Enterprise Edition

Smart Facilities

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GIS for Facilities Management

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Perth Airport Flies High with Geospatial Intelligence

Australian Airport Gains Enterprise-Wide Access to Location Intelligence Tools

Westralia Airports Corporation (WAC) effectively disseminates and manages its data throughout multiple departments, creating workforce efficiencies through time-saving and near real-time information sharing processes.

Western Australia is home to a strong economy led by natural resources, and since Perth is Australia's most isolated capital city, Perth Airport is a critical infrastructure component in the state. The airport has recently experienced the highest passenger growth rates of any Australian capital city airport, reporting a 7.5 percent increase in passenger numbers for the 2009–2010 financial year. More than 10.4 million passengers traveled through Perth Airport in 2009–2010, and total passenger movements per year are forecast to more than double to 18.9 million by 2029.

To meet this growth projection and prepare for the expansion of terminal facilities, WAC sought to gather more data throughout the airport estate, taking multiple safety and security, operational, environmental, customer service, commercial, and service infrastructure factors into account. WAC wanted to be able to integrate data from this range of complex, interrelated areas and understand how the location of various factors was influencing their use and constraints.

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Westralia Airports Corporation effectively disseminates and manages its data throughout multiple departments, creating workforce efficiencies through time-saving and near real-time information sharing processes.

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Perth Airport Flies High with Geospatial Intelligence

To achieve this, WAC required a solution that provided more enhanced spatial information management. During the research and investigation process, WAC contacted Esri Australia Pty. Ltd., Esri's distributor in Australia, which had developed a technology that could help Perth Airport find a corporate-wide location intelligence solution, and the two companies decided to work together on the project.

The team's key goals were to create a solution using ArcGIS technology that would

- Provide a single authoritative source of spatial information.
- Add value to the business and decision-making processes.
- Improve efficiencies in repetitive or complex tasks.
- Provide an intuitive way to locate information held in business systems.
- Ensure that adequate and reliable technology is deployed to support location-based systems and business activities.

At the heart of WAC's location intelligence solution was Esri geographic information system (GIS) technology and Dekho software, which was developed by Esri Australia. Based on ArcGIS, Dekho helps WAC integrate information from databases that have a location element, including property and asset management. The software enables WAC to effectively disseminate and manage this data throughout multiple departments, saving time by allowing access to near real-time information sharing processes.

WAC is a significant service provider, managing the power, gas, sewer, water, fuel, drainage, and communications needs of two terminals and more than 200 tenants. It is also effectively the landlord, retail hub, and conservation authority within the Perth Airport estate. The corporate-wide solution enables WAC staff throughout the entire organization to access essential location-related data to support operation of the airport.

"Before we implemented GIS, all spatial information requests were submitted to the design office to generate the relevant maps and data," says Shannon Browne, GIS administrator at Perth Airport. "This meant that departments did not have real-time access to information, and the design office could become bogged down fulfilling the myriad of simple requests rather than utilizing [staff] skills for design and spatial information management.

"Through the implementation of GIS, we now provide all staff with access to self-serve maps," Browne continues. "These can help with anything from planning the location of a new vending machine to scoping the environmental impacts of building a new warehouse on the estate. With so many stakeholders using location intelligence to get a greater insight into their working area, staff are better informed and therefore empowered to make better business decisions."

Beyond the ability to create maps and visualize where assets are, location intelligence is playing a major role in planning and development of the expanding airport precinct.

"Location intelligence is vital in planning the airport infrastructure for the construction or relocation of services and the maintenance of airport assets," says Browne. "Through effective use of location intelligence, we will be able to move to a more proactive maintenance schedule and more efficiently allocate and plan resources, resulting in significant cost savings and a better-running suite of assets."

WAC has many more plans for using location intelligence at Perth Airport to optimize workflows and better understand the dynamic nature of the site. These include further integration with the asset management and maintenance processes, detailed land-use reporting, enhanced use of location intelligence for operational activities, and mobile access to GIS.

For more information, visit esri.com/fm.

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Based on ArcGIS, WAC integrates information from databases that have a location element, including property and asset management.

Building Smart from the Ground Up

Kuwait University Uses GIS for Design and Construction of Multibillion-Dollar Development Initiative

Kuwait University (KU) is embarking on one of the most ambitious campus development projects in the world. A massive university city is being designed and built from the ground up and will emerge over the next five years of construction as part of a multibillion-dollar development initiative.

Kuwait University has committed to using GIS technology to support the planning, design, development, and operations of the new Sabah Al-Salem University City at Shadadiya Campus. In early 2010, Kuwait University recognized a need for specialized consulting and documentation of requirements for the geodatabase design of the project. For the plan to be successful, the needs of both Turner Projacs, project manager located in Qatar, and Kuwait University were to be incorporated in the details of design and construction of the project.

Kuwait University chose to apply the geospatial concepts it discusses in its GIS classes to support the entire process of designing, building, and operating the huge new University City. This ambitious endeavor posed many challenges and represented a level of enterprise data development that is unmatched in the world today.

All information is stored in a geodatabase and easily accessible using a Flex viewer.

Modeling and Storing Data for an Entire Campus

To address these complex challenges and establish a common information foundation throughout the entire life cycle, Kuwait University turned to OpenWare Information Systems Consulting Company, Esri's distributor in Kuwait. Esri's reputation and proven performance in the enterprise GIS arena made it a natural source to start framing a system architecture to support KU's vision. OpenWare partnered with PenBay Solutions LLC, headquartered in Brunswick, Maine, and Turner Projacs, based in Doha, Qatar, to create a strategic road map for understanding the milestones and level of effort required of this facilities information infrastructure project.

One of the major challenges was deciding how to model and store information for an entire campus, which included indoor, outdoor, underground, connected, and temporal data.

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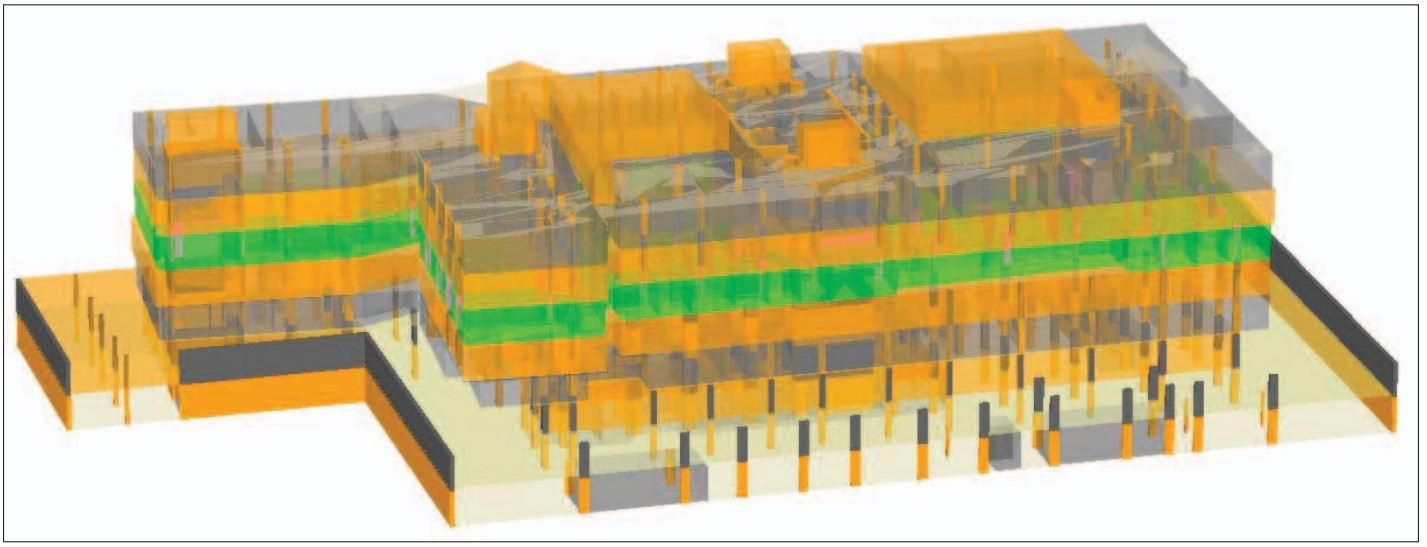

Progress and key indicators can be viewed in a 3D GIS view of the campus.

