Geodesign Edition

Smart Facilities

Esri • Winter 2011/2012 GIS for Facilities Management

The Next Great GIS Frontier

For the last 30 years, government, business, and academic organizations have been building a geospatial fabric that incorporates parcel, transportation, and other information. Although tremendous progress has been made in this endeavor, it is a fabric rent with gaping holes. These holes in the geospatial fabric represent building footprints, and they are cause for concern.

Urban areas constitute a man-made ecosystem that has a profound effect on the natural landscape surrounding it. Buildings are also where more of the population spends its time and where capital is most concentrated.

Why has geospatial information stopped at the building footprint level? In part, this was a by-product of how many organizations created basemaps. Many relied on aerial photography and/or GPS, which are data capture methods blind to building interiors.

However, understanding the urban ecosystem is becoming increasingly important. According to the United Nations Population Fund, in 2008—for the first time in history—more than half the world's population lived in towns and cities. The trend toward urbanization is accelerating, and in densely developed places like Manhattan, New York, the extent of floor space in buildings far outstrips the land area encompassed by borough boundaries.

Facilities management (FM) is the interdisciplinary profession that integrates support

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In This Issue

Industry Perspective

Cornerstone

By Shelli Stockton, Esri Global Facilities Industry Manager

The key to developing true insight into our complex and dynamic world is creating a framework of understanding. We need to take many different pieces of past and future data from a variety of sources and merge them in a single system. Geographic information system (GIS) technology is already widely used by planners, engineers, and facility managers to do this. GIS helps us study all forms of location-referenced data about where people live and work.

GIS effects a framework for smart design and management. Users can inventory and display large, complex spatial datasets and use them to analyze and manage issues. Whether at a single organization, as illustrated in this issue by the article about NASA, or in an entire city, such as France's Toulon Provence Méditerranée, the potential interplay between various factors can be studied, monitored, and measured.

With GIS, you can

- Streamline asset information collection, dissemination, maintenance, and use
- Facilitate better planning and analysis
- Allow efficient sharing of information in and out of the field, providing a comprehensive view of operations

To make this even easier, the ArcGIS for Facilities system includes a series of templates for facilities and a data model; as a result, facility managers can integrate their facilities data into one standard format, apply cartographic rules to the data so it is easy to view and understand, and make the data easily accessible to others in their organizations. Information on the newest template—Campus Place Finder—is included in this edition of *Smart Facilities* newsletter.

For more information on these concepts and the use of GIS to help facility managers, visit esri.com/fm.

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The Next Great GIS Frontier

for people, places, processes, and technology used to manage the built environment. *Facilities* is a broad term that covers airports, university campuses, military bases, and commercial sites. By considering the interactions of all processes, FM allows building systems to be managed strategically. An abundance of data about buildings exists in CAD and building information modeling (BIM) formats.

Increasingly, FM professionals are turning to GIS, with its tremendous capacity for integrating this detailed data from disparate sources. Instead of looking at facilities as a collection of parts, GIS lets managers see these subsystems holistically—as parts of a whole—integrated based on commonality of location, which enables analyses. GIS is a complementary, not competitive, technology that brings data on the built and natural environments together and spans scales from the global to a building interior.

GIS can be used to follow a building through its entire life cycle, from site selection, design, and construction to use, maintenance, and adaptation, through closing, repurposing, and reclamation. The challenge is managing each step of the process so a building's benefits are maximized and its short- and long-term impacts on the natural environment minimized.

The ability of GIS to assess the relationship between a building and the landscape that surrounds it can be analyzed with respect to effects on both the building and its environment. Through simulation, a building can be placed in specific environments to evaluate its performance and determine how location changes the structural requirements for that building. Aspects of design, such as energy efficiency or resistance to the effects of climate change, can be incorporated into this simulation testing. By running the analysis from a geodesign perspective, the effect of the building on the landscape can be modeled, measured, and modified where necessary. By relating existing structures and systems on a campus or military base to the requirements for new infill, buildings can be optimally sited.

The GIS tools available for these analyses are rapidly improving. With Esri's recent acquisition of Procedural, the technology in CityEngine 3D cities and buildings modeling software will be integrated into ArcGIS, providing full 3D design in geographic space.

Three-dimensional visualization is a vital aspect of GIS use for FM because it provides the multiple views at the level of detail needed not only to construct the building but also to identify possible conflicts before construction starts. In addition, some problems, such as line of site, collision detection, containment, skyline, and shadow analysis, can only be solved in 3D.

The ability to model virtual cities on scales down to the contents of individual rooms benefits not only design and construction but also facility and space management within buildings. GIS-based analysis at the building level supports decisions related to allocation and monitoring of fixed resources such as printers in an office or crash carts in a hospital. This same capability can address emergency preparedness issues such as determining the best route for evacuating not only the building but the vicinity. By adding the fourth dimension, time, GIS can more effectively manage maintenance activities. Work orders can be consolidated based on both location and time frame.

The incorporation of GIS into FM continues to be driven by many factors. For many organizations, rising facility overhead (especially as related to energy costs) remains the largest operating cost item after personnel expense. Sustainability is becoming important to many organizations, particularly educational institutions. The need for a more effective method of addressing the vulnerabilities of public places to security threats remains pressing. Finally, in the current adverse economic climate, the need for buildings that are code compliant, competitive, safe, and sustainable is greater than ever. Consequently, the urban landscape is the next great frontier for GIS.

Massive Research Center Uses GIS to Optimize Space Utilization and Cut Costs

NASA Langley Research Center

The Langley Research Center, established in 1917, focuses on aeronautical and space research.

The National Aeronautics and Space Administration (NASA) Langley Research Center (LaRC) in Hampton, Virginia, has a reputation for solving difficult problems. So in 2004, when confronted with the possibility of dramatically reduced future budgets, LaRC came up with forward-thinking options to downsizing the infrastructure on the 800-acre campus.

Scenarios that addressed budgetary reductions of 25 percent and more meant that a widespread area of real property, including many aging and obsolete facilities, needed to be reassessed. To address these issues, LaRC became one of the first NASA centers to benefit from Esri's GIS technology for real property management.

Space Utilization Optimization

The Center Operations Directorate's GIS team is responsible for spatial data and associated technical support at NASA LaRC. To facilitate reorganization scenarios, the team extended Esri's technology by developing space utilization optimization tools to map out and analyze the use of each area.

The team was then able to propose solutions to reduce the number of buildings in use and increase efficiency, with a goal of ultimately reducing operation and maintenance costs by $1 million per year.

