ArcNews

Esri | Winter 2018 | Vol. 40, No. 1

Briefly Noted

United Nations Gets a Global Data Hub
Esri and the United Nations Statistics Division (UNSD) are working with a number of member states to employ a data hub, based on the ArcGIS platform, that will allow countries to measure, monitor, and report their progress in achieving the Sustainable Development Goals (SDGs)—all in a geographic context. To learn more about how Esri supports the SDGs, visit go.esri.com/Sustain_Dev.

Volunteers Receive Personal Use ArcGIS Licenses
To help GISCorps achieve its mission of providing mapping and disaster response services to communities and organizations in need, Esri will donate personal use ArcGIS licenses to each GISCorps volunteer who takes the GIS Service Pledge to volunteer for a good cause. Learn more at giscorps.org.

Business Users Get Greater Capabilities
A new Plus subscription in ArcGIS Maps for Power BI gives business users access to premium global demographics, expanded data mapping, and more content from Esri's Living Atlas of the World.

New Podcast Explores Intersection of GIS, Tech Trends
To aid industry and government leaders in understanding how GIS drives growth, Esri launched a weekly podcast that features executives, industry analysts, technologists, and Esri experts discussing how GIS converges with key technology trends. Listen to *Esri & The Science of Where* on iTunes, Google Play Music, Stitcher, TuneIn, Blubrry, and Overcast or at esri.com/podcast.

The Eye After the Hurricane

Geospatial Coalition Rapidly Supplies Storm Impact Imagery to Aid Rescue, Recovery

After three category four hurricanes struck the United States in less than a month in 2017—Hurricane Harvey in Texas, Hurricane Irma in Florida, and Hurricane Maria in Puerto Rico and the US Virgin Islands—rescue and recovery workers needed information about the location and extent of impact, fast.

First responders were looking for people injured, trapped, or otherwise in need. Humanitarian organizations needed to deliver food, water, supplies, and medical care to victims. Federal and state agencies were coordinating relief efforts while ensuring safety and figuring out how to restore services. And insurers needed to begin fulfilling claims so people could start rebuilding their homes.

With a limited number of boots on the ground in each affected location, everyone involved in the rescue and recovery work relied on eyes in the sky to report what was going on below. For this triple hurricane assault, these eyes came in the form of aerial sensors that produced accurate, detailed imagery so people and organizations could get a quick, up-to-date view of what was happening on land.

↑ Hurricane Irma's wind and rain barraged Las Olas Boulevard in Fort Lauderdale, Florida.

To obtain and deliver this imagery, a coalition of leading geospatial firms formed a partnership with the National Insurance Crime Bureau (NICB). Together, they acquired and published high-resolution imagery for nearly 24,000 square miles across Texas, Florida, Puerto Rico, and the US Virgin Islands.

Vexcel Imaging, an Esri partner that provides high-end mapping products and geospatial data services, managed the response, leading the efforts of some of the nation's largest and most advanced aerial mapping companies, including other Esri partners Quantum Spatial, The Sanborn Map Company, and GPI Geospatial, as well as Keystone Aerial Surveys. Each of these organizations provided aircraft equipped with UltraCam vertical and/or oblique aerial sensors to ensure the highest-quality and most accurate imagery possible. Esri served as a key member of the coalition, and those involved in response and recovery efforts used an array of ArcGIS software and apps to access, visualize, analyze, and record spatial data.

"The disastrous aftermath of the hurricanes called for the right coalition of organizations to rapidly collect critical information for assessing regional impact and to ultimately help provide relief to those in need," said Erik Jorgensen, Vexcel's president. "Vexcel Imaging is fortunate to have partners in leading aerial mapping companies to rapidly deploy assets to quickly capture aerial imagery of

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Learn to Design Beautiful Maps

Take Esri's Newest Massive Open Online Course: Cartography.

It used to be that only cartographers made maps. Today, however, anyone can. Still, cartographers can teach people to make better maps, just as professional chefs can show people how to cook better meals.

That's why a team of experienced cartographers, led by Esri's Ken Field, will teach Cartography., a free, six-week massive open online course (MOOC) that Esri will host beginning April 18. (Registration closes May 2.) With coaching from Field and other Esri cartographers, as well as practical, hands-on exercises using ArcGIS Pro, participants will learn cartographic techniques that make them more savvy mapmakers, ready to go beyond the typical workflows and defaults.

"Cartography as a discipline and a profession has much to offer," said Field, a senior cartographic product engineer. "Learning a little about how a cartographer thinks about mapmaking will help you make better maps."

Cartography. is Esri's fifth MOOC. The course coincides with the release of Field's new book, *Cartography.*, being published by Esri Press.

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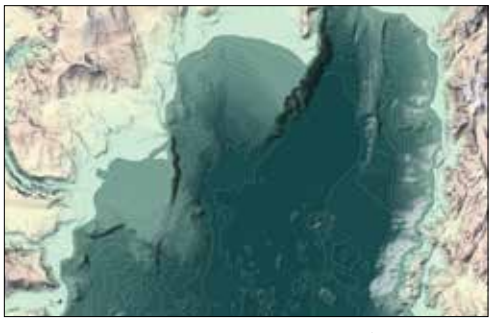

↑ Participants in Esri's new Cartography. MOOC will learn cartographic techniques that make them more savvy mapmakers.

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During a disaster, ArcGIS processes imagery fast, enabling response teams to share critical intelligence across agencies and among stakeholders so everyone can deal with the emergency as rapidly as possible.

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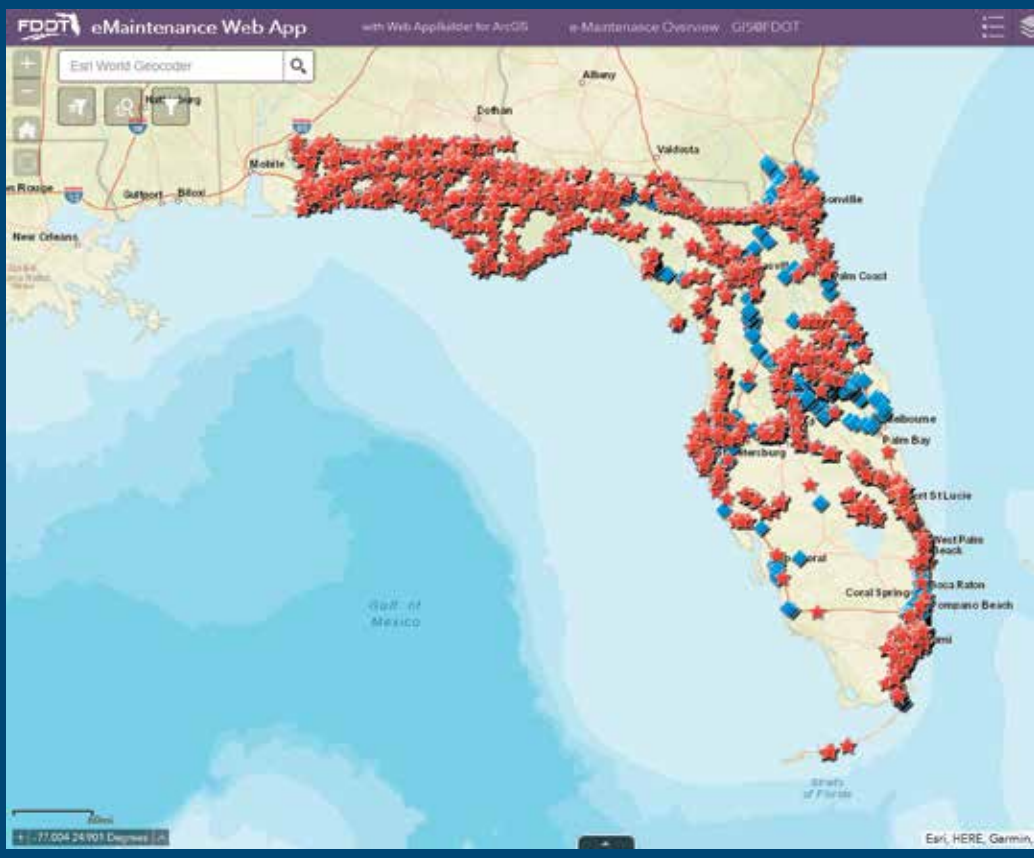
ArcNews (ISSN 1064-6108) is published quarterly by Esri at 380 New York Street, Redlands, CA 92373-8100 USA. *ArcNews* is written for the Esri user community as well as others interested in mapping and geographic information system (GIS) technology. It contains material of interest to planners, foresters, scientists, cartographers, geographers, engineers, business professionals, and others who use spatial information.