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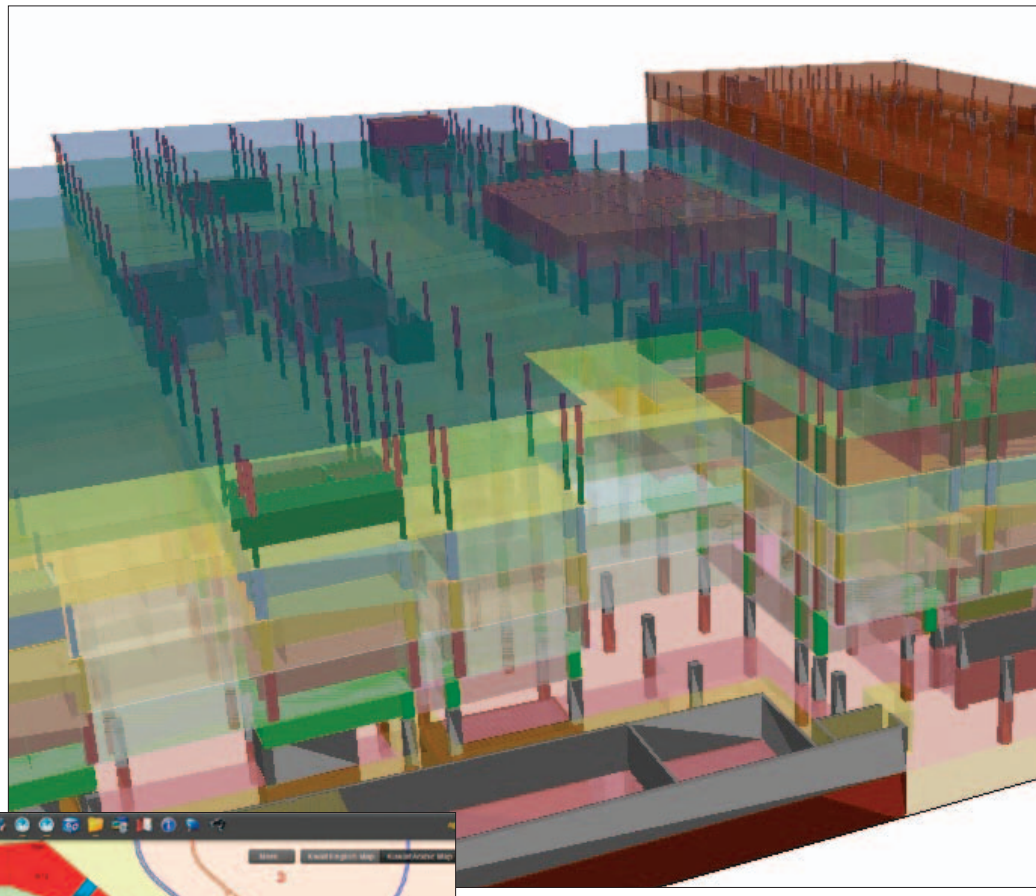
Building Smart from the Ground Up

It was a major effort to bring international experts to the table to design a unique, world-class data model for implementing this vision in GIS. However, the result is one of the most remarkable, all-encompassing data models ever implemented, one that will support the full life cycle of KU's vision and beyond.

The goals of the project included establishing a powerful GIS for the new university from a comprehensive geodatabase for the as-built data. Along with ArcGIS for Mobile and many web applications created with ArcGIS Viewer for Silverlight, ArcGIS for Server is used to manage the campus assets and provide a platform for future geospatial needs.

Using ArcGIS as the foundation technology, the project team has created a number of advanced applications.



The master program displays over the master plan map for status reporting.

Master Plan Support

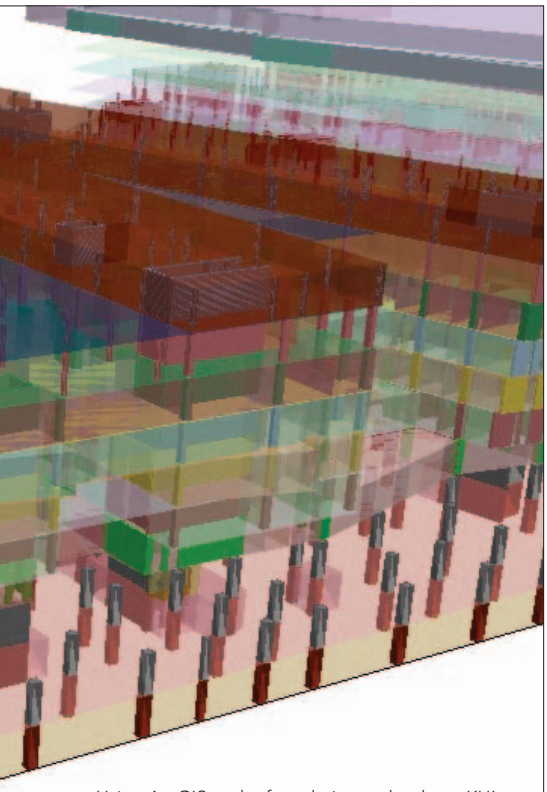
Coordinating a design and construction job of this size and duration requires a small army of dedicated experts and many years of planning and revisions. The project is engaging design firms from around the world to design specialized structures for the 100-plus proposed buildings on campus. The master planning process is one of the first stages in which GIS plays an integral role in bringing together and unifying the designs from individual bid packs into a single, seamless view. By doing so, planners and decision makers can better determine design impacts and understand considerations that would never have been realized without a holistic understanding of the sum of the design parts. Esri technology allows the team to do this in 2D and 3D, both of which are important at different points in the master planning process.

Construction Management and Planning Support

At the peak of construction, there will be more than 10,000 construction personnel on-site daily and untold vehicle trips requiring access to building sites for deliveries. The construction management team is a seasoned group of professionals who have traditionally worked through planning and daily operations using paper drawings and markup pens. Through the use of GIS, they can now retrieve, update, and analyze construction logistics and scheduling data, temporary staging locations and assignments, and daily operations across the entire campus through a simple web viewer. Daily stand-up meetings now utilize this information through the construction management viewer and allow quick markup that is printed and taken to the field. This quick temporal snapshot helps the team meet the demands of the day as well as the long-term planning activities to make construction logistics run smoothly.

Status Monitoring and Reporting

As the project progresses, reporting and schedule monitoring are a critical aspect of project controls. Because so many tasks are dependent on critical milestones, there needs to be a razor-sharp view of progress of all the ongoing activities. The GIS Reporting web applications take data from tabular project reports and displays it on the map, showing where activities are falling behind and which adjacent elements might be impacted. Through quick



Using ArcGIS as the foundation technology, KU's project team has created a number of advanced applications, such as the 3D GIS view.

visual reporting, a full project snapshot can be easily understood by anyone on the project team. For this reason, maps now accompany all progress reporting.

