3D software also lend themselves to repurposing as animations and QTVR scenes.

For the reasons given above, use of 3D software by most cartographers to create artistic bird's-eye views will not be a realistic option for some years to come, if ever. Few of us have worked as a Hollywood special effects artist. Looking a notch or two lower on the artistic scale, however, we find 3D solutions aimed at generalists. User-friendly Sketchup, which I discussed in a previous section, now lets users familiar with drawing software create competent 3D building models. Working from photographic references, in a reasonable amount of time one could make enough buildings to fill up a small park site. Importing these buildings into a consumer-level 3D application and placing them on an obliquely viewed street map would yield a basic scene suitable for static bird's-eye views and multimedia presentations. It won't be as eye-catching as L. Kenneth Townsend's view of the collapsing South Fork Dam, but it will be more refined than what a non-artist could accomplish without 3D software. And, over time and with practice, the results will only get better.

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## Websites

The companion website for this article and gallery of NPS bird's-eye views:

[www.shadedrelief.com/birds\\_eye/gallery.html](http://www.shadedrelief.com/birds_eye/gallery.html)

Bollmann Photo Maps:

<http://www.bollmann-bildkarten.de/>



Casady, Chris (NPS contract illustrator):

<http://www.tilenut.com/nps/>

Foley, Don (NPS contract illustrator):

<http://www.foleymedia.com/>

Google Earth

<http://earth.google.com/>

Library of Congress Panoramic Maps 1847-1929:

<http://memory.loc.gov/ammem/pmhtml/panhome.html>

MSN Virtual Earth

<http://virtualearth.msn.com/>

NOAA - LIDAR DEMs:

[http://www.csc.noaa.gov/crs/rs\\_apps/sensors/lidar.htm](http://www.csc.noaa.gov/crs/rs_apps/sensors/lidar.htm)

NPS Harpers Ferry Center

<http://www.nps.gov/hfc/>

Virtual Los Angeles:

<http://www.ust.ucla.edu/ustweb/projects.html>

Whiteman, Lily. The High Life. *Audubon Magazine* (online article)

<http://magazine.audubon.org/birds/birds0011.html>

Wood Ronsaville Harlin, Inc (NPS contract illustrators):

<http://www.wrh-illustration.com/>

### Software

Adobe Illustrator and Photoshop:

<http://www.adobe.com/>

ArcGIS

<http://www.esri.com/>

Bryce

<http://bryce.daz3d.com/>

Canoma

<http://www.canoma.com/>

ImageModeler

<http://www.realviz.com/>

Maya

<http://www.alias.com/>

Sketchup

<http://www.sketchup.com/>

Surfer

<http://www.goldensoftware.com/>

World Construction Set and Virtual Nature Studio:

<http://www.3dnature.com/>

## cartographic collections

### From Drawer to Digital: A Statewide Collaboration for Building Digital Historic Map Collections

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### ABSTRACT

Nowadays, when you tell someone you recently visited a map library, it's hard for them to discern whether you mean virtually or in person. The two comprehensive public universities in Nevada are building complementary digital collections of historic maps of interest to the region to enable virtual map library visits. This article briefly describes the two university library map collections, discusses the criteria that were used to select maps to be digitized, provides insight into some of the scanning issues and how they were resolved, discusses technical considerations in using CONTENTdm<sup>®</sup>, and talks about metadata issues in the collaborative effort. The conclusion provides insight into what has been learned and why the project is important as a foundation for the future.

### INTRODUCTION

The history of mapping the New World and the North American continent goes back to the 16th century; until the mid-nineteenth century, Nevada, along with much of the Southwest, was identified, if at all, as terra incognita – unknown land. Historic maps of Nevada and the Southwest are relatively scarce and, within Nevada, are scattered across a large territory among a small number of historical institutions, libraries, and