Big Data Is Coming, and FDOT Is Prepared

How the Florida Department of Transportation Has Put Technology Front and Center

By April Blackburn and Lydia M. Mansfield, Florida Department of Transportation



↑ With FDOT's public-facing eMaintenance Web App, anyone can see inspection results for crash cushions and guardrails across the state of Florida.

Traditional transportation networks and accessible technology have evolved to the point that they are now intertwined and inseparable. As technology continues to advance and transportation systems begin to bring in more big data, departments of transportation need to assess—and potentially change—the cultures they have developed around technology.

At the Florida Department of Transportation (FDOT), we have examined the way we collect, govern, and use data and technology in our day-to-day operations and business obligations. Now, instead of trying to build our way out of challenges—which can be slow, expensive, and fleeting when talking about physical infrastructure—technology is a core agency strategy. This means that technology—and GIS in particular—always has a seat at the table at FDOT and is never an afterthought.

Catching Up with Technology

FDOT is responsible for one of the largest and most extensive transportation systems in the country. Supporting more than 20 million residents and over 100 million visitors annually, Florida's transportation network includes 15 seaports and 2,890 miles of navigable waterways, 2,895 miles of rail line, 122,659 centerline miles of public roadways with 12,262 bridges, 779 airports, 2 spaceports with 10 launch facilities, and 31 urban transit systems.

With assistance from developing technologies, each aspect of Florida's transportation system produces data—and a lot of it. How to best use and manage this growing amount of data became an important point when discussing the intersection of transportation and technology. But FDOT had always assessed, planned, and financed transportation and internal technology initiatives separately. Because of this, transportation technology was not being funded appropriately, even though the nature of transportation development was inherently growing more technology oriented. This disconnect placed the agency responsible for shaping the transportation of the nation's fourth-largest economy at a serious disadvantage and risk of falling behind in terms of growth and innovation.

To meet the challenges that both big data and emerging technology were posing to Florida's transportation systems, FDOT established its aptly named ROADS initiative, which stands for Reliable, Organized, and Accurate Data Sharing, in early 2015. Its goal was to create and implement an integrated enterprise information management system.

The agencywide movement set out to ensure that FDOT's current and future data is accurate, secure, and reliable in the hopes that it can empower employees to perform their jobs at an even higher caliber. With improved internal communication, data collection, and storage, FDOT's employees and stakeholders can more efficiently and reliably access relevant business data and share it across the department.

Around the same time that we launched the ROADS initiative, the Federal Highway Administration (FHWA) had also begun issuing national guidelines and standards on data governance to all state transportation entities. The aim was for departments of transportation to organize and implement an institutionalized set of policies, procedures, structures, roles, and responsibilities when it came to managing data and information. From these guidelines, we began exploring the concept of civil integrated management (CIM) in relation to FDOT's own business practices. With CIM, the idea is to collect, organize, and manage data related to highways, bridges, and other transportation assets using a single, authoritative source that offers standardization and easy access to users.

Alongside FDOT's ROADS initiative and through the conceptual exploration of CIM, the agency also established the Office of Transportation Technology (OTT) in 2016. This formally solidified the relationship between key transportation technologies and the funding for transportation infrastructure.

OTT required a groundbreaking internal reorganization that resulted in the newly established office that houses FDOT's Information Technology division and the recently formed Office of Civil Integrated Management, named for and focused on the same data governance principles implemented by FHWA.

"CIM is about leveraging advanced analytic tools with our existing transportation assets to do a better job in forecasting trends, conditions, and remediation," said John Krause, the CIM officer and ROADS strategic liaison at FDOT. "It will provide us a safer, more cost-effective, and ultimately better transportation network for all Floridians, businesses, and visitors."

Our implementation of CIM included getting an independent assessment of FDOT's information technology capabilities, personnel, and infrastructure. The critical evaluation identified that we had a fundamental disconnect between transportation initiatives and technology plans. Like the allocated funding, the strategic plans for transportation business were developed and considered separately from the agency's technology business. Isolating the two hindered our potential and limited how well FDOT could prepare for the cultural changes that were already occurring and poised to do more.

Based on these results, FDOT elevated the data governance and planning discussions it was already having and began to modernize the way it does business.

Integrating Technology and Transportation

With the implementation of ROADS, CIM, and OTT, FDOT started integrating technology initiatives and transportation planning in a way that is organically tied to its daily business processes. Suddenly, technology was no longer a footnote. And with the aid of GIS, we have built a new culture at FDOT for how we integrate technology with transportation assessment and planning.

The department's Office of Maintenance provides a prime example of how this transformation has gone. Until recently, FDOT employees used clipboards, paper, and pens to record the condition of various transportation facilities out in the field. The physical reports then had to go through a lengthy data entry process before being collated into reports required by FHWA. But with mobile GIS technology, such as Collector for ArcGIS, employees in the field can now record all necessary information digitally, on the spot, and share the data with others throughout the organization.

Having cut down on turnaround time and made this data easier to retrieve, the director of the Maintenance Office is now able to compile FHWA-required annual reports in a matter of minutes. Previously, this would have taken weeks.

Maintaining This Vision for Data Governance

The changes we have made to data management and governance at FDOT—which we maximize by using GIS—save time and money. On top of that, they are also making it possible for us to sustain this increased efficiency and greater transparency.

For example, we implemented ArcGIS Server to support the agency's electronic document management system, and now employees can easily combine business plans and related documents (design plans, contract information, project financials, and more) to create visual presentations. Decision-makers throughout the department use these resources to guide teams and assist with planning. And the success of our technological initiatives has driven demand for accessible and transparent data solutions at all levels of the department. As more people have started using GIS over the last few years, the number of ArcGIS Online users at FDOT has quadrupled.

None of this would be a reality, however, if we hadn't implemented a new vision for data governance. Now, the CIM concepts adopted by the agency, together with the increased integration of GIS, have revolutionized the way FDOT does business. Because we have enhanced the relationship between technology and transportation from an institutional perspective, we now have room to innovate and are prepared to handle the big data that is starting—and will only continue—to come down the pipeline.

Any state agency can do this. It just might require changing the prevailing business culture so that it's centered on technology rather than being inattentive to it.

About the Authors

April Blackburn, PMP, is the chief of transportation technology at FDOT, where she is responsible for aligning information technology with operational technology. Lydia Mansfield is a GIS mapping analyst at FDOT. For more information about how the agency has prepared to take on big data, email Blackburn at april.blackburn@fdot.state.fl.us or visit fdot.gov.

Navigating Wyoming's Snowy, Blowy Roads

The Wyoming Department of Transportation's Interactive, Mobile-Friendly Map Helps Truckers, Tourists, and Locals Plan Safe Trips

Known for its rugged beauty, Wyoming is a place where cowboys and wildlife still roam the plains. While the state's population numbers just over a half a million people, millions visit each year to see Yellowstone National Park, Grand Teton National Park, and Devils Tower National Monument; go skiing, hiking, and fishing; and experience vast wilderness.