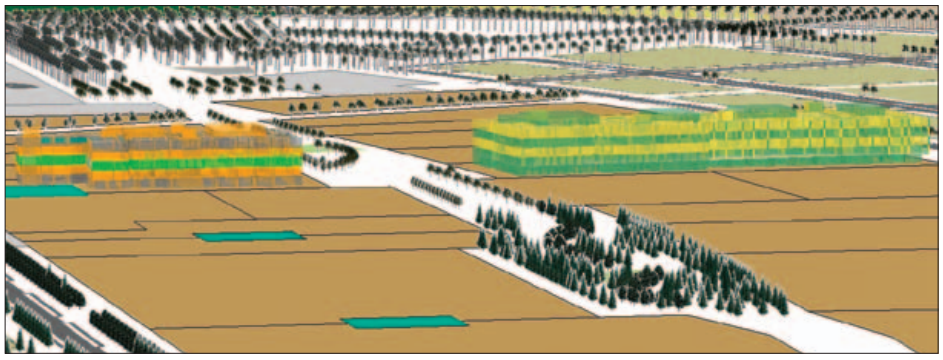
Another way of visualizing progress and key performance indicators is in a 3D GIS view of the campus. Using ArcGlobe services and ArcGIS Explorer, executive leadership can view an up-to-date snapshot of building construction progress in 3D as well as select scene items to pull up documentation or links to other systems.

Space Programming

While the campus buildings are not going to be finished and occupied for years, there is a requirement to begin the massive process of arrangement for the academic occupancy. Because of KU's GIS vision, the university is receiving the design floor plans in geodatabase format. This means that prior to completion of construction, university staff will be able to do scenario planning with that data, assigning personnel and assets to define an optimal spatial arrangement. It also supports validation of space requirements by size and type as well as proximity to building services or required facilities. They can do this for not only a single floor but throughout the entire building as well as other buildings.

The benefits of using GIS technology to support this process are numerous. The use of GIS strengthens and streamlines the design and construction phases of campus development, GIS use also supports operations management while establishing a GIS infrastructure that can be expanded to other advanced application areas. This project encourages the development of a campus GIS unit that works in conjunction with the current team to build a core technical capability that can eventually take over the operational system and expand to future applications. Additionally, the same technology and much of the data may be useful for helping support academic programs, including a laboratory that students can use to develop new application ideas.

For more information on how GIS assists organizations around the world in their facilities management needs, visit esri.com/fm.



The construction process and how it impacts open space was easily modeled in ArcGIS.

Industry Perspective

Cornerstone

By Shelli Stockton, Facilities Management Industry Solutions Manager, Esri

As a facility manager, you know a lot about your assets and buildings—but do you know what you don't know? The answer may be no if you are looking at your facility as a collection of disparate parts instead of as an integrated, functional system of interdependent pieces.

Most CAFM and IWMS systems provide large amounts of detailed data on a myriad of items, from the smallest screw to the largest HVAC system. Even so, many provide no ability for the user to see where maintenance items are located so work orders can be consolidated and handled more efficiently. They also can't analyze information contained in the system. For example, users can't easily view facility information to find out that crime incidents have spiked in a particular area where outdoor lighting fixtures are not working or have become blocked by overgrown bushes.

What's the solution? Integrating enterprise GIS with your CAFM and IWMS can provide insight into your entire system. Instead of seeing one asset at a time, GIS provides a view of all assets in real space. This gives users the ability to understand relationships between each part and analyze information to see trends and patterns. Using a map as an intuitive, graphic front end, any employee—all the way to the executive level—can use GIS to make decisions. So find out all you can about your facilities and assets; use GIS to give you the insight necessary to manage your resources in the most efficient manner.

Integration Project Saves a Million

Utility Makes Business Information Accessible through Single Seamless Path

By Toni Jackson, GISP, San Antonio Water System

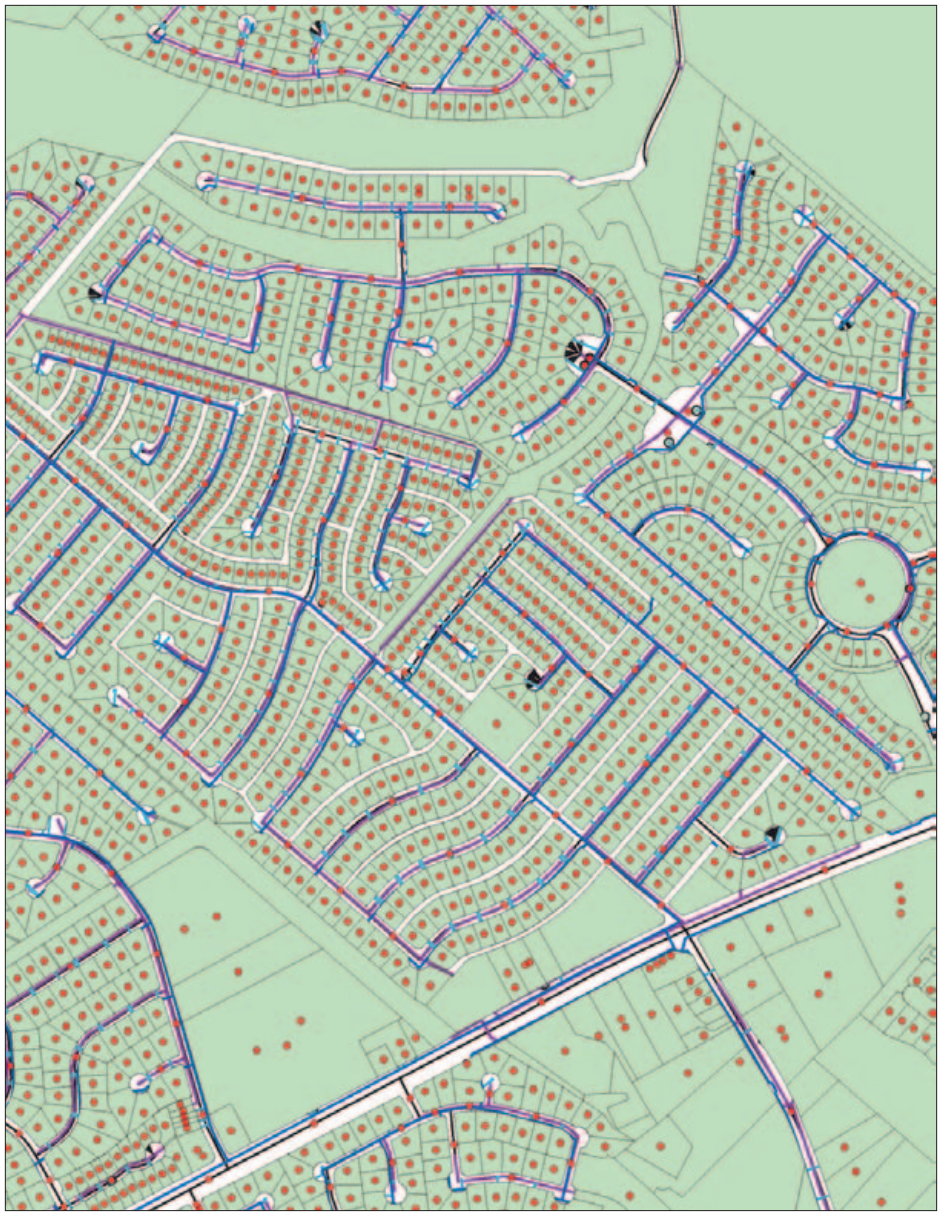
No matter how talented the landscaper, without consistent care and rich soil, a garden will not flourish. The same is true for corporate data repositories, which must be planned, built, and maintained with care. Isolated databases typically don't provide data-rich business intelligence. It's an analogy that utility company San Antonio Water System (SAWS) of San Antonio, Texas, understands well.