GIS team leader Brad Ball recalled the stringent requirements placed on his team to reorganize a building for a long-term satellite research project, which required extensive collaboration between researchers to be successful. The satellite project manager wanted his team to be located on a single floor. Using a GIS space optimization model, the GIS team was able to show how the satellite project team could work together on one floor of a building. This required two other organizations to relocate within that building, but the GIS team identified new locations for them as well. "I am pushing [for] space optimization. I think that's probably the most valuable tool we've developed in the time I have been driving the GIS efforts here," Ball said. "I think it has value across the entire federal landscape and in industry and academia."

Cost-Cutting Benefits

In addition to the savings the agency will realize from more efficient property use, Ball believes the system is paying dividends in terms of effectiveness. He says the system's ability to integrate data from various sources allows the agency to make better decisions, resulting in opportunities for further operational improvements and reduced costs. "We can come up with new approaches to do things that we couldn't do previously because the data was not readily available," he said.

Ball cited janitorial and grounds maintenance contracts as examples of additional efficiencies and cost savings that GIS enabled.

"We were able to identify the square footage for grounds maintenance," he said. "Previously, we were just telling the contractor to cut [the grass in] this area, and we would say we have 800 acres. Well, by the time you take out the parking lots, the roads, the buildings, and wetlands, that tremendously reduces the area."

On a Path to Success

Ball said NASA LaRC's efforts to downsize are on course. The center was so successful in using GIS for real property management that now other NASA centers, such as the Johnson Space Center, use it too. Other government and private facilities and countries are showing interest as well.

"NASA Langley's master plan is being very well received," Ball said. "We're going to demolish the old buildings. We're going to have a smaller carbon footprint. We're going to compress . . . [but] we will still support most of the areas of work that we have [had] over the last 40 to 50 years."

Daunting Task Gets Easier

Geotagged Photos Aid Real Property Inventory

By Kevin P. Corbley

Roger Miller, the Real Property Administrator for the Corps' Omaha (Nebraska) District

An efficient and easy-to-use photo-mapping inventory process developed by the US Army Corps of Engineers (USACE) is being used to inventory real property assets and output ArcGIS feature layers that map geotagged photos and contain attributes.

The Chief Financial Officers Act of 1990 (CFO Act) sought to reduce government waste by improving the efficiency of financial management and accounting practices at US federal agencies. Among its many mandates, the act directs government departments to conduct regular inventories of their assets worldwide—this includes audits to assess and document real estate assets.

Under the act, real property audits apply to vacant parcels as well as improved properties. Audit guidelines require every government agency to inventory its properties and determine where they are located and assess how much they are worth. Documentation must include photographs of any buildings and structures and their geographic coordinates.

The inventory mandate was challenging for all federal agencies, but particularly daunting for the USACE, which owns, operates, and manages thousands of civilian and military properties located around the world. Primarily responsible for major civilian design, construction, and public works projects within the United States, the corps also maintains land records for 250 military facilities on behalf of the US Army and US Air Force.

"[USACE] real property runs the gamut, from a radio tower and building on a piece of land to a major dam complex with 1,200 individual items," said Roger Miller, the real property administrator for the corps' Omaha (Nebraska) District.

The corps is divided into 45 districts worldwide, delineated either by watershed (for civilian projects) or political boundaries (for military support activities). Omaha District has more than 6,000 buildings or structures in management areas covering eight states. This district became the first to develop a highly efficient inventory process that involves geotagging and photo mapping to create a real estate layer in ArcGIS.

Until recently, the corps primarily used CAD for mapping projects. However, many divisions in the agency are now adopting ArcGIS for this purpose. The corps' Northwestern Division, which includes Omaha District, is building a division-wide GIS containing layers for real property, engineering, operations, and project management. Once completed, this web application will make details of properties, facilities, and projects available to anyone in the corps via a web browser.

Finding a Solution

Miller recalled the difficulties he encountered during his first assignment to perform an inventory of a project site. He was given a handheld GPS receiver and digital camera. At each feature, he snapped photos from one or more perspectives and then jotted down the latitude-longitude coordinates from the GPS screen.

"I came back from that not too happy with how long it took," said Miller.

And if the time spent in the field seemed excessive, even more time was required back at the office to correctly correlate digital photos with property locations. Once the handwritten notes were correlated, it was a manually intensive process to rename and post the photos to their correct locations. To get an aerial view of a specific area required looking up each one using the resources available on the Internet.

Miller searched the web looking for an integrated system to streamline the asset inventory task. He eventually found Ricoh cameras (models 500SE and G700SE) with built-in GPS, compass, and attribute notation capabilities. He also discovered software that drastically reduced the correlation and mapping work back at the office. The Ricoh camera was offered as a bundled solution by Esri partner GeoSpatial Experts, LLC, of Thornton, Colorado, developer of GPS-Photo Link photo-mapping software. The software automatically correlates photos with their geographic coordinates and stamps the location and time, along with any other user-defined attribute data, as watermarks on each photo. GPS-Photo Link then outputs the photos to an annotated map layer in ArcGIS.

Putting Photo Mapping to Work

Typically, Miller travels around the project site by foot or car. Since all projects in Omaha District have been inventoried at least once, he carries a printed list of items that must be visited and photographed as he looks for new assets that have been built since the previous visit. In the interests of accuracy and consistency, Miller has devised procedures for how each asset will be photographed. Large buildings, for example, are photographed from each side, while a small picnic table pad requires only one photo.

The Ricoh G700SE and 500SE were designed for use with GIS. Miller takes full advantage of their capabilities. As he photographs each item, the camera's GPS records the location. When positional accuracy is critical, he stands immediately next to the feature, holds a GPS lock button on the camera, and then moves away from the feature to snap the photo so the unit records the location of the item rather

Attributes, such as hand receipt number, location, and asset type, are embedded in the photo. Geotagged photos can be exported from the photo-mapping software as an ArcGIS map layer containing icons placed at the precise geographic locations of photographed features.

than the location of the camera when the photo was taken.

In some situations, such as a large dam structure, properties are not accessible by foot. In those cases, he links a TruPulse laser range finder to the camera via wireless Bluetooth connection. The laser determines the distance to the feature, and the software combines that distance information with the bearing and position information from the camera to calculate an offset position.