With 6,800 miles of highway, Wyoming also serves as a major corridor for commercial truck traffic—particularly on Interstate 80, which runs through the southern part of the state. It is one of the busiest routes in the United States for moving freight from coast to coast.

Truckers, tourists, and locals alike can now navigate Wyoming's often unpredictable highways and byways with the help of real-time information from the Wyoming Travel Information Map, built by the Wyoming Department of Transportation (WYDOT) using Web AppBuilder for ArcGIS. On an average day, the map gets about 170,000 visits—and that number can climb to four million when there's a big storm.

"Road condition information in Wyoming is critical to safety," said Vince Garcia, the GIS/ITS program manager for WYDOT. "Wyoming gets severe winters with a long duration. We have the worst blowing snow conditions in the country."

WYDOT created the Wyoming Travel Information Map, available at https://map.wyoroad.info/wtimap, largely to help drivers plan their travel before they set out on the road.

"Without this map, people coming from other states may not be well prepared," added Garcia.

The interactive map displays the state's current road conditions, construction areas, and advisories. Other map layers include web cameras on certain parts of the highway, rest area locations, size and weight restrictions, weather stations, truck parking areas, and the locations of variable speed limit signs.

With so many elements in one map, WYDOT didn't want to have to build things from scratch.

"We preferred to configure instead of code and customize or extend where we *[needed]* it," said Ben Saunders, a GIS professional with Srednaus Mapping, which worked with WYDOT to build the Wyoming Travel Information map. "The functionality of Web AppBuilder is ready out of the box, *[and]* Esri's help documents and the user community gave us the confidence that we *[were]* working within a well-documented environment."

Web AppBuilder for ArcGIS features ready-to-use widgets, configurable themes, and custom app templates. Apps can be hosted online or run on an on-premises server. And the HTML/JavaScript apps that it builds are responsive and intuitive.

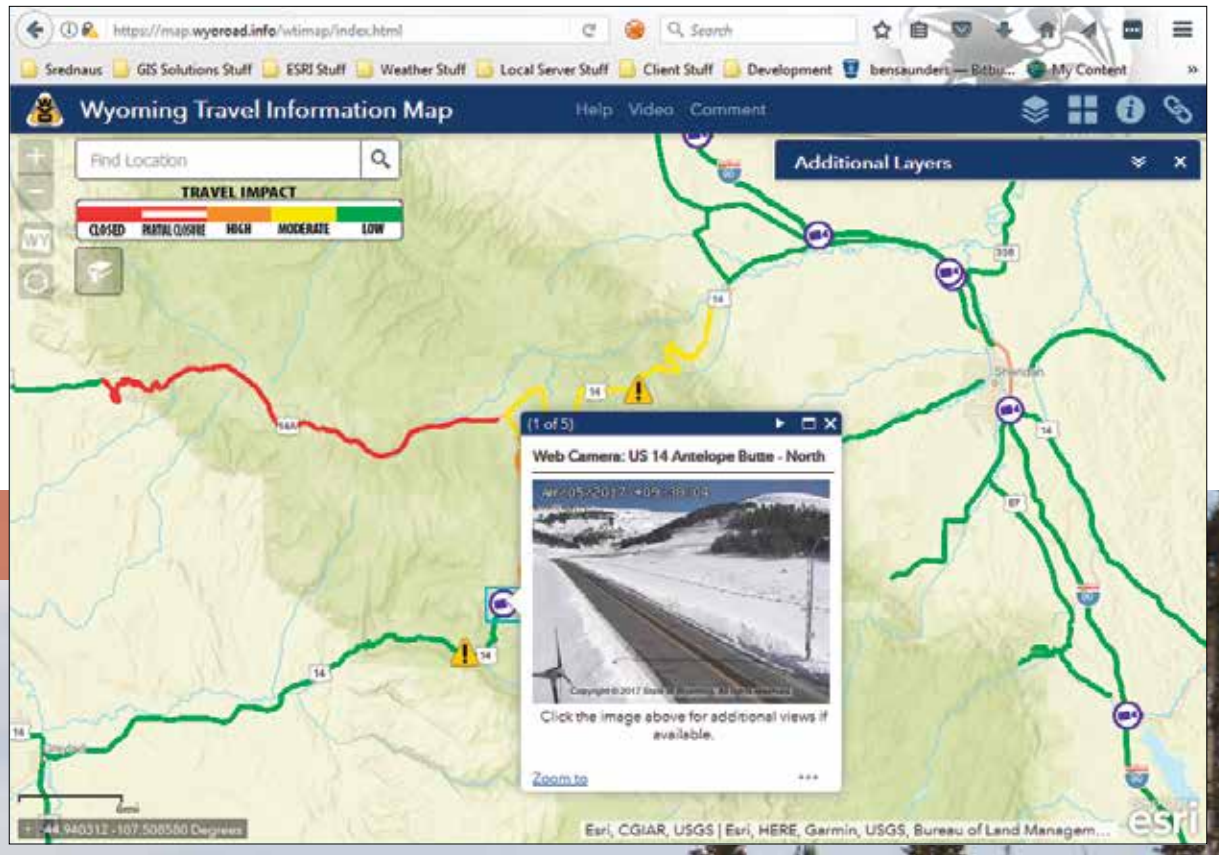
"We wanted this map to be mobile friendly, and *[we]* liked that Web AppBuilder offers a responsive design," said Trenton Rawlinson, a GIS developer with WYDOT. "We also wanted to make the initial download smaller so people can access it when there is limited Internet service. We used image caching versus feature services to make it load more efficiently."

Although during development, WYDOT created several iterations of the map, the basic process of building it took just three days. After tuning up its performance, administering user testing, and working through network issues, the WYDOT team delivered the Wyoming Travel Information Map to the public within six months of conceiving the project.

"There's no way we would have been able to put this together using the old technology," Garcia said. "Some of the lessons learned led directly to more efficient development of subsequent maps for the Wyoming Department of Tourism. And the platform allows us to add additional functionality and data, like National Weather Service radar loops. The application can continue to evolve."

For more information about the Wyoming Travel Information Map and how it was built, email wyoroad@wyo.gov.

→ Users can turn on additional layers in the interactive map, such as web cameras on parts of Wyoming's highways.



↓ The Wyoming Travel Information Map shows users current road conditions, construction areas, and advisories.

Smarter Data for Safer Roads

New Zealand Transportation Agency Models Curve Risks on Rural Roads to Save Lives

When it comes to investing in road safety—a primary concern for all governments—the focus is to identify and prioritize projects that will save the most lives and prevent as many serious injuries as possible. Road managers are already using geospatial analysis to identify high-risk roads and prioritize safety projects. These types of analysis are usually reactive in nature, though—relying on crash data to highlight black spots (places where there are clusters of crashes) and reveal crash trends. But as transportation agencies pinpoint and address these hot spots, they can increasingly use smart spatial apps to discern the next problem spot that may not be immediately apparent from looking at crash data alone. A particularly challenging area, however, is low-volume rural roads, where crashes tend to be random and sporadic in nature.

The NZ Transport Agency (NZTA), the government organization responsible for delivering a safe and efficient national transportation infrastructure system in New Zealand, set out to develop a spatial road safety risk assessment methodology that specifically targets these low-volume rural roads. The agency wanted to be able to evaluate the safety of horizontal curves—those gradual turns that connect two adjoining strips of highway—based on a road's geometric and operating speed features. So Esri partner Abley Transportation Consultants, which specializes in designing and implementing road safety strategies, helped NZTA build a geospatial risk prediction methodology based on the ArcGIS platform.

Categorizing Curves

NZTA had two key requirements for the risk assessment methodology. First, it needed to be created using already-available knowledge of the road network, including existing spatial data and associated transport attributes, such as speed limits. Second, it had to be cost-effective so it could be readily applied across an extensive road network.