SAWS provides water to the seventh-largest city in the United States and was adept at cultivating and maintaining a significant network infrastructure that ensured clean water and efficient sewer services for its customers. It also accumulated many data layers specific to SAWS network assets and service locations that supplied business intelligence.

However, SAWS had not developed harmonious, integrated information systems. More important, geography had been overlooked. With no seamless connection among mission-critical data plots and no unified spatial asset references, SAWS was nurturing "a subpar bed of overgrown weeds," making it difficult to maintain its high level of service and plan for business growth, according to SAWS GIS manager Cindy Tuttle.

"Our information management systems involved a real patchwork of paper maps, electronic tables, CAD files, mainframe tables, and various other disparate databases," said Tuttle. "All of those isolated pockets of information created a perfect breeding ground for data duplication and inaccuracies and made sharing geographic data and updating it really difficult. Moreover, without an accurate spatial view of our assets and customers, it made it hard to analyze our business, adequately respond to clients, and proactively plan for business development."

Recognizing the need for a better solution to manage and share important business data, SAWS launched an initiative to create an enterprise-wide GIS and an asset management system. This combination would provide an integrated and automated environment to easily update and maintain accurate map, network, operations, and account data throughout the entire organization. However, Tuttle realized that to be successful, this ambitious project would need to begin by cleaning SAWS data.



Above is one of the maps created after the team reviewed hundreds of MicroStation maps, attribute layers, and account tables to tie asset locations, attributions, and customer service points to 500,000 addresses.

SAWS GIS professionals began meticulously digging through disparate databases, weeding out data inaccuracies and duplications, seeding data gaps, pruning existing data layers, and integrating and harmonizing dataflows in an effort to clean, purge, and integrate critical business data.

The GIS team converted hundreds of MicroStation-based water/sewer map layers

into GIS-based, spatially accurate map files that support the asset management system.

Two years later, Tuttle and her small staff have triumphed over significant data conversion challenges, enabling them to fulfill SAWS's vision of producing business information that is accessible through one seamless path. The web-enabled GIS not only provides a seamless view of the SAWS service area—its networks, assets, service points, and taps—but also provides the core datasets for the asset management system. It allows personnel to better assemble and schedule work assignments, monitor the pipeline network, perform quality and as-built inspections, correct discrepancies in the customer billing system, and analyze its customer base to identify new business opportunities—and business is blooming because of it.

Serving One Million Customers

Though the history of providing water and wastewater services in the San Antonio region dates back to the late 1800s, SAWS was established as a single water utility in 1992. Created through a consolidation of three previously separate utility providers, SAWS today provides water and wastewater services to about one million customers and maintains more than 9,000 miles of water and sewer mains that are buried below its 560-square-mile service area.

True to its conservation mantra, SAWS built and manages the nation's largest recycled water delivery system. The system distributes approximately 29 million gallons of recycled water per day that flows through more than 100 miles of pipeline to golf courses, parks, and commercial and industrial customers throughout the city. In September 2010, SAWS achieved the bio-waste-recycling trifecta at its Dos Rios Water Recycling Center. The first plant of its kind in the country, the facility recycles wastewater and waste solids and converts the methane off-gas into natural gas to sell on the open market.

As operations have expanded and diversified, SAWS has continually accumulated corporate information that records and monitors the company's daily operations. However, efforts to create, maintain, and connect that data have not been as aggressively pursued as SAWS service expansions. Without a direct and stable hub to internally connect the company's external service points, SAWS was inadvertently washing business opportunities down the drain.

> "We estimate the money saved in our first year alone is nearly one million dollars. Moreover, the software has freed our team to initiate projects we otherwise would have never had the time or resources to do."
>
> Cindy Tuttle, SAWS GIS Manager

"Carrying out routine, simple business tasks would often send staff on laborious, long hunts—either physically or electronically—to find all the information they needed," said Tuttle. "Then, when they did find data, it often wasn't complete or accurate, particularly asset attributes and location data such as addresses, which are critical to our service." Core datasets, such as assets and customer accounts, were held in different databases that lacked any geographic representation. "That was impacting our ability to comprehensively analyze our networks, service connections, and customers to identify savings or revenue opportunities," said Tuttle.

In 2005, SAWS launched an initiative to correct this data disconnect. A centralized Hansen asset management system and an enterprise-wide ArcGIS platform would provide personnel with a unified, detailed, and spatial view of the organization's most critical business information and automate routine tasks such as generating work orders. While the move would provide data intelligence to enhance SAWS business operations and services, building the system would only be possible by resolving significant data conversion challenges.

Integration Challenges

It didn't take long for the small GIS team to identify notable data interoperability challenges. Of particular concern were how best to validate, harmonize, and geographically visualize the account data held in mainframe tables, billing data maintained in separate mainframe tables, operations tabular data kept in another database, and hundreds of MicroStation-based water/sewer map layers stored in another database.

One of the maps (see page 6) was created after the team reviewed hundreds of MicroStation maps, attribute layers, and account tables to tie asset locations, attributions, and customer service points to 500,000 addresses.

"All our datasets had been created and maintained in isolation, with a single-minded purpose for each department," said Tuttle. "So significant challenges arose when we tried to integrate data from different formats, schemas, and databases to serve a unified information management system. These general incompatibility issues became magnified when we needed to map all that data to bring a precise visual element to every tabular list and numerical value."

However, even more problematic than rectifying missing attributes, inconsistent schemas, or incomplete datasets was the inaccuracy or complete absence of precise spatial representations of customers' addresses. "Addresses have been recorded and stored in myriad ways throughout SAWS, the majority of which have been in tabular form with no tied geography," said Larry Phillips, a planner with SAWS. "The problem with that is accurate location data is fundamental to GIS—it is the basis for which all other elements are referenced. So it was clear that the data conversion process had to start at the root of all other data layers and functionality—the address."

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Integration Project Saves a Million

An intense, daily effort began to untangle and weed hundreds of MicroStation map and attribute layers and account tables.

Every tabular address field had to be converted into a geographic location on a map. "Address points had to be on the correct parcel where they belong and service points had to match the actual service location of their meter or sewer connection," said Phillips. "We had to validate and correct every one of those points, and we were doing this manually, one by one, for half a million points."

After two years of this laborious process, it became clear that the GIS department needed to find a more expeditious but not overly costly way to resolve data interoperability issues to successfully launch the SAWS integrated information system.

Trolling the web, Phillips discovered Esri's ArcGIS Data Interoperability extension. This tool uses Safe Software's FME spatial extract, transform, and load (ETL) technology that enables users to convert, integrate, transform, and distribute data in more than 100 geospatial formats. It provides more than 200 transformers to help automate functions and perform quality control checks across different data sources. In short, it seemed to be the "do more with less" tool that was needed.

The GIS team converted hundreds of MicroStation-based water/sewer map layers, such as this one, into GIS-based, spatially accurate map files that support the asset management system.

From Days to Minutes

Thirty days after implementing the extension, Phillips had successfully transformed a two-day data manipulation task into a five-minute exercise. SAWS road network layers are routinely received from a third-party source, requiring a professional to spend two days manipulating and correcting the road features to properly integrate with the GIS. Using the extension, Phillips created an automated workflow that transforms, corrects, and integrates each new road file with one mouse click. The time savings just for the road tool paid for the first extension license.

For the GIS team, that automation was not just an aha moment. Merging road layers, the team suddenly saw the potential for it to become the tool of choice for cleaning up, integrating, manipulating, and distributing more than three million data features and supporting a host of automated workflows and business analysis tools.