The Ricoh G700SE and 500SE act as data collection devices as well as cameras and GPS units. Each USACE asset is identified by a property identification (PID) number. While on-site, Miller selects values from drop-down menus—created on a PC and transferred to the camera—to collect attributes for each item. These attributes are embedded in the photo. The attributes stored for each item are PID number, hand receipt number, location, asset type, structure number, description, original cost (if available), outgranted/outleased status, contract number, whether it is a cost share item, and the real property type and use codes.

Up to 100 notes or memos can be stored in the camera as attributes along with the GPS coordinates, which are linked permanently to each photo. Some assets have bar code stickers containing PID numbers that the Ricoh cameras can scan and automatically store with each picture.

Because thousands of photos may be taken for a single project during an inventory, Miller first organizes the pictures by location. He uses the basic editing software provided with the camera to add, delete, or update information. He then uploads the photos and attributes to the GPS-Photo Link software on a standard personal computer. The software can correlate hundreds of photos with GPS point locations and attributes in just a few minutes.

He then decides which attributes (e.g., coordinates, acquisition date, PID, assessed value) will be stamped with a watermark on each photo. Back in his Omaha office, Miller outputs the geotagged photos from the photo-mapping software as an ArcGIS map layer containing icons placed at the precise geographic locations of photographed features. Users click icons to view photos and related attribute information.

With photo-mapping software, Miller can output photos in a variety of other formats including PDFs, HTML reports, spreadsheets, or Microsoft Word documents.

Creating a Real Property GIS

The move away from CAD to GIS for storing information relating to real estate and other facilities will offer significant benefits across the corps, according to Jesse Otterson, a cartographer in Omaha District.

"It's a dataset that becomes helpful not just to our real estate division but also to people involved in operations and maintenance," he said. It helps people understand the buildings they maintain.

Miller's inventory process is so efficient and easy to use that he has been asked to teach it to other real estate specialists throughout the corps and in other government agencies. The corps is currently performing its real property inventories in three-year cycles. Because it was the first government agency to complete an audit under the CFO Act, the corps' procedures are being emulated by other federal offices.

About the Author

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3D Data Gives Toulon Provence Méditerranée a New Perspective

The community of cities known as Toulon Provence Méditerranée (TPM) is a large metropolis comprising 10 different municipalities around the city of Toulon, located in the Var and the Provence-Alpes-Côte d'Azur in the southeast of France on the Riviera. Founded in 2002, this is the ninth-largest urban center in France (with respect to its population of 560,000 and number of companies—27,000). This is an area with a growing population and a strong economic and cultural life, particularly around its harbor, one of the largest in Europe, which has long shaped its history and maritime and military vocation.

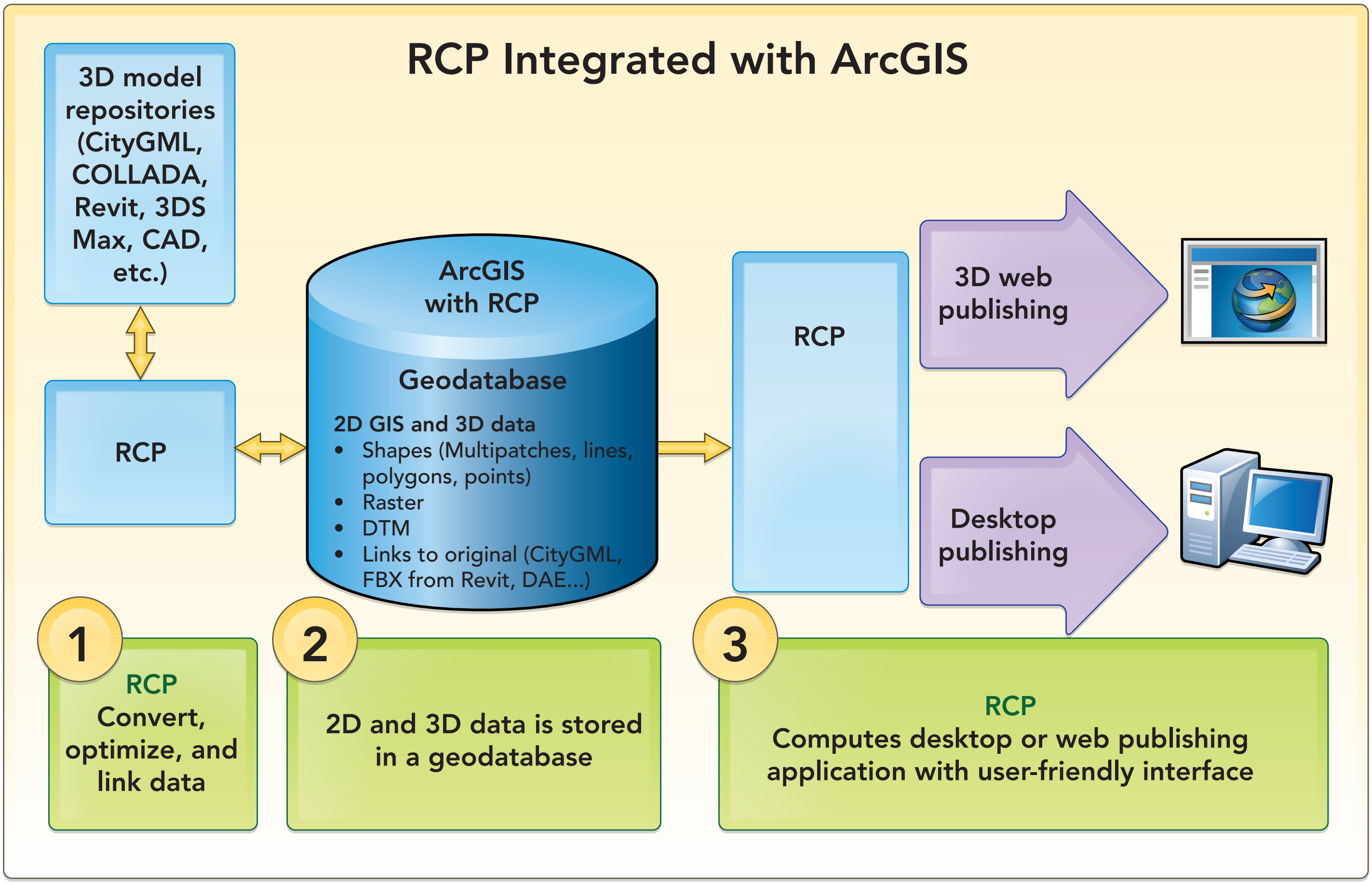
As in numerous other territories, the governance of TPM is responding to two new expectations. First, the demand for public communication and territorial marketing keeps growing. Second, 3D urban modeling continues to arouse interest among new stakeholders (such as town planners, architects, and the news media). This has caused GIS departments to rethink some of their practices to optimize available data and build tools enabling them to better understand their territories.