Abley based the NZTA's geospatial risk prediction methodology on a road engineering process that includes driver behavior models for acceleration on straight roads and deceleration on curves along high-speed corridors. The risk assessment process involves comparing approach speeds with the radius, or tightness, of a curve to assign a risk classification to each curve in both directions of travel. This risk classification is a proxy for the likelihood that a driver will lose control while taking the curve.

Abley also included in the methodology the Operating Speed Model from Austroads, the lead organization for Australasian road transportation and traffic agencies. The model is designed to be administered manually on relatively short segments of road—about 10 to 25 kilometers, or 6 to 15 miles.

Here's how it worked: A traffic engineer would split a road corridor into a series of straights (with known lengths) and curves (with known radii) and then follow a complex methodology to identify maximum desirable speeds based on the overall curvature and terrain profile of the road. The traffic engineer would then assess each element of the road (straight or curve) to determine the start and end operating speeds for each road curve segment by using vehicle acceleration or deceleration models.

The transportation authority could then categorize curves by comparing the approach speed to the curve radius. Curves where drivers need to decelerate only slightly are considered "desirable" or "within context." Curves where substantial deceleration is required are classified as either "undesirable" (moderate risk) or "unacceptable" (high risk).

This model works, as there are fewer crashes where it is applied. But to have road authorities manually implement it across all the high-speed roads they manage would be too time-consuming and cost prohibitive. Because the inputs for the speed model are available as a spatial dataset, however, Abley automated the process using ArcGIS Desktop and the available road centerline network.

Assessing and Predicting Risk

Abley developed a number of smart geospatial workflows—including ArcGIS models and Python scripts—to segment road corridors, identify curves, calculate curve radii, predict vehicle operating speeds along corridors, and assess curve risk based on approach speeds and curve radii across the entire high-speed road network.

Using the available road centerline network, the project team employed ArcGIS Desktop to create a process for identifying curves and straights. The process splits the road into 10-meter (32-foot) sections and calculates the curve radius over a 30-meter (98-foot) arc. Individual curves were identified as contiguous sections with a radius of less than 500 meters (1,600 feet), which is what defines a horizontal curve, and a curvature going in the same direction. Abley then modeled maximum desirable operating speeds for each section of road by combining the overall terrain (based on a digital elevation model) and curvature of the road, which ranged from flat and straight (allowing cars to go 110 kilometers per hour, or 68 miles per hour) to mountainous and tortuous (only allowing for speeds of 75 kilometers per hour, or 46 miles per hour).

From there, Abley calculated actual free-flow operating speeds and curve risk by running a Python script in ArcGIS Desktop that sequentially evaluated each element of the road—both curves and straights—to model vehicle speeds and driver behavior. On undivided roads, vehicle operating speed and curve risk is analyzed in each direction, making it possible to identify curves whether the risk to drivers occurs in only one or both directions of travel.

To validate the methodology, Abley compared 10 years of crash data against horizontal curves across the whole road network. It was found that two-thirds, or 67 percent, of loss-of-control crashes occurred on 20 percent of curves classified as unacceptable or undesirable in at least one direction. This finding suggests that by targeting a small percentage of high-risk curves for further investigation and intervention—such as improved signage, surfacing, or side protection—road agencies could greatly reduce the likelihood of additional crashes occurring at these high-risk locations.

Being More Proactive

So far, this is the only known road-network-wide geospatial tool designed specifically to help road agencies identify and prioritize high-risk horizontal curves without needing to collect field data. Because the methodology assesses the risks independent of crash information, road agencies can now proactively target interventions toward high-risk locations and have confidence that safety will be improved—whether or not the location has an established crash problem. The methodology effectively bridges the gap between being aware of major safety issues on high-speed roads and coming up with detailed strategies to reduce the likelihood and consequences of crashes that happen on horizontal curves.

"These guides and tools have revolutionized the way we and our partners are able to view and understand the various road safety risks across the New Zealand road network," said Colin Brodie, lead adviser of interventions for safety and the environment at NZTA.

This methodology has now been rolled out across all high-speed (80-kilometer-per-hour, or 50-mile-per-hour) roads in New Zealand, which consists of 42,000 kilometers (26,000 miles) of roadway. The Centre for Road Safety in New South Wales, Australia, has also implemented it on 37,000 kilometers (23,000 miles) of state-owned roads. Additionally, the Department of Transport and Main Roads in Queensland, Australia, is close to being able to apply this methodology there.

Austroads safety program manager David Bobberman believes there should be "no surprises for drivers" on the 900,000 kilometers (560,000 miles) of roads that its transportation and traffic agencies collectively manage. Abley's director, Paul Durdin, shares this philosophy.

"Messaging conveyed to drivers needs to be consistent and reflect the risk of each curve," said Durdin. "Using Esri technology to identify risks and prioritize for intervention before a crash happens allows road controlling authorities to be more proactive and socially responsible and to ultimately save lives."

For more information on Abley's geospatial road safety risk assessment methodology, get in touch with Durdin at paul.durdin@abley.com or +64 3 367 9004 or contact Brodie at colin.brodie@nzta.govt.nz or +64 27 212 5238.

← When curves require drivers to decelerate substantially, they can cause loss-of-control crashes, as the symbols on this map show.

↓ High-risk curves on mountainous roads can be easier for drivers to manage when they have adequate signage and barriers.

↑ Meemim color-coded the utility's features, making electric utilities red; water utilities blue; sewer and drain lines green; and gas, oil, steam, and petroleum materials yellow.

Mixing the Real with the Virtual

Out in the Field, New Jersey Utility Uses Mixed Reality to View Simulated GIS Features

In March 2014, articles about virtual and augmented reality being the next big thing flooded the Internet. Len Bundra, the IT/GIS director for the Toms River Municipal Utilities Authority (TRMUA) in Toms River, New Jersey, foresaw a day when this technology would allow field-workers to "see through the ground," as he put it, and view the utilities beneath their feet without having to rely on vehicle-mounted rugged laptops, which display static 2D GIS features. He wrote a post on LinkedIn outlining his idea to use virtual or augmented reality goggles to project features from ArcGIS onto the real world.

While Bundra's post was viewed several hundred times, it sat on the social media site for almost three years without any responses. But then, in October 2016, he received a message from Alec Pestov, a developer from Toronto, Canada, who shared Bundra's vision. Pestov, the founder and CEO of Esri startup partner Meemim, Inc., proposed that, together, they build something entirely new—a mixed reality app that would allow utilities (and eventually other organizations) to collaborate with shared content and data in novel ways.

Mixed reality, often described as a combination of virtual reality (VR) and augmented reality (AR), enables users to see virtual objects that are not visible from a real-world perspective. This is akin to a VR experience, though the real world doesn't get occluded. With mixed reality, users can view and retrieve information about both the visible, real-world objects surrounding them and the virtual objects being projected by headsets. In Bundra's opinion, mixed reality was the perfect environment for allowing his fieldworkers to see concealed utilities while remaining situationally aware of their actual surroundings.

Bundra and Pestov immediately set out to turn this idea into reality.

Getting Support for Simulation

Before the two innovators could get started on the project, Bundra had to get backing from TRMUA's executive director and Board of Commissioners. Pestov proposed that Meemim fund the up-front programming costs so long as staff at TRMUA made themselves available for technical consultations and field testing during the app's development phase. TRMUA would be able to defer additional expenditures until Meemim had completed a demonstrable pilot project.

Fortunately, TRMUA's board had a history of supporting the early adoption of technology that would allow the utility's employees to be more efficient and, in turn, save its ratepayers money. So after Meemim created a test case and presented the technology to the board, TRMUA received approval to go forward with the project.

To get things going, Pestov's team chose the Microsoft HoloLens as the smart glasses TRMUA would use. The head-mounted holographic computer was the only viable device that met all TRMUA's functional requirements. Plus, it would be supported by the largest network of hardware and software technicians and developers at Microsoft. Esri's longstanding partnership with Microsoft factored in, too, since TRMUA has been an enterprise client of both companies for many years.