Million-Dollar Savings

To ensure the central data layers were ready for operational applications, Phillips applied the extension to validate the initial data cleanup and rectify any discrepancies as well as create the framework to easily update and integrate new customer address accounts and service points. Because MicroStation-based sewer and water features were not directly connected to their attributes, it was difficult to readily identify relationships between sewer lateral lines and sewer connection points or their exact geographic locations.

Using the Data Interoperability extension, Phillips designed an automated point snapper workflow. The software automatically snaps a sewer service point to its correct lateral line, along with all the attribute information relative to each point and line. In three days, the tool corrected and moved 211,000 sewer lateral points, saving the two GIS professionals eight months' work.

Phillips customized a similar process for spatially correcting and linking sewer laterals to manholes—a task that he says would not have even been considered possible with other software tools. Previously, measurement references for distances from laterals to the downstream manhole were annotated on each MicroStation drawing in several numerical formats. Phillips accurately tied each lateral to its relevant manhole and transformed those annotations into precise and consistent spatial references attributed to each lateral/manhole asset. In two days,

the tool populated the GIS with nearly 171,000 sewer lateral measurements.

Now that the extension has readied the GIS, the team continues developing new ways of applying it. For example, Phillips created three customized quality assurance/quality control workflows to routinely analyze SAWS sewer, water, and address/service point data layers. Set to run weekly, the tool checks for data discrepancies and automatically alerts the GIS team of problem areas. Quality checks are not confined to the GIS; the tool also analyzes Hansen data to ensure that the information management systems are in sync.

With once insurmountable data conversion issues solved, the GIS is now ready to support several Hansen-based operational applications and functions including an automated work order module that enables personnel to seamlessly integrate service requests and generate corresponding work orders—functionality that allows them to execute 11,000 orders a month. By the end of 2010, the GIS also served the core data for more automated business tasks such as permitting and customer service.

Conclusion

The extension "has truly allowed us to be much more productive in much less time with far fewer people and with much higher-quality results," said Phillips. "We have significantly reduced labor efforts, from days into hours, for a host of routine data tasks." In addition to the consistent, integrated, accurate, and dynamic GIS, SAWS now has a seamless environment for viewing and analyzing its business.

"We accomplished a massive data conversion project and developed an enterprise-wide GIS with an extremely small team and very little cost," added Tuttle. Without the cost-effective Data Interoperability tool, "we would have needed to double our team to accomplish what we did with a few people's effort. In fact, we estimate the money saved in our first year alone is nearly $1 million. Moreover, the software has freed our team to initiate projects we otherwise would have never had the time or resources to do."

With more time to dedicate to bettering the GIS datasets and functionality, SAWS's data management will continue to grow organically to support increasing demands and changes in business directions. That is an information landscape worth nurturing.

For more information, on how to manage facility and asset infrastructure, visit esri.com/fm.

Philadelphia Saves Money Each Year

GIS-Based Traffic Light Project

The City of Philadelphia, Pennsylvania, is using ArcGIS software to implement its LED Traffic Lights Project, an ambitious traffic light replacement program funded in part by an American Recovery and Reinvestment Act of 2009 grant. With ArcGIS, the city's Department of Streets will track and manage the project, which will replace 87,000 incandescent light bulbs with energy-saving light-emitting diode (LED) bulbs. Estimated operational savings, resulting from significantly lower use of electricity, the greater longevity of LED bulbs, and the fixed department costs to replace bulbs, are expected to top $1 million per year.

In addition to saving money and field personnel time, Philadelphia's enterprise implementation of the system provides data access to other departments within the city, resulting in a significant return on investment.

Andy Mehos, GIS manager for the Department of Streets, says, "The opportunity to capture the asset data for the light replacement project, use it for other applications within the Department of Streets, and share it with other departments saves the city a considerable amount of time and money. It is significant enough to offset any cost of software development and the purchase of equipment. After observing our success in implementing this project, other city departments are considering similar GIS projects of their own."

The largest city in Pennsylvania and home to the Liberty Bell, Philadelphia is a longtime user of ArcGIS software.

The department employed Esri partner geographIT to develop a customized GIS application integrated with ArcGIS that supplies a spatially enabled mobile solution for tracking street-related city assets. The application's bar code scanning capability provides a quick way to add an LED bulb record to the geodatabase while in the field. In addition to LED bulbs, the department is capturing asset data about traffic heads, traffic control boxes, and light and sign pole attachments with the application.

A video about Philadelphia's light replacement program, *The Recovery Act Is "Lighting Up" the Streets of Philadelphia*, can be seen at esriurl.com/1726.

For more information about Esri's public works solutions, visit esri.com/publicworks.

The Value of a GIS for the Facility Management Life Cycle

This article starts a series that will discuss the value that a geographic information system can offer to each stage of the facility management life cycle.

With more than 100 million buildings and 60 billion square feet of interior space in the United States alone, facilities represent one of the greatest capital and physical resource investments on the planet. In urban areas, it is not uncommon for there to be as much as six times more floor space than land area. Therefore, in spite of the incredibly rich fabric of geospatial data that we have collectively developed over the years, we find that less than 20 percent of our cities are mapped, since current maps do not include building interiors. Having little to no accurate information about the interior of buildings is a constant challenge to facility managers.

These challenges can be particularly daunting for those managing facilities within a campus setting. Often responsible for several enterprise-wide operations, these managers are under pressure to keep costs low, efficiencies high, and facilities safe inside and out, presenting many competing priorities. By using location information coupled with details about the data points at that location, facility managers have access to powerful tools to make their jobs easier and more successful.

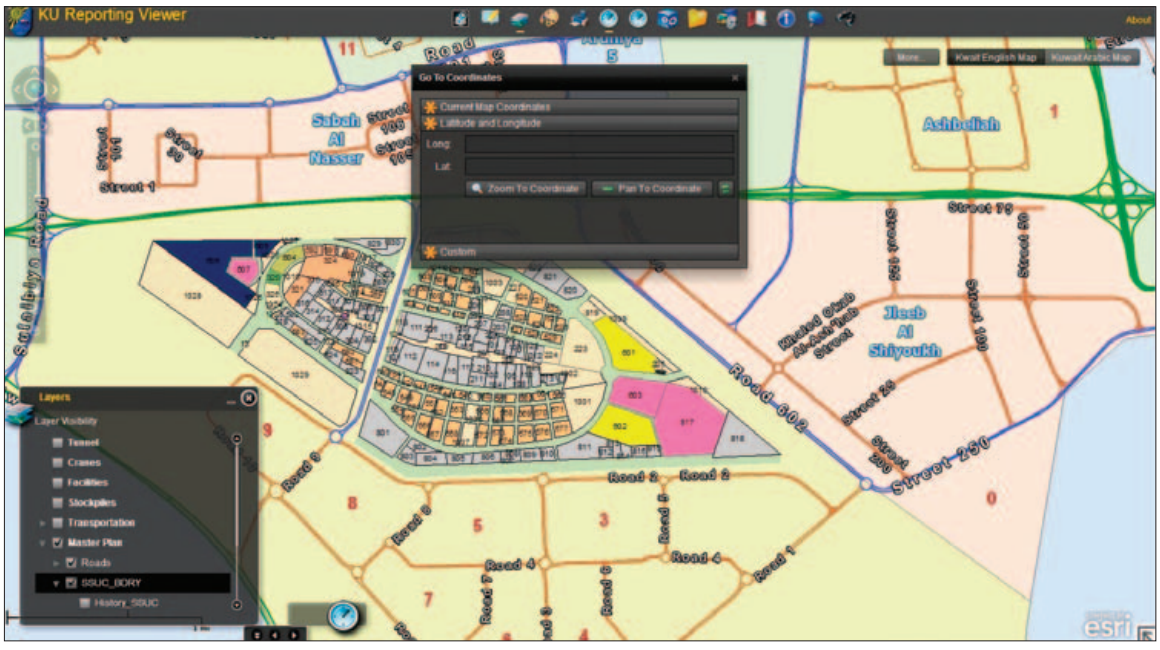
The Benefits of a GIS for Facility Management

A GIS allows facility managers to use location and detailed information to view, understand, question, interpret, and visualize a variety of data to reveal relationships and trends in the form of maps, charts, and reports, providing them with many practical uses. GIS acts as a complementary technology that, when integrated with existing enterprise technologies and applications, provides facility and executive managers with the power to make better-informed decisions.