This strategy was crucial for the head of GIS for TPM, Arnaud Demellier, graduate of the French National School of Geographic Sciences. With a career history that includes positions as department manager of an IT company, manager of a regional agency at the French National Geographic Institute, and manager of a bank agency, he understood straightaway the significance of the adaptability of 3D modeling and the requirement of making the data available within end-user departments. He was convinced that there was a developing interest in 3D visualization to support decision making on large-scale urban development projects. Further, he was convinced that the time had come to better integrate 3D data into TPM's existing ArcGIS platform and thereby more easily manage and distribute the benefits of 3D to other stakeholders and to the public.

Meeting the Challenge

To meet this challenge, TPM purchased numerous datasets, for example, a high-resolution digital orthophotography dataset, an enriched digital terrain model, and a topo-

Above is a view of 3D buildings for Porte d'Italie in Toulon, exported by RCP and ready for analysis in ArcGIS.



graphic and altimetric database. In addition, TPM sought a software solution that could integrate with ArcGIS to manage 3D data as easily as a 2D database. Demellier knew that this solution would have to enable the importing of its internal and external datasets and manage, structure, exchange, and use raw 3D data without the need for additional resources (3D specialists, etc.), the purpose being to remain autonomous and operational in real time and simple to use in the face of various demands from the business departments.

Following a careful search of technologies, TPM found the missing link to its 3D chain and enlisted the aid of Esri partner VirtuelCity of Montbéliard, France. VirtuelCity had developed an ArcGIS plug-in named RCP that enables integration and management of the different formats of 3D data (multipatch, FBX from Revit, DAE, KMZ, CityGML, etc.). This solution allows data administrators to visualize 3D data in a high-definition 3D viewer.

Up and Running

Now, TPM's RCP solution creates new processing chains of data—importing different structures of three-dimensional objects coming from diverse data suppliers and producers. This solution also enables TPM to better manage the data exports at different levels of modeling (terrain, buildings, texturing, etc.).

RCP, integrated with ArcGIS, has allowed TPM to keep working in an environment known and mastered by its GIS department. This provides the opportunity to use the analysis tools of ArcGIS on the data integrated by RCP and then manage the 3D data (multipatch and polygons) in ArcGIS after importing to RCP. The training and knowledge transfer guarantee ease of execution.

Data is dynamic, interoperable, and reactive. Everything can be changed, added, or deleted in the ongoing projects; indeed, RCP allows managing a 3D database in the same way as 2D, expanding possibilities to produce 3D models about projects in any format, extracting from them movies for promotion and real-time 3D web and desktop publishing. It provides a simple and relevant solution to make the management of 3D data accessible to anyone and transform GIS into 3D GIS.

For more information, contact Arnaud Demellier, GIS department chief, Toulon Provence Méditerranée (e-mail: ademellier@tpmed.org) or Fabrice Simondi, CEO, VirtuelCity (e-mail: f.simondi@virtuelcity.com, tel.: 0033-6-82-57-27-96).

Small Scripts, Big ROI

ArcGIS Resources Dramatically Speed Property Reappraisal

In 2009, Guilford County, North Carolina's tax department could not process large numbers of street-level photos for a property reappraisal project and had no budget to pay for a solution.

In a flagging economy, shrinking government budgets can sometimes force managers to investigate existing available resources, creating solutions with what they already have or can be obtained for free. In this environment, GIS managers can tap into no-cost online resources such as free extensions and scripts, many designed to solve specific workflow problems. Project supervisors in Guilford County discovered free ArcGIS applications that helped the tax department create a photo geotagging system that dramatically exceeded the county's objectives.

The extension allowed the appraisers to load photos into the ArcPhoto window and drag the photos over their corresponding parcel polygons in ArcGIS, geotagging the image by populating the GPS coordinate fields in the EXIF metadata.

Sync Problem

To ensure fair implementation of the new tax system, all Guilford County properties had to be photographically reappraised. Using simple point-and-shoot digital cameras the county already had, tax department staff took photographs of single-family residential structures to assess their current value. It wasn't long before they realized the department's system of processing the photos wouldn't meet the project's deadline. A key step in this process was manually renaming the photos. At a minimum, the system should automatically title each photo with its parcel ID and populate the image file's metadata.

Ideally, these photos could then be dragged and dropped into parcel polygons on the map, providing an augmented visualization by linking the parcel with its photograph.

The tax department went to Guilford County GIS Department. The departments agreed the new system should automatically associate each photograph with its parcel record stored in the computer-aided mass appraisal (CAMA) system. Initially, everyone thought that GPS might be the answer.

"The county already had a few GPS units," said Stephen Dew, GIS manager at Guilford County. "We thought we could automate the process by syncing the camera's internal clock with the GPS unit's internal timing." GPS units collect a data point every second and store it in a track file, which can be displayed as a series of points outlining the route taken by the GPS user. This method could give each photo a spatial location that could be mapped and matched to a digital parcel number in the county's GIS. There was only one problem: the cameras' clocks could not be reliably synchronized with the GPS receivers' clocks.

Way to Geotag

While Dew and his staff pondered another solution, appraisers resorted to manually locating their photos using the free ArcPhoto software extension to ArcGIS found at Esri's ArcGIS Resource Center (resources.arcgis.com). Developed by Esri programmer Thomas Emge, ArcPhoto tools enable the quick import of digital photographs into ArcGIS by working directly off the Exchangeable Image File (EXIF) format metadata encoded into standard digital imagery. In professional-grade cameras or photos taken with ArcPad 7, imagery can hold GPS location information.

The extension allowed the appraisers to load photos into the ArcPhoto window, then drag the photos over their corresponding parcel polygons in ArcGIS, geotagging the image by populating the GPS coordinate fields in the EXIF metadata. The ArcPhoto extension can directly read the EXIF metadata and allows streamlined integration of photos in maps. Using this method to geolocate the parcel images increased productivity from 50 to approximately 200 images per day—a significant improvement but, unfortunately, not on target with the looming deadline.

After automating the process somewhat, Eric Funderburk, GIS analyst and lead researcher for the project, downloaded one of the ArcScripts for ArcPad from the ArcGIS Resource Center. The script created a data entry form in ArcPad that allows the user to enter the number of the first digital image taken.