Meemim then had to develop a way to digest TRMUA's ArcGIS features—surveyed coordinates, data, and projections. Although Bundra had 25 years of experience editing, creating, and exporting GIS features to and from conventional formats, exporting holographic projections to mixed-reality hardware was something completely new. Since several of Meemim's programmers were already experienced in working with Unity, a development platform used to create 3D worlds for many online games, the startup chose that as the simulation engine. Thus, GIS programmers met Unity programmers, and it worked.

Turning the Virtual into Reality

Meemim began developing the technology in December 2016. Within three months, the company had created its app, called vGIS, which could process ArcGIS feature services, upload the output to Meemim's Microsoft Azure cloud service, and communicate directly with HoloLens to create the holographic projection of underground utility features from the perspective of the headset wearer's location and orientation. Both Microsoft and Esri independently confirmed that Meemim and TRMUA were innovating, since they were not aware of any other project in the world that was doing what the two organizations were trying to do.

By May 2017, it was time to test the technology out in the field. Bundra's main concern was whether the Microsoft HoloLens could accurately project and display TRMUA's underground GIS

features—which were field surveyed and postprocessed to subdecimeter accuracy—so the wearer would see them aligned with the real world.

"We are dealing with five or six utility lines underneath a street," said Bundra. "We have to locate our utility lines so that when we dig up a street, we are confidently aware of all other utilities around us. Given a more dynamic situation—a car hits a telephone pole, the pole collapses onto the street—seven separate agencies are on scene, each viewing *[its]* own GIS utilities on separate devices. What I am trying to do is provide all field personnel with one common interface to see all underground utilities beneath their feet—*[so]* one shared vision via a shared interface."

On Tuesday, May 2, Bundra set out to take one small step for the future of GIS, going where no other GIS specialist had ever gone. On a quiet street in Toms River, he stood on the sidewalk, adjusted his HoloLens headset, and launched Meemim's vGIS app.

Using Meemim's patented geocalibration process, Bundra anchored himself to a nearby visible GIS feature (a sewer manhole) and then provided the HoloLens with a precise headset orientation via a simple two-step process. It took less than a minute for the HoloLens to perform the calibration, and afterward, Bundra could see all the water, gas, electric, and sanitary and storm water sewer utility features begin to project themselves around him.

Then, using a voice control system that Meemim built into its vGIS interface, Bundra was able to give the HoloLens standard mapping commands, such as "zoom in," "pan left," "select," and "close." This allowed Bundra—and would enable other fieldworkers—to see and retrieve information about the utilities around him, hands-free. Meemim had color-coded the utility features by utility layer, according to common conventions; electric utilities were red, water utilities were blue, sewer and drain lines were green, and so on. The startup ensured that the holograms displayed pipe sizes according to their actual diameters, so that a pipe with a two-inch diameter would appear smaller than a pipe with an eight-inch diameter. Additionally, each utility line was represented by two lines—a solid one that showed the utility line at its depth and a dashed one that showed where the utility line would be marked out (spray painted) on the road or sidewalk.

Whenever Bundra moved his eyes, a small white cursor would follow. If he placed his gaze on a GIS feature, he could say, "select," and an attribute information window would appear. If he said, "close," the window would disappear.

Bundra walked along a water main. He made a turn at the first water service line and ended his mixed-reality tour at a water meter beneath his feet. Everything coincided both visually and virtually to within inches of each other.

For the first field test, Bundra could not have expected better results. What he saw only reinforced his initial vision: that mixed reality and GIS technology would soon converge to provide tangible benefits for all utility field operations.

Game-Changing Impact

TRMUA now uses the app in the field. And anyone who sees it quickly realizes that this technology is most powerful when organizations share their data so that everyone can see what is beneath their feet.

↑ As Meemim founder and CEO Alec Pestov (pictured here) demonstrated, mixed reality allows fieldworkers to see concealed utilities while maintaining situational awareness.

Given that TRMUA serves 100,000 citizens across multiple jurisdictions and coordinates its operational activities with seven public and private entities, the app is now bringing the utility closer together with neighboring political entities. So far, the app has helped initiate long-overdue conversations regarding data sharing and GIS mapping standards.

Ideally, mixed reality can bring the same game-changing impact to the GIS community that it has initiated in the media, entertainment, and gaming worlds.

For more information about mixed reality, email Bundra at lbundra@tomsrivermua.org or Pestov at alec.pestov@meemim.com.

↓ When TRMUA IT/GIS director Len Bundra conducted the test of Meemim's vGIS app, he first anchored himself to a sewer manhole so the HoloLens could calibrate its location.

ACCELERATING
Small-Town Services on a Small-Town Budget

Just outside Washington, DC, in an office in the public works department of the City of Falls Church, Virginia, sits the city's lone GIS employee. Although Andrew Peters is only one individual, he has used GIS to improve workflows throughout the entire city—namely, by turning to the Esri technology his organization already had.

Rather than spend weeks developing apps from scratch, Peters rolls some out in less than a day. Using the ArcGIS platform—including ArcGIS Pro, ArcGIS Online, Web AppBuilder for ArcGIS, and the ready-to-use map and app templates available on the ArcGIS Solutions website—he can deliver the focused apps that city staff need for inventorying trees, inspecting bridges, and more.

When Peters came on staff as GIS manager in late 2016, he immediately began to look for ways he and the city could use GIS to become more efficient. Only one staff member, a planner, was using GIS—making development maps for city council meetings. Peters wanted to get more users on board. Fortunately, his GIS predecessors had set up the city's ArcGIS platform, including an ArcGIS Online organizational account. They had collected a lot of great data and, by adding public works project and land data, kept the file geodatabase current. But making changes one by one in the file-based system was too time-consuming.

Peters realized that if he was to keep up with the demands of a changing city, as well as put that great data to work for staff and citizens, he needed a system that could accommodate many users simultaneously. To do that, he would need to convert the file geodatabase to an enterprise geodatabase. Peters took online Esri courses, worked with his account representative, and talked with a solutions engineer—and with all that guidance, he created an enterprise geodatabase that would be easier to manage, accessible to other users, and able to support different city workflows.

Fast: Building an App in a Week

Once Peters began converting the city's datasets to the enterprise system, he wanted to put the data to work right away. So he began using two methods to create and deliver apps: Web AppBuilder for ArcGIS, an app-building environment inside ArcGIS Online that requires no coding, and ArcGIS Solutions (solutions.arcgis.com). The idea was to create mobile apps so people could access and interact with data in a way that helped them complete tasks.

Most of the city's geographic data layers were already in ArcGIS Online and served out through an open data website so that people could access web maps on their mobile devices. But Peters wanted to make the maps more valuable by adding interactive functionality.

For example, Peters decided to tweak the county's tree inventory app. Web AppBuilder for ArcGIS walked him through tasks for adding a web map, location widgets, search capabilities, and work order configurations. He gave the app extent capabilities that show users more data layers as they zoom in to the map. He then saved his work and launched the preview before deploying it in ArcGIS Online. The entire process took about a week.

In comparison, VDC Research Group, Inc., a technology market research firm, reports that, on average, organizations require more than six months to develop and deploy a single mobile app while spending, on average, $140,000 for it. VDC also found that 36 percent of organizations were dissatisfied with the speed at which they were adopting mobile apps.