While there has been GIS data at the landscape level for years, it has only focused on a few of the assets in a facility portfolio. Some facility management issues, such as the management of pavement, municipal water, and wastewater infrastructure and electric utility distribution, have been addressed with the use of aerial imagery or GPS technology. However, significant "holes" have developed in the fabric of this geographic landscape, representing the lack of information for building interiors. Given that building interiors contain the world's most concentrated financial investments and are where most people spend 80 percent of their time, having accurate, detailed information about interiors can be the difference between success and failure.

Fortunately, new technologies have emerged to provide existing information about the inside of buildings—fast, accurate data collection technology; CAD floor plans; building information models—and integrate them with surrounding, landscape-level data. This integration allows geospatial analysis and visualization in relation to business processes inside the building. Furthermore, the use of GIS helps us understand the spatial aspects of every component of facility management workflows to decrease cost, increase productivity, and save lives. The power of GIS is evident in the way that it supports the integration of information from spatial, temporal, and informational dimensions for intelligent decision making. Management professionals are quickly realizing the value that geospatial support represents in the enterprise-wide decision-making process.

"Facilities managers are finding that GIS tools, which have been used successfully for many years . . . support a broad range of applica-



Facility Information Infrastructure Projects at the University of Kuwait

tions inside and outside buildings, such as operations planning, emergency management, ADA [Americans with Disabilities Act] compliance, safety and security planning, and space utilization and optimization," says Jack Dangermond, president of Esri.

Just as there are framework layers—roads, parcels—for the landscape, they also exist within the building in the form of floor levels, walls, doors and other architectural structures. Once these layers have been established, several other layers can be derived from them, such as space use, lease areas, security zones, asset locations, and evacuation routes. With this information, geospatial support can inform a variety of enterprise systems and business processes for effective facility management.

There are countless data sources already available that are focused on the built environment. Many, if not most, of these datasets can be much more valuable if they are put on a map. Once this is done, we have the ability to provide tremendous value to a wide variety of business processes for all the stages of the facility life cycle, including site analytics, design and construction, space and occupancy, operations and maintenance, public safety, and sustainability.

Some benefits of mapping facility datasets include

- Grouping multibuilding and multisite work orders by location to reduce transportation and logistics cost
- Visualizing energy consumption data at the room, building, or enterprise level
- Analyzing space use, availability, and optimization across a campus or region
- Conducting building condition assessments for inspections and asset inventory using handheld, location-aware devices
- Visualizing proposed space or emergency planning scenarios

Facility Information Infrastructure

Facility managers are using this interior space mapping concept to make the most of GIS inside buildings. The framework of this enterprise concept is called facility information infrastructure (FII), a central repository of all the spatial data, inside and out, that exists about a building, campus, or portfolio. An FII offers a holistic view of a building or campus's spatial data, from lease management to energy consumption, helping decision makers answer complex questions, like, What is the most effective use of the available space in our facilities? How do we get employees or residents out of the building safely in the event of an emergency? and, What is the most efficient workflow of my production facility?

> "Facilities managers are finding that GIS tools, which have been used successfully for many years . . . support a broad range of applications inside and outside buildings."
>
> Jack Dangermond, President, Esri

An FII uses the basic concepts of visualizing and analyzing mapped locations in the landscape and applies those concepts to the insides of buildings. Since issues that involve the landscape outside the building—public safety, security, and environmental issues—also pertain to the inside, an FII repository is an invaluable resource to many different interests.

As an enterprise investment, an FII supports many different business processes. In an FII, data developed and maintained for one purpose can be reused for another. For example, public safety professionals do not need to invest in the development or maintenance of basic floor plans, but they use floor plans developed for other purposes and add the elements that are important to them as an additional layer. Therefore, many different business processes can be supported by a combined FII, supporting the entire facility life cycle.

An FII will speak to those asking "where" questions about their facility assets while it interoperates with and extends other enterprise systems, from real property and work order management to visualization of environmental sampling. Consequently, an FII helps decision makers in every department, agency, or business unit understand the facility inside and out, giving them the power to leverage existing investments and share information from other departments or agencies for their own purposes—or to make strategic, high-level decisions for the good of the whole.

"Several of today's facility management challenges have a geographic context—work order management, public safety, retail site selection, security, and portfolio and risk management. Answering these challenges using geographic information gives a new perspective to familiar problems and, therefore, allows facility and campus planners and managers to make better-informed decisions," says Stu Rich, CTO of PenBay Solutions LLC.

A current example of FII in use is a project at Kuwait University, where GIS technology is being used to support the planning, design, development, and operations of the new University City. Goals for incorporating an FII into university plans include establishing a powerful GIS system for University City, creating a comprehensive geodatabase for the as-built data, managing the campus assets effectively, creating advanced applications based on a comprehensive geodatabase, and establishing the GIS infrastructure for future geospatial needs (see story on page 2).

For this five-year, multibillion-dollar project using Esri's GIS software and PenBay Solutions' expertise in GIS for the interior, Kuwait University has recognized that GIS is an important asset to every stage of the facility life cycle.

For more information, contact Esri business partner PenBay Solutions LLC at www.penbaysolutions.com, or call 207-230-0182.

The Business Benefits of GIS: An ROI Approach

The Business Benefits of GIS: An ROI Approach is a methodology that helps GIS practitioners complete a return on investment (ROI) process that clearly demonstrates how, when, and where the implementation of a GIS could create business value for their organization.

The original methodology was developed by PA Consulting Group, Inc., a global management consulting firm. Under license from PA, the methodology was customized for GIS practitioners' use by the authors of a book by the same name. A wide variety of GIS practitioners, including managers, business architects, and consultants, can use the material in the book in conjunction with the supporting website (gis.esri.com/roi). The website provides access to all the tools and templates necessary to implement the steps in the methodology.

The methodology's 10 steps lead people through the whole process, from the initial idea to a complete, compelling report that can be presented to a review committee or funding body. Although this is an end-to-end process, it is anticipated that some organizations will use only portions of the methodology. For example, some may use the approach to create a robust budget or model the benefits they expect to be delivered by their ongoing work.

Victoria Kouyoumjian, Esri technical strategist and coauthor of the book mentioned above, explains, "The approach focuses on six key topics that we believe are critical to creating a defensible position on the value of GIS for any organization: demonstrate the real business value, determine the specific costs, estimate the time frame for delivery of benefits, understand the resource requirements, define the governance and management, and calculate the return on investment."