Clicking the Register Picture button writes the complete image file name to the attribute table of the shapefile. After entering the first image, the script sequentially autonumbers the next digital image in the attribute table. This method allowed field crews to quickly take the photo and concurrently assign a point to a digital map before photographing the next house.

Automating with Python

When the appraisers returned from collecting photos, they copied the images to Guilford County's local network. Funderburk simplified this process using Python. "After inserting the camera's SD [secure digital] card into the desktop USB reader, a Python script executes from the user's desktop that reads the SD card in the card reader, including the time and date each digital image was taken," says Funderburk. "This creates a secure directory on the server and copies the images by date to their corresponding directories."

Next, appraisers had to figure out a way to automatically rename each photo (e.g., IMG 001, IMG 002) with its associated parcel ID number (e.g., 334). With the help of Esri technical support analyst James Unger, Dew and Funderburk used another Python script that renamed photos using the point feature class that held the parcel number and the original image file name. The Python script searches the directory where the photos are stored, loops through the records in the point feature class to find a matching image file name, and uses the Parcel_Number field in the feature class to rename the original image with its parcel ID.

Projected Output Exceeded

Reappraisal productivity at Guilford County increased immediately and dramatically. At its peak, crews collected and named more than 750 images per day using the new methods—an increase of 1,500 percent from the initial output. With just two crews in the field, almost 4,000 images were collected and georeferenced in three days. Before adopting this workflow, the tax department had hoped to have a few thousand photographs ready for the new tax system. By the February 2010 cutoff date, it had delivered more than 40,000 images.

Although Guilford County had no money to fund its reappraisal project, using in-house equipment and existing expertise, the tax and GIS departments collaborated and improved the daily output associated with this project. The increase in productivity boosted the morale of the entire appraisal staff and made the project viable.

For more information, contact Stephen Dew, GIS manager for Guilford County, at sdew@co.guilford.nc.us.

The ArcPhoto window allows Guilford County GIS staff to view photos within ArcMap. ArcPhoto writes the coordinates in the EXIF header of the JPEG and geotags the image.

Campus Place Finder Template for ArcGIS 10

The Campus Place Finder template is a configuration of ArcGIS for Server and a JavaScript application that allows employees and visitors to locate people and places on a campus or in a single building. This application is typically used by employees or university students to locate an office or conference room in a building but can also be used by visitors to locate an individual employee.

Campus Place Finder offers a map-based view of interior and/or exterior assets on a university or business campus that enables employees, students, and visitors to locate an area of interest and review common information stored typically in an organization's human resources and facilities databases. It also allows employees and visitors to deliver a web-based service request application for a building or campus.

The Campus Place Finder application provides employees, students, and visitors with an easy way to find a building space or person by name. They can also enter the space name or simply use the map and floor navigator to find an area of interest. When a space name is entered, the application presents a list of spaces with similar names and allows users to select the appropriate space. When the name of a person is entered, the application either finds the space or presents a list of people with similar names and allows users to select the appropriate person from the list.

As an optional step, Campus Place Finder can also be configured to support a web-based service request application for a building or campus. The application can be used by facilities, buildings and grounds departments, public works agencies, or other organizations to deliver service requests. It provides 24/7 access to the organization and typically supplements the customer service phone numbers staffed by corporations, universities, or government agencies. In organizations that have deployed an automated system (CRM/CMMS) to track service requests and work activities, the online requests can be routed to staff responsible for their resolution. If an automated system is not present in the organization, a manual service ticket can be created and routed to appropriate staff.

Users can configure the Campus Place Finder template in their environment and, in doing so, learn how to publish and serve their own maps using ArcGIS for Server and the organization's data. To complete the configuration, experience with ArcGIS for Server and Microsoft's Internet Information Server (IIS) is necessary. Those new to JavaScript applications can use this template to deploy their own JavaScript applications and publish web maps using ArcGIS for Server.

The Campus Place Finder application allows employees, students, and visitors to locate people and places on a campus or in a single building.

Esri CityEngine Adds a New Dimension to Your GIS

3D Content Creation and Urban Design

A conceptual view of Rotterdam, the Netherlands, with content created using ArcGIS and CityEngine.

Since Esri announced the acquisition of Swiss company Procedural and its flagship product CityEngine, many users have been exploring how they could leverage this new product for their GIS work. The key functionality provided by CityEngine—high-end 3D content creation from simple 2D GIS data—is simple enough to understand, but how does it work? Perhaps more importantly, what do you, as a user, need to make it work?

CityEngine relies on three ingredients: features, attributes, and defined rules. The more detail you can provide in each of these elements, the greater the complexity and real-world accuracy you will get in the generated 3D content. While CityEngine can potentially create many kinds of 3D content from these three ingredients, it is currently focused on the construction of urban environments through integrated sets of buildings; building interiors; streets; and scene-filling objects, like trees, light poles, cars, and people.

For simplicity in understanding how CityEngine works, consider how it generates the exterior of buildings.

As a GIS user, you already have access to the first two parts of the puzzle (features and feature attributes) in your geodatabase. Suppose you're lucky enough to have polygon features that directly represent building footprints, and each feature has some information about the size and type of building it represents. By connecting a building construction rule in CityEngine to this data, a 3D representation of the physical building can be created.

First, the base 2D polygon of the building footprint is extruded upward—using a BuildingHeight attribute—to make it a 3D block. This is a common and simple representation of a building, but in CityEngine, you've just started the construction process. If you have more information, like the roof type of each building, the rule can construct different rooftops, such as hip, flat, or gable. If you have a field containing FloorCount, you can use the rule to split up your extruded blocks into floors and split each floor into windows with windowsills or balconies. Very advanced 3D building geometries, all driven by GIS data, can be constructed using this workflow.

To add realism to 3D buildings, CityEngine also supports rules to define textures. Textures are the imagery draped on the roof and sides of the generated models. For example, the texture of a building's roof could be defined by a field called RoofMaterialType containing values such as Tile, Concrete, or Corrugated Iron. Alternatively, you could take a different approach and have the rule extract a piece of satellite imagery and drape a real-world texture on the roof. Then, for the sides of the buildings, you can define different textures for the ground, intermediate, and top floors and have your buildings automatically "painted" with the applicable construction material, like wood, brick, or stone. CityEngine also contains styles you can use to define a whole suite of these options in one step.

This all sounds amazing, but what if you don't have building footprints with all these attributes? Can you still make buildings using your GIS data?