Faster: Repurposing Already-Made Apps

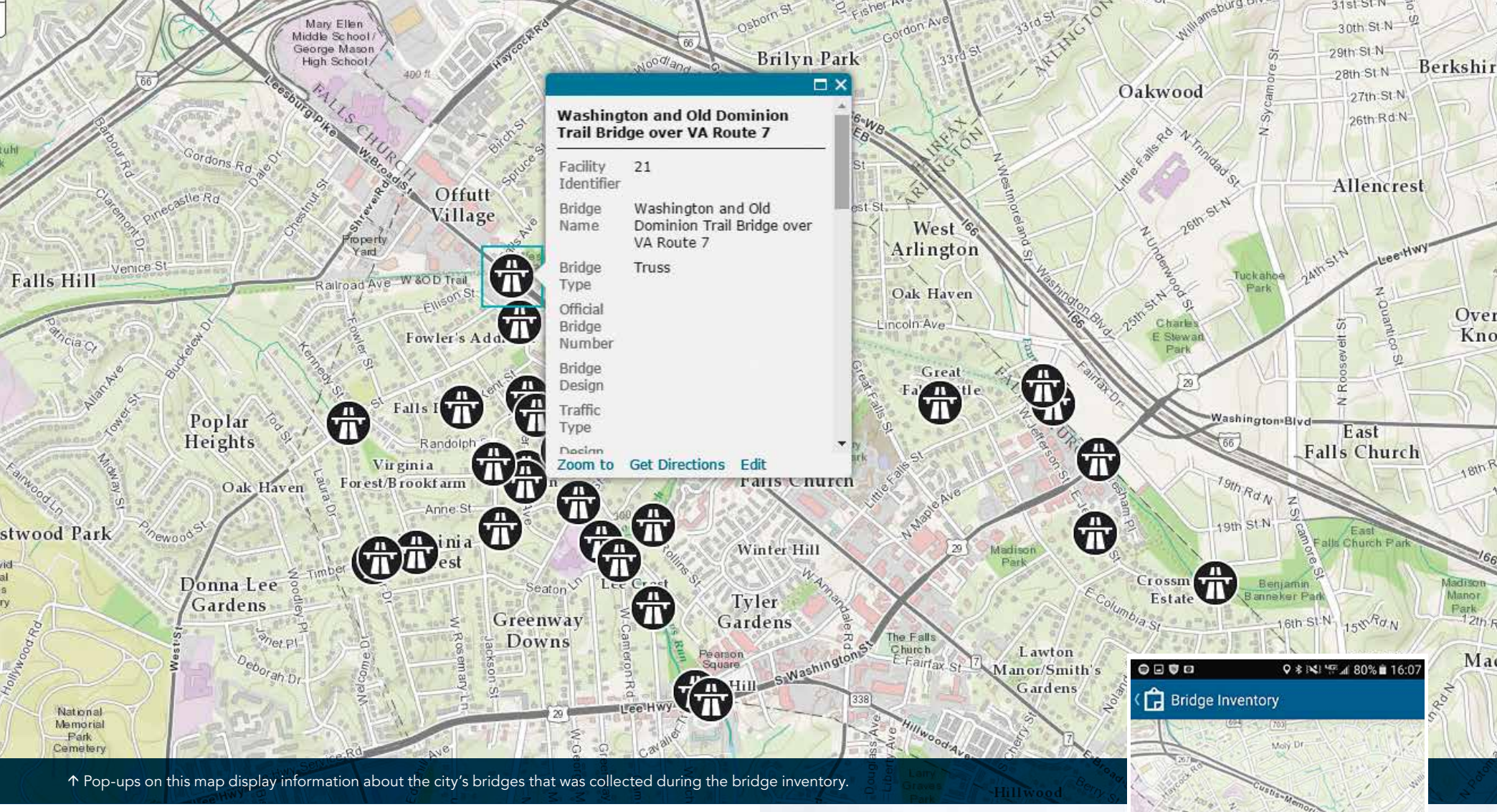
Why should Peters waste time reinventing an app when so many cities are doing nearly the same work and using pretty much the same GIS workflows? Working with industry experts, Esri curates a collection of industry-specific solutions that include ready-made maps and apps to help local governments quickly get the GIS technology they already have up and running. In the ArcGIS for Local Government suite, for instance, Esri offers solutions just for public works. It has 12 configurable workflow apps, ranging from public road network maintenance to facilities and grounds maintenance.

From among the ArcGIS government solutions, Peters selected ready-made apps for tax assessment, snow removal, streetlight inventory, sanitary storm water conveyance, and bridge inventory. The configurable solutions include map documents for publishing field-collected data, as well as the state government geodatabase with sample data. Esri users have access to more than 100 solutions for free.

If a GIS manager selects the Streetlight Inventory solution, for example, he or she can see that it helps state departments of transportation develop a comprehensive inventory of streetlights and poles and prepares the information for maintenance workflows. The mobile app has a toolbar and predefined methods to automatically populate attributes, such as pole identifiers. It comes with a map document for computing facility identifiers and associated signs, as well as where signals and streetlights connect to their respective poles. The web app also includes two map documents—one to publish the poles service and another to publish the streetlights service. And it incorporates the state government geodatabase with sample data.

Fastest: Deploying an App in Four Clicks

Using the latest tools in ArcGIS Pro, which is included with ArcGIS Desktop, Peters has been churning out GIS web apps and putting them into the hands of city workers to help them meet their departments' missions. With the ArcGIS Solutions Deployment Tool—an ArcGIS Pro add-in available from the ArcGIS Solutions collection—he can configure and deploy an app in less than a day.



↑ Pop-ups on this map display information about the city's bridges that was collected during the bridge inventory.

"I'm glad that Esri found a way to simplify the web app-building process and deployment," Peters said. "Previously, I was manually creating the extent, configuring the table, and converting field names into words that *[nontechnical]* people understand. The *[ArcGIS Solutions Deployment]* Tool automatically performs those tedious processes in just a few clicks. The *[app]* exponentially reduces time because I'm not fiddling around making decisions about which icons, fields, and schemas to use. I can easily configure the app with the data I already have."

One of the first apps he rolled out using the ArcGIS Solutions Deployment Tool was for completing a bridge inventory, a task that most public works departments across the country know well. The Federal Highway Administration mandates that each state inspect its public highway bridges in accordance with the National Bridge Inspection Standards. The Virginia Department of Transportation (VDOT) delegates bridge inspection duties to localities, meaning that the City of Falls Church inspects state and federal bridges, as well as its own city-maintained bridges, using these standards. The city inspects most bridges listed in the National Bridge Inventory on a two-year cycle, and those in poor condition more frequently. In addition, Falls Church inspects its own bridges on varying cycles, based on current condition, usually every two or four years. The inventory helps VDOT address bridge deterioration, damage, and other concerns. If a bridge presents safety concerns, VDOT posts weight limits, detours traffic, and repairs these structures.

To help contractors and city staff gather and update bridge data more easily, Peters created a mobile app that contains tools for collecting identification information, bridge type, and design data and is aligned with the federal standards for bridge inspections. In ArcGIS Pro, all Peters did was click Deploy an ArcGIS Solution to see Esri's state government group of ready-to-use apps. From this list, he selected Bridge Inventory and clicked Deploy. The ArcGIS Solutions Deployment Tool automatically consumed the city's previous bridge inventory map in ArcGIS Online and made it accessible via Collector for ArcGIS, a mobile app that field staff use to gather information. The ArcGIS Solutions Deployment Tool also added a bridge inventory layer to the city's files that are hosted in ArcGIS Online and pushed the collected bridge information data to the file. The final step was to click the Finish button.

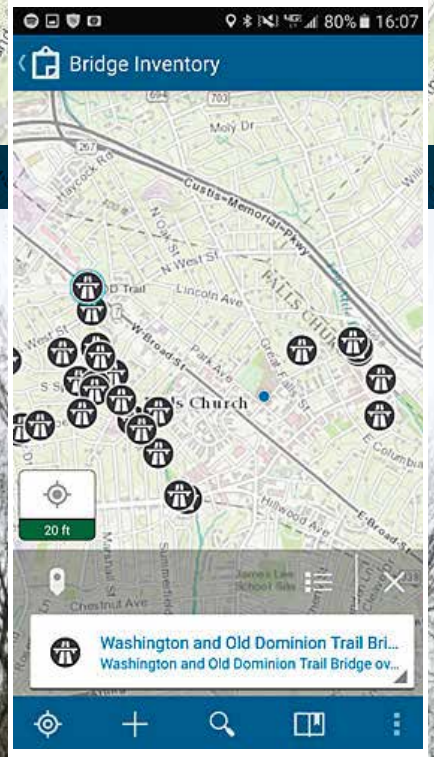
In just four clicks, Peters selected an app, set up a hosted map and layer, and deployed it as a mobile app. The app was immediately ready for workers to access and put to work via their Android smartphones.