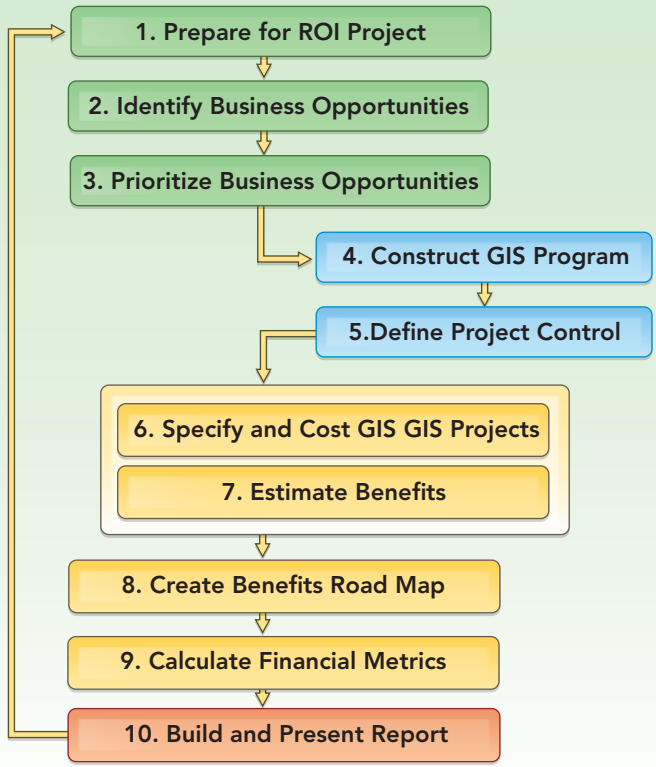
One of the most difficult challenges typically faced by GIS professionals is gaining stakeholder commitment and buy-in throughout the whole organization. Because GIS has traditionally been seen as a departmental tool rather than an enterprise solution such as SAP, there are often difficulties in getting the necessary broad-based support.

Regarding the methodology, one of the most challenging steps for most GIS professionals is estimating the benefits of GIS projects. There are many benefits to using GIS in virtually all types of organizations. Some benefits are tangible and can be assigned a monetary value, while others are soft or intangible and are difficult to measure. Estimating the benefits of a GIS program is more difficult than specifying the costs—not so much in identifying the benefits but in translating the benefits into specific, measurable terms that can be ascribed a monetary value.

To access the methodology and learn more, visit esri.com/roi.

The return on investment (ROI) methodology provides an achievable, fact-based, and benefits-focused approach to arrive at a quantifiable ROI. The process will enable you to gain backing and consensus among organization stakeholders while educating and preparing them for change.

A holistic approach is adopted to determine how GIS technology can be applied to solve problems or create new opportunities and services in an organization. This allows upper management to make the best business decision for one or more departments and the organization as a whole.



Esri's book and program on how to measure gains on GIS implementation are available on the Esri website and can be implemented by any organization.

Augmented Reality and GIS

Making GIS Content Available in Interesting and Useful Ways

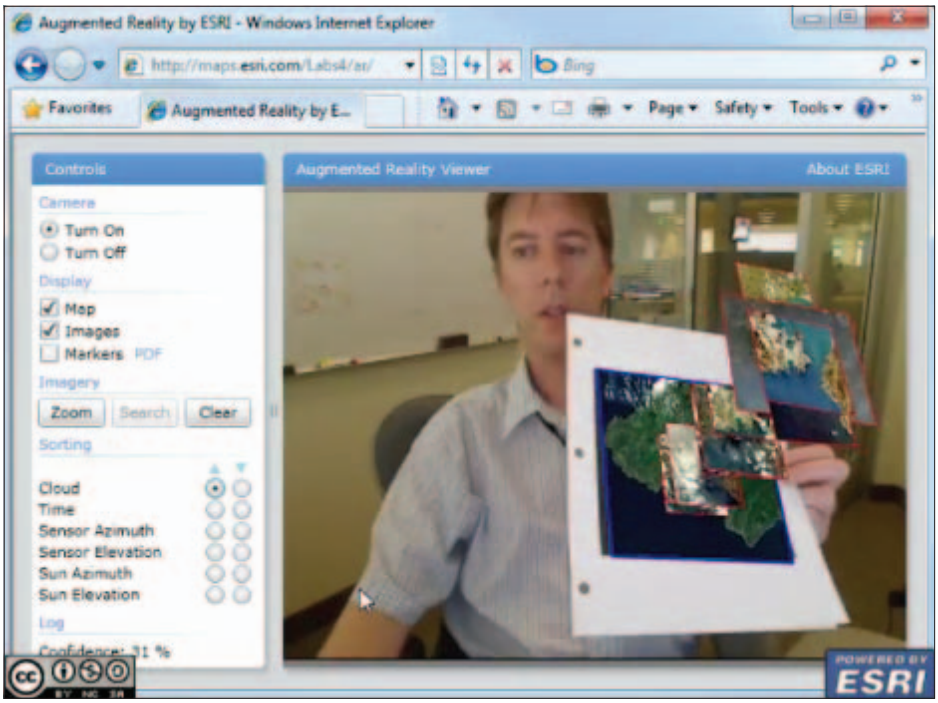
By Keith Mann, Esri Writer

If you own a smartphone, such as an iPhone or Android, you probably have an app that uses augmented reality (AR). This technology superimposes digital information on whatever you're looking at through your phone's camera.

AR apps usually combine an assortment of miniaturized technology devices—optical sensors, accelerometers, GPS, gyroscopes, solid state compasses—along with context-sensitive information that is delivered as a web service. The service content may be displayed as location-based labels (or billboards) that hover over or in front of objects you see through the camera display. The labels usually present additional information, including photos, and often provide reviews and contact information for things like restaurants, Wi-Fi hot spots, or houses for sale. You might use AR apps to discover and learn more about objects around you.

Richie Carmichael, of the Esri Applications Prototype Lab, built this AR/GIS app using ArcGIS API for Silverlight and the open source Silverlight Augmented Reality Toolkit. It orders and offsets overlapping imagery. Imagery is tagged with sensor information such as capture date, percentage cloud cover, and satellite position.

Some AR apps allow you to use your phone camera to perform sophisticated measurements of distances and angles or even track cosmological events such as the azimuth of the sun. Still other AR apps recognize patterns in photos, diagrams, and bar codes that then link you to additional content or services, such as product reviews, price comparisons, or videos.



Richie Carmichael, of the Esri Prototype Lab, shows the AR/GIS app using ArcGIS API for Silverlight and the open source Silverlight Augmented Reality Toolkit.

Familiar Applications of AR

While the concepts of AR have been around for decades, the technology has been applied to so many different types of media that it is difficult to point to any single application as the embodiment of augmented reality. For example, American football fans are used to seeing the virtual first down line that appears on the field during televised games—they expect to see it. Movie directors have portrayed augmented reality in movies, such as *Minority Report* (2002) and *Avatar* (2009), to show how immersive technology might be used. Some of the most visually exciting examples of AR entertainment are augmented projections or projection mapping in which computer imagery is projected onto physical objects, such as a building facade, to create an augmented but realistic-looking new object that morphs continuously before the viewer's eyes.

The military uses a type of AR in the head-up display (HUD) that appears on the cockpit window (or view port) of a jet fighter. These displays make it easier for pilots to access critical information, such as airspeed or angle of attack, without having to break their focus from the scene in front of them. Similarly, automobile manufacturers are also experimenting with HUD windshield displays to improve driver safety.

Seeing GIS Data Using AR

Carmichael has been experimenting with using AR to visualize GIS content. He thinks of AR as simply adding to reality in a way that enhances or improves upon what you see displayed in a web or desktop application.

"GIS data is already a source of spatially enabled information that can be fed directly to your mobile device," explained Carmichael. "Your phone knows where it is, the direction the camera is facing, and the inclination of the device in your hand. This information, combined with GIS data, not only adds to the end user's experience but also makes GIS accessible in a new and interesting way."

As AR becomes more prevalent in phone,

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Augmented Reality and GIS

tablet, and computer applications, more developers will begin integrating GIS services and content to serve real and practical purposes. Mansour Raad, a senior software architect at Esri, envisions AR apps that will channel GIS content to professional end users using mobile devices to help them make decisions on-site using the most up-to-date and reliable information available.