The answer is absolutely yes—CityEngine can construct representative buildings using as much, or as little, information as you provide. Highly detailed urban environments can be generated from landownership parcels with

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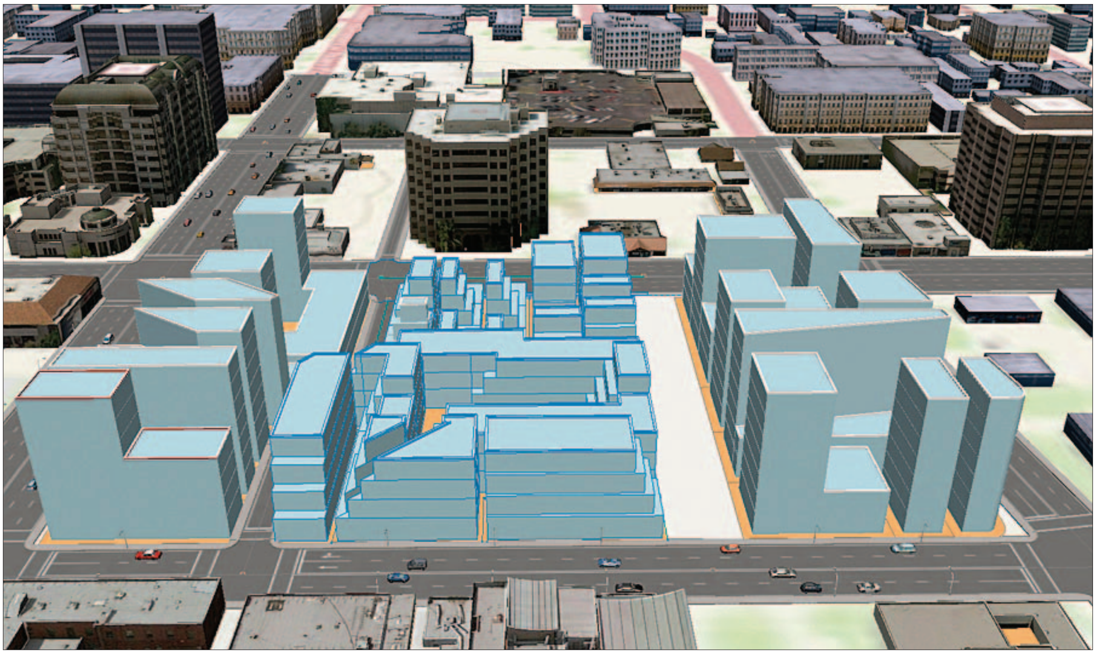
Esri CityEngine Adds a New Dimension to Your GIS



A Block-Building Representation of the City's Zoning Regulations

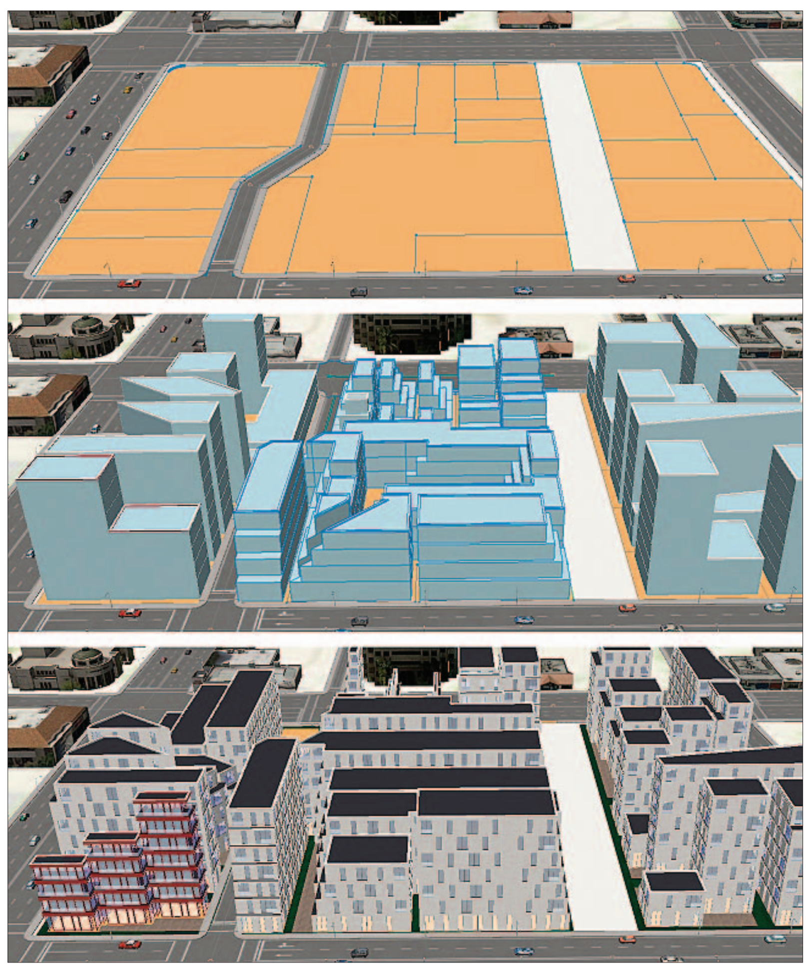
information on zoning laws or even something as simple as a street network. The detailed examples and tutorials that come with CityEngine demonstrate how this is done.

You can use the models created in CityEngine in many different ways. Urban designers can bring them back into their GIS database for in-depth analysis using all the geoprocessing power provided by ArcGIS and the ArcGIS 3D Analyst extension. Professional users in entertainment and security simulation might use them as part of a larger workflow with other 3D rendering and gaming packages. It's also likely that innovative users in other fields will find ways to use these new tools; one example already being discussed is the creation of 3D volumes for the maximum swing-and-sag zone for transmission lines, making it possible to better protect against major outages from line damage.

So what's the catch? It comes down to the level of effort and understanding required to make all the different elements come together. CityEngine is a highly professional and adaptable piece of software and will perform best after some investment in learning how it works.

Simply put, CityEngine has powerful capabilities to create an incredible variety of 3D content from often very simple GIS data. It makes it easier than ever to add that extra dimension to your GIS and move you into 3D.

For more information and to download a free 30-day trial, visit esri.com/cityengine.



Maximum Building Blocks and a Residential Design that Adhere to Local Zoning Laws

Geodesign in the Real World

By Stu Rich, PenBay Solutions LLC

This article is the third in a series of four that discuss the value that GIS can offer to each stage of the facility life cycle.

Geodesign processes can be used in novel ways to bring value to each stage of the facility life cycle, from site analytics and design to planning, construction, operations, security, and sustainability. The use of ArcGIS as an enterprise geographic information system platform is a natural place to start framing system architecture to support full facility life cycle management.