Tapping Technology's Potential

Technology should help cities work better—more intelligently, more efficiently, and with greater accuracy. If it does not, management needs to rethink it.

New technology can be expensive, especially for small towns on tight budgets. But the GIS technology that cities already have may not be so much outdated as it is underutilized. The fact is that most US cities already have a GIS that has the potential to streamline workflows and deliver decision-making intelligence throughout the community. Most cities are just not tapping that potential.

City managers must actively look for opportunities to improve processes using the technology they already have while being open to enhancements such as an online subscription, add-on tools, and ready-made maps. A good place to look first is the ArcGIS for Local Government suite at esri.com/software/arcgis/arcgis-for-local-government.



↑ City staff use a mobile app to gather and update bridge data.

A city employee uses Collector for ArcGIS on a mobile device to obtain information about a bridge in Falls Church. (Photo courtesy of Andrew Peters.)

Enterprise GIS Reduces Paper Workflows in the Wood Industry

By Luís Campos, Abastena

Portuguese paper companies are increasingly taking more heed of their environmental and social responsibilities. Since the growth of the industry depends on one natural, renewable resource—trees—companies are developing their own sustainable management systems in the areas where they work.

Abastena is one of Portugal's most experienced wood suppliers—especially when it comes to operating sustainably. Not only does it provide wood materials to pulp and paper mills, board factories, and sawmills, but it also uses its Forest Stewardship Council (FSC)-certified groups to support forest owners and producers who want to implement responsible land management into their operations, as well as suppliers who want to provide FSC-certified wood materials.

As Abastena's client list and workload began to increase, it needed to make more information accessible to more people in less time using fewer resources. This required shifting from its deep-rooted paper-based workflows to web-based ones. To make this transition, the company relied heavily on the ArcGIS platform—most notably, Collector for ArcGIS and ArcGIS Enterprise.

Three to One

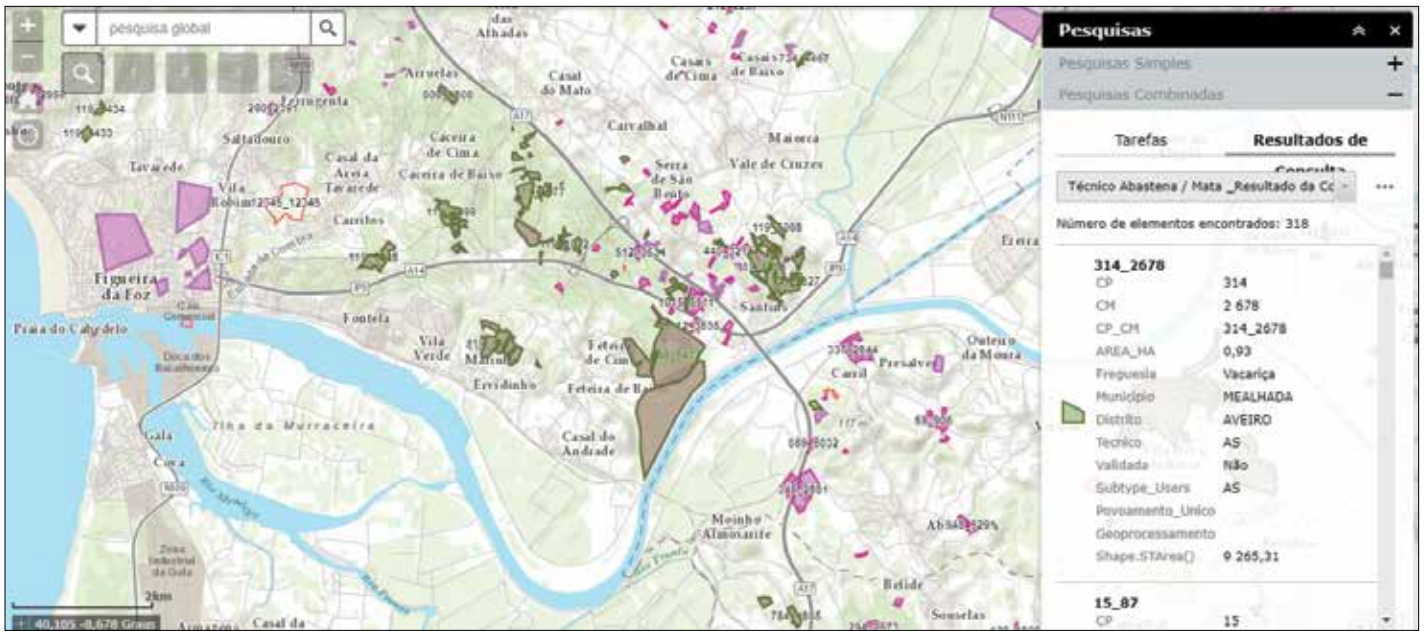
Prior to implementing the ArcGIS platform, when Abastena would step in to help landowners gain FSC certification, the company's technicians would take dozens of paper forms into the field to be filled out with information about landowners and their parcels of forestland. An administrative assistant back at the office would convert these registries into Microsoft Excel files, and a forest engineer would verify all the data. The majority of the data was then archived on paper. The information was difficult to access and inconvenient to use when timely decisions had to be made.

To turn this into a fully digital process, Abastena first implemented Collector for ArcGIS. Now, using Collector on a smartphone or tablet, one person can gather, record, and verify all the necessary information to determine what needs to be done to a parcel of land so it is eligible for FSC certification. Collector makes it easy for technicians to fill in the data fields, and it traces the geometry of each parcel. All this information is then incorporated into ArcGIS Enterprise in real time, which helps forest landowners, producers, and managers immediately see what they need to do with their land to obtain and maintain FSC certification.

The company estimates that this workflow alone now takes a third of the time that it used to. More importantly, it only requires one person to complete the workflow from start to finish, freeing up other employees to take care of other tasks. But that is only one root of Abastena's whole geospatial system.

Quick and Easy Access

Abastena also created an online platform where forest landowners, producers, and managers can see the locations of their properties, as well as all the information related to them—tree species distribution, the years trees were planted, and wood volume forecasts, for example—and their applicable forestry management plans. These users also wanted to be able to identify all the tasks associated with their management plans; eventual restrictions to their work, such as road networks, electrical grids, and ecological areas; and any alerts they should be aware of (if some documents aren't in compliance with



↑ Forest landowners, producers, and managers can easily see which management plan goes with which parcel of land so they can ensure that their management plans adhere to all Forest Stewardship Council (FSC) rules.

FSC rules, for instance). Additionally, it was important for them to be able to use geography to calculate costs and revenue, just as they use it to calculate risks and opportunities.

The company integrated its published data services with its enterprise resource planning (ERP) system and connected all its ERP data to the ArcGIS platform. Abastena could then share its data securely via ArcGIS Enterprise. Now, forest landowners, producers, and managers have easy access to the information they need through an ArcGIS Enterprise portal, which enables Abastena to apply its own security settings and configure the site so it conforms to the company's look and feel.