"Imagine that you could point the camera on your phone at the ground and see the location and orientation of water pipes and electric cables buried under the ground because your AR app is cross-referencing the GIS system with your location and giving you a kind of x-ray vision so that you can visualize the infrastructure underneath you," explained Raad.

"Not only would you be able to see hidden objects," Raad continued, "you'd have access to their attributes; you'd be able to pull up engineering diagrams and even tap into real-time sensor networks to view water pressure or amperage." Raad suggests using your phone's camera to take a photo of the augmented display and e-mailing it to your project team or syncing it with the GIS-enabled work order system so that it can be accessed by the project manager and the work crew. "What makes the combination of AR and GIS really exciting is not just the visualization of GIS content, which is very cool, but the integration of that content with the rest of the enterprise. That's what GIS is all about."

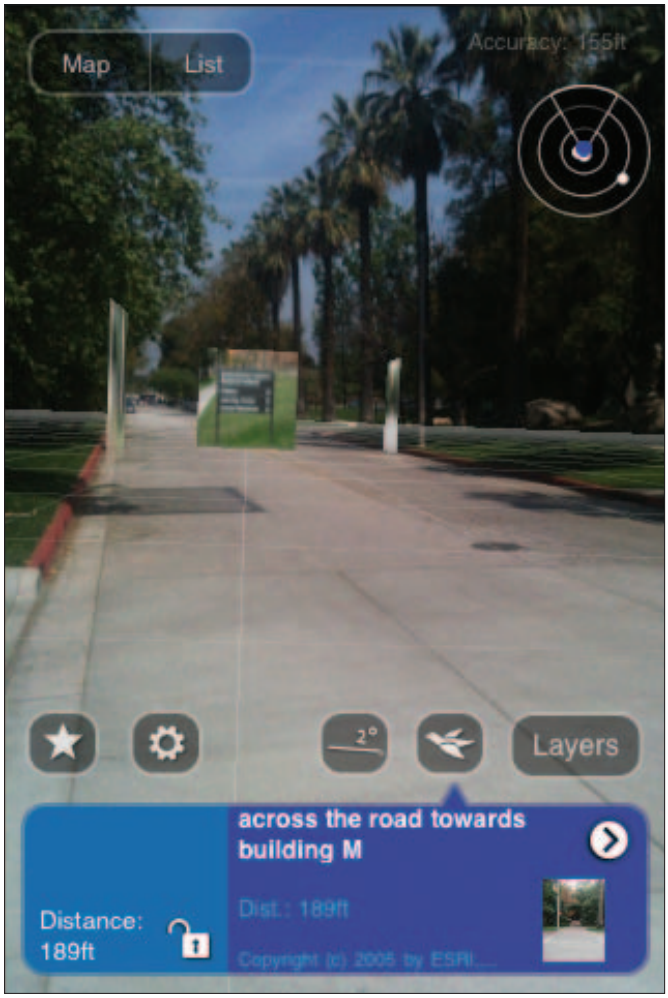
> AR and GIS would seem to be a perfect match, not only for consumers but for professionals who rely on geographic information to make real-time decisions.

Getting Started with AR Development

AR app development is surprisingly straightforward. AR service providers, such as junaio and Layar, provide both an AR browser and the development resources needed to simplify deployment for iPhone and Android.

Thomas Emge and Sathya Prasad, also of the Esri Applications Prototype Lab, created the AR app with ArcPhoto tools and Layar's iPhone app. It georeferences images from a geodatabase and displays them as billboarded entities.

To use the junaio app, start by registering a channel with junaio. The channel provides a callback to your server, where the processing will take place. For example, if you use the app to find geographic information near your current position, junaio brokers the calls to your server, which processes the request, then passes that information back to your device. For a GIS developer, this means accessing the REST endpoints of ArcGIS for Server services as the link to dynamic GIS content and tools or preprocessed geographic information such as 3D terrains, videos, or map layer stacks.



Thomas Emge and Sathya Prasad, of the Esri Applications Prototype Lab, created the AR app with ArcPhoto tools and Layar's iPhone app. It georeferences images from a geodatabase and displays them as billboarded entities.

"Augmented reality can be difficult to explain to people," said Emge. "It's often easier to show someone an AR application first, let them experience it, and then start the conversation about what you want to do with it. At first, there's the cool factor that's fun to do and easily impresses most people. Next, you have to start thinking about design and usability."

Emge suggests that developers begin by considering the end user's experience. "There are different ways to apply AR to your app," said Emge. "In one case, you are overlaying additional information in your camera's viewfinder. Here the device's location and orientation play an important role. In a different case, the information seen by the camera is sent to a server and processed, then sent back to you. Here, pattern recognition technology is being employed, and the response can be as simple as playing a video or as complex as showing the results of spatial analysis."

Raad sees great potential for using the pattern recognition capability of AR. "The image can be anything—a photo, a map, a bar code, or even the stars in the sky. Using the camera, the AR app recognizes the pattern and does something that augments or mixes additional content with what you're seeing."

For example, Raad has created a sample app that uses pattern recognition to let users point an iPhone camera at a photo of a map, which triggers the loading of a video that shows a ro-

tating globe displaying the same information. Raad used ArcGIS to compose the 2D map data and drape it on a globe. Then he animated the globe and created the video, which is hosted on a server. Next, he registered a channel with junaio that links his video with the junaio AR application. Anyone with an iPhone can download the junaio app, search for the channel, point the iPhone camera at a photo of the map, and view the rotating globe.

Carmichael also used pattern recognition. He linked a photo on a piece of paper to a related image of a map layer stack in his desktop application. However, in this case, the layer stack appears to dynamically hover above the photo—even if the photo is moved around.

Any developers using an AR toolkit and one of the ArcGIS APIs for Silverlight, Flex, or JavaScript can start building their own AR-GIS apps. The original ARToolkit was developed by Hirokazu Kato of Nara Institute of Science and Technology in 1999 and was released by the University of Washington Human Interface Technology Lab (HITLab). Since 1999, numerous ARToolkit spinoffs have been created. In 2010, René Schulte ported the ARToolkit to Microsoft's Silverlight platform, which was released as the SLARToolkit.

Emge cautions developers to recognize the limitations of mobile devices. "You may find that the limited accuracy of the GPS won't allow you to place labels and billboards as precisely as you'd like or that AR calculated measurements are only approximations," he said. "This may frustrate end users with GIS and CAD experience because they expect a high degree of accuracy and precision." Both Emge and Carmichael recommend that AR apps be used to query trusted GIS services for precise measurements and reliable attribute information instead of relying on a phone's capabilities.

Regardless of the popularity of AR or the current limitations of some mobile devices, AR and GIS would seem to be a perfect match, not only for consumers but for professionals who rely on geographic information to make real-time decisions.

Learn More

Raad maintains a very active personal blog at thunderheadxpler.blogspot.com. Carmichael and Emge are regular contributors to the Applications Prototype Lab blog. Both blogs contain posts on AR topics.

Sources for AR Information

junaio: www.junaio.com
Layar: www.layar.com
HITLab: www.hitl.washington.edu/artoolkit
Wikipedia: en.wikipedia.org/wiki/Augmented_reality

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The Facilities Management Team
Shelli Stockton, Facilities Management Industry Solutions Manager
E-mail: sstockton@esri.com
Tel.: 909-793-2853, ext. 1-2210

Amy Thorson, Marketing Strategist
E-mail: athorson@esri.com
Tel.: 909-793-2853, ext. 1-2024

380 New York Street
Redlands, California 92373-8100 USA