From a geodesign perspective, one of the major challenges is defining data representation models and sound workflow integration between CAD and GIS data to support the full life cycle vision. This requires examining the needs of each work stage, from concept to detailed design and from construction to operations.

Facility master plan data is inherently conceptual, a general layout of block buildings, roads, landscaping, and grand themes intended to guide design. At the start of a project, this data is formed into the base layers of the GIS to support early site planning and logistics. Selected features, like the site infrastructure, buildings, and building spaces, can be extracted from the design CAD drawings for use in the GIS to support construction management, quality assurance, clash detection, logistics, and the monitoring of progress.

Design data for each building can now be more detailed, since it is created to support actual construction. As-builts can be submitted in either CAD or geodatabase format that complies with the data model requirements, which include a large set of geometry and attribute data for use in GIS.

A much more extensive range of features, including the detailed locations and characteristics of facilities and assets, can be captured from the as-built drawing information as each part of a new site is finalized and commissioned. The final geodatabase created during this stage would include all the essential features needed to support the final operations stage of project development.

A facilities information infrastructure (FII) model requires setting CAD and geodatabase design guidelines that all design firms would follow so that drawing files can be quickly integrated into the master GIS geodatabase

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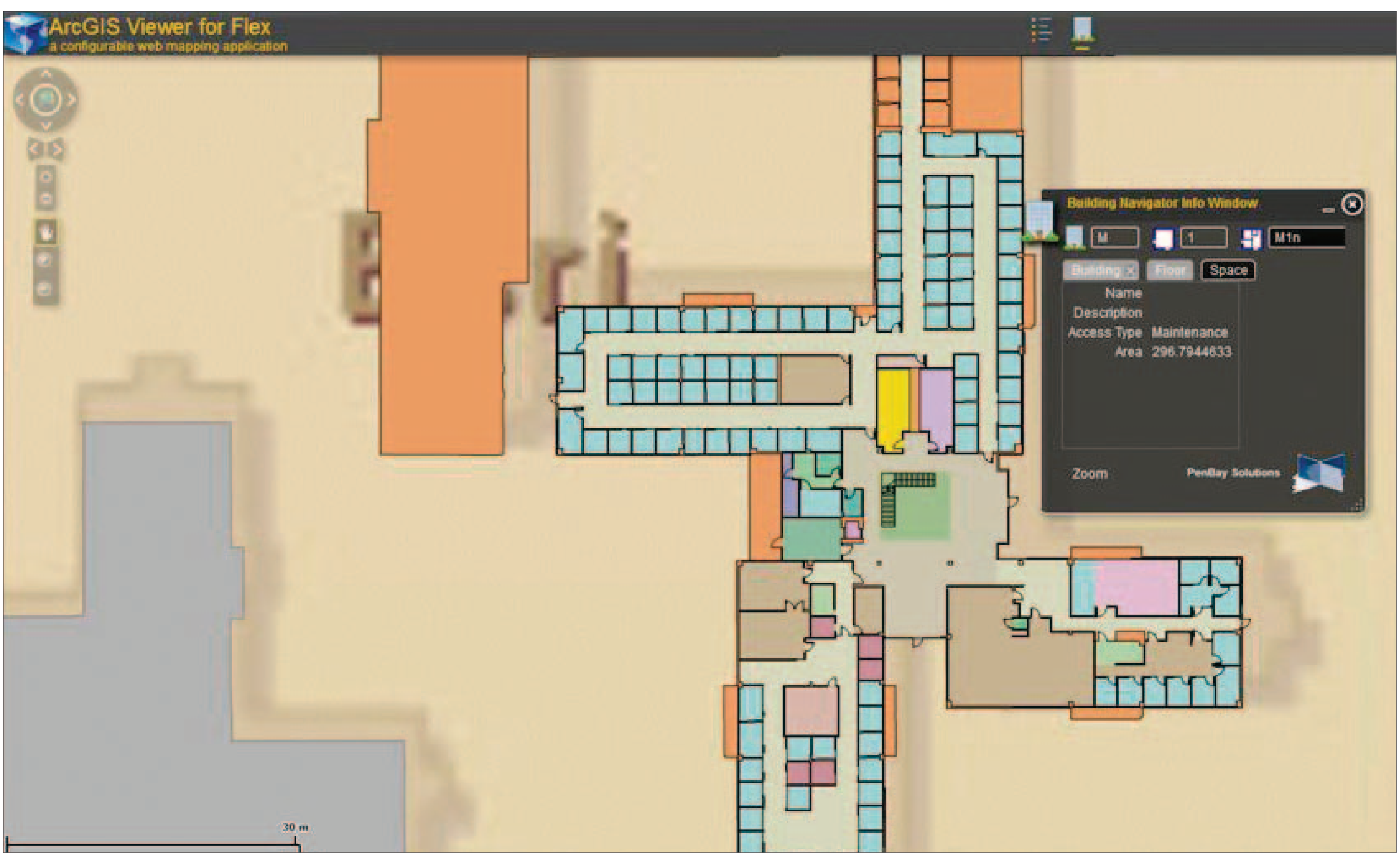

Construction data is made available throughout the life cycle of a building when it is stored and managed using GIS.

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Geodesign in the Real World

upon delivery. In turn, the GIS would be linked to the project, document, and drawing management systems to support the monitoring and reporting of construction progress and change management across the entire site. What makes a facility geodatabase unique is that it has to span features indoors and outdoors, underground and above, permanent and temporal. Thus, the FII model extends beyond the geodesign phase into enterprise operations for the duration of the life cycle.

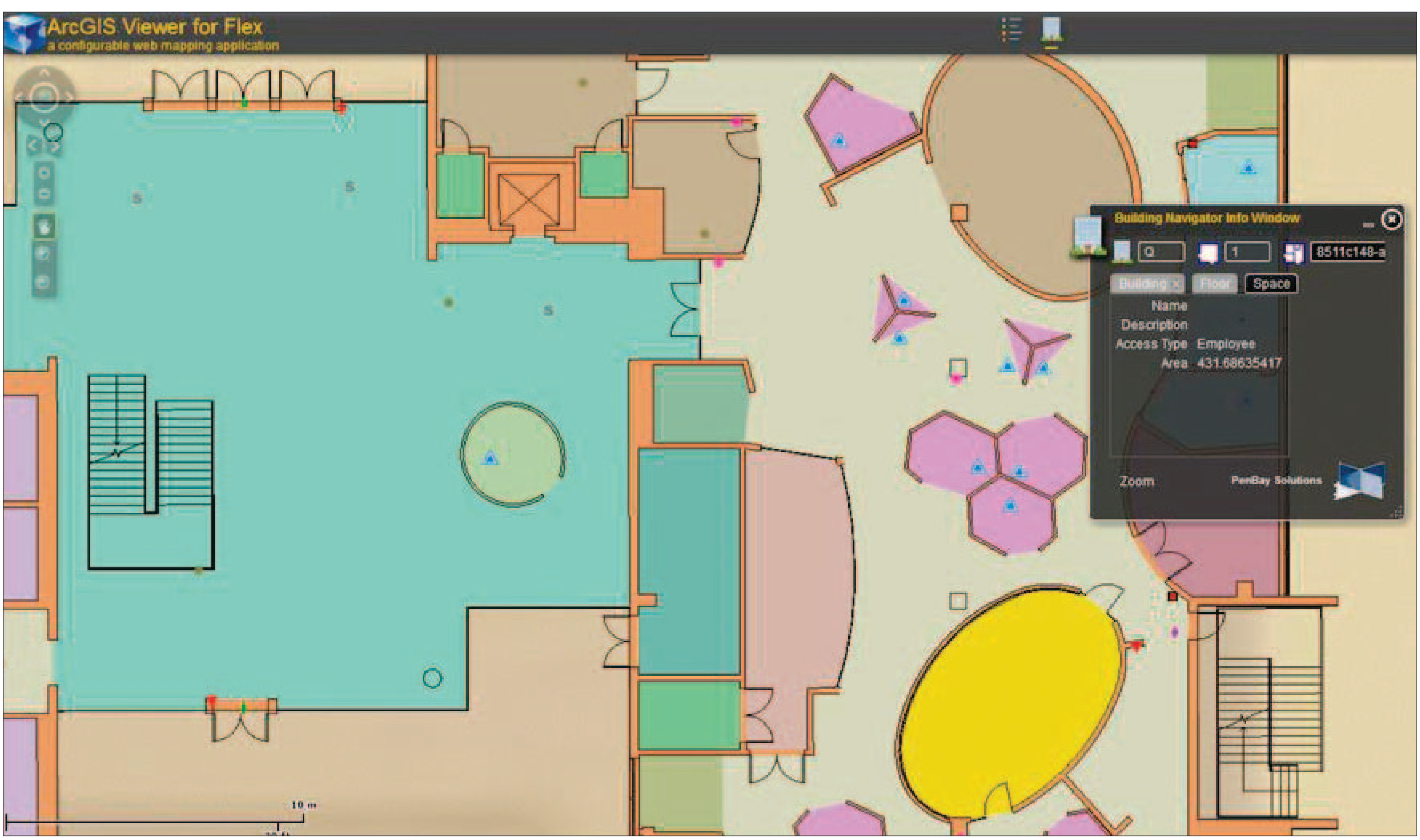
Master Plan Support

Coordinating a campus design and construction job requires a small army of dedicated experts and many months of planning and revising. The master planning process is one of the first places where geodesign plays an integral role, optimizing program elements and unifying designs from individual bid packages into a single seamless view. Subsequently, planners and decision makers can recognize design impacts and understand considerations that would be missed without a holistic understanding of the sum of the design parts. Some of the most compelling benefits of geodesign process and evaluation modeling include viewshed analysis from ground vantage points as well as windows, drainage, security planning, and solar/radiation modeling.

Construction Management and Planning Support

Through the use of GIS, construction team members can retrieve, update, and analyze construction logistics and scheduling data, temporary staging locations and assignments, and daily operations across the entire site through a simple web viewer. At daily standup meetings, utilizing an easy-to-use dashboard viewer that allows quick sketching and markup, this information can be printed and then taken to the field. Each quick temporal snapshot helps meet the demands of the day as well as the longer-term planning activities, making construction logistics run smoothly.

As many construction managers can attest, construction implementation rarely occurs without the need for design change. This is especially common on large construction efforts when managers realize midstream that an important factor has been missed, like an existing utility easement, or that a new technological advance has come out that greatly reduces a particular design constraint. Geodesign is used to change modeling processes and includes room for adaptive management, which allows design changes and impact assessment midimplementation to ensure that program goals are met and design



Using a mapping interface, designers, planners, construction managers, and others, have access to information allowing them to make better, more informed decisions.

changes have no unforeseen impact on other design elements.

Equally important to timely management is the visualization over time (4D) of construction. Construction managers and decision makers can view and identify spatiotemporal clashes, accessibility problems, and other logistic issues before they happen.

Status Monitoring and Reporting

A construction project can be like a large, three-dimensional chess game—a giant, complex, moving puzzle. As the project progresses, the verification and monitoring of defined performance goals, risk, cost, and schedule—the critical aspects of project controls—become increasingly important. Because so many tasks are dependent on significant milestones, there needs to be a razor-sharp view of progress across all the ongoing activities. It can be helpful to create a GIS reporting web application to take project assessment data from the tabular project report and display it on a map, showing where activities may be falling behind and adjacent efforts that might be impacted. This quick visual reporting style, using the map as a dashboard, embodies all progress reports, providing intuitive, full project snapshots that can be easily understood by anyone on the project team.

Another way to visualize progress and key performance indicators is to create a 3D GIS view of the site. Using 3D solutions such as ArcGlobe services and ArcGIS Explorer, project leaders and executives can quickly get an up-to-date view of construction progress in 3D or request a high-level report.

Lessons Learned

The benefits of using geodesign processes to support facility life cycle management are numerous:

- Geodesign plays a significant role in the complex world of adaptive management throughout the construction process.
- The use of GIS strengthens and streamlines the design and construction phases of the site development process.
- A robust geodatabase forms the foundation for key applications that service reporting, project and document management, and logistics and scheduling.
- ArcGIS for Server and ArcGIS for Windows Mobile make it easy for anyone with a web browser to visually check the status of a project in 2D, 3D, or 4D.
- Web-based sketching tools take the traditional pencil-and-paper process and make it digital for daily construction and logistics updates that can be shared, as appropriate, with all project team members.
- Through a mapping interface and dashboard, designers, planners, construction managers, project control managers, and other decision makers have ready access to various types of information, enabling them to make better, more informed decisions.
- Integrating key components of completed as-built drawings into a final geodatabase forms a foundation on which an organization can build out an enterprise system for future management and growth.

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