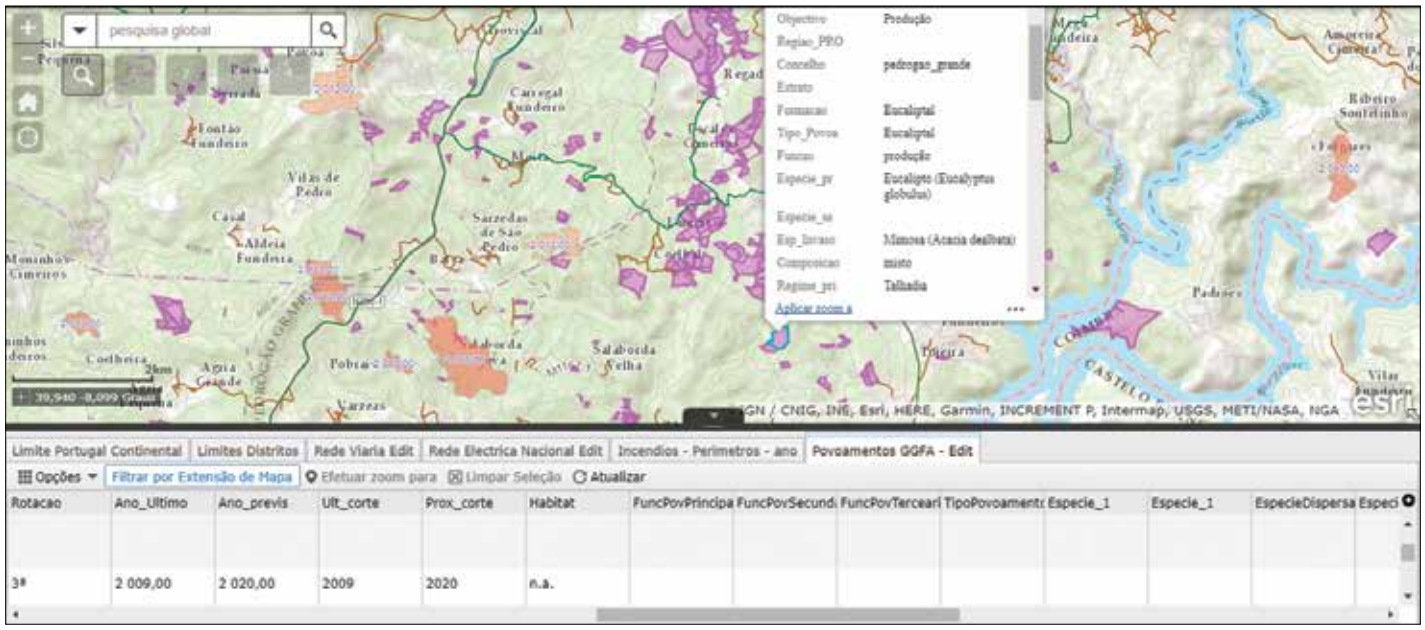
By accessing the ArcGIS Enterprise portal through the ERP, forest landowners, producers, and managers can see which management plan goes with which parcel of land. Having all this information available via ArcGIS Enterprise helps them ensure that their management plans adhere to all FSC rules, such as preserving or strengthening the well-being of local communities and workers and conserving or restoring ecosystems. Additionally, users can easily see how to combine their own interests and priorities with sustainable forestry maintenance, since the information about each parcel of forestland is readily available in ArcGIS Enterprise.

Apps are a key part of Abastena's enterprise GIS as well. Using smartphones, tablets, or computers, every forestry landowner, producer, and manager has quick and easy access to land management information, including the area of the land, the distribution of tree species, and any restrictions on the land.

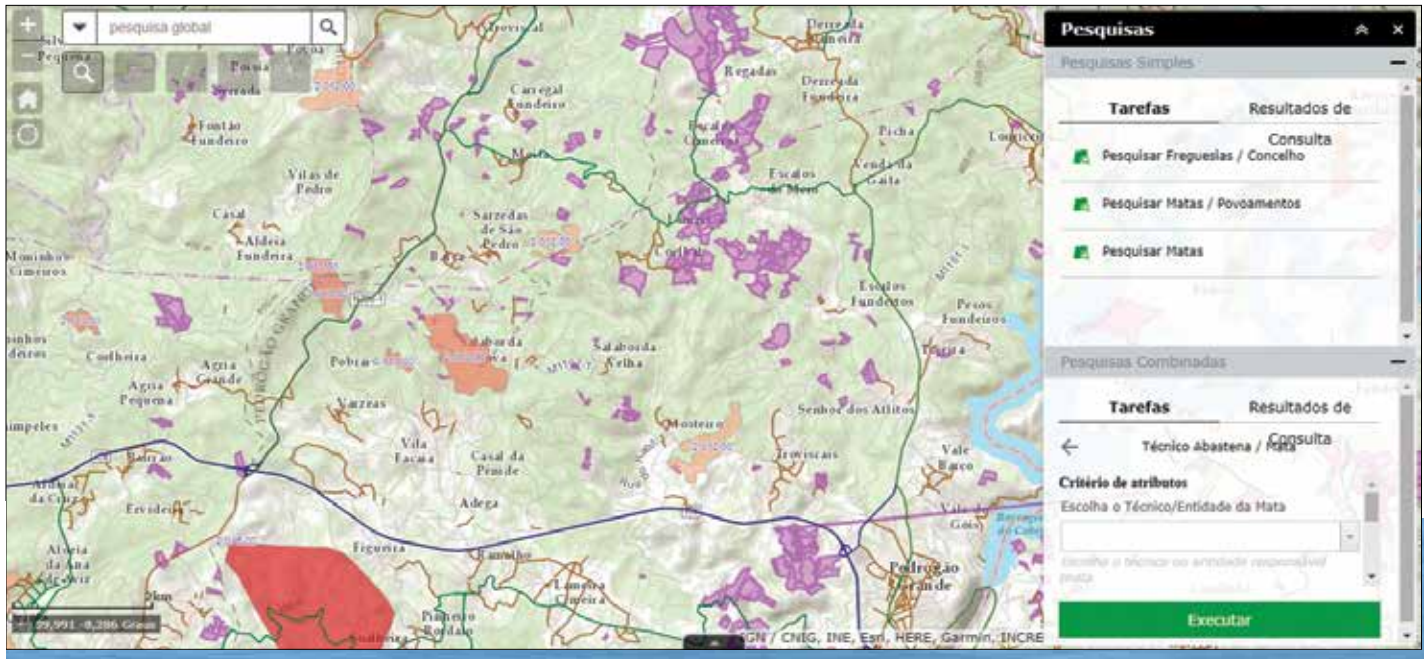
A Single, Web-Based Platform

All of Abastena's information and work is now centered in one single platform that is accessible, both internally and to clients, from any device. The company's web platform integrates myriad data—photos, land-use information, weather data, maps, and more—all of which changes constantly. But with fieldworkers updating information at any moment, from any place—and with that feeding in real time to ArcGIS Enterprise and the company's ERP system—Abastena's clients have all the data they need to obtain and maintain FSC certification and grow sustainably.

For more information about Abastena and this project, head to abastena.pt or email marketing@esri-portugal.pt.



↑ Relying heavily on Collector for ArcGIS and ArcGIS Enterprise, Abastena has shifted from deep-rooted paper-based workflows to web-based ones.



↑ Forest landowners, producers, and managers wanted to be able to identify all the tasks associated with their management plans.

Portuguese wood supplier Abastena uses GIS to help other wood and paper companies obtain and maintain FSC certifications.

About the Author

Luís Campos, the GIS and certification manager for Abastena, coordinates sustainable forestry management plans for the company's clients.

One App Takes On 2,000 Trees

By Jonathan Weaver, Cabarrus County, North Carolina

→ James Collins, a certified arborist, measures the circumference of a tree so he can enter it into Collector for ArcGIS on his iPad.

It's daunting to think how much time and effort it would take to do a manual inventory of all the trees on the more than 500 acres of arboreal land maintained by Cabarrus County, North Carolina. But a tree inventory is what the county's grounds and maintenance division needed. So in December 2015, Cabarrus County's infrastructure and asset management department met with the GIS administrator to figure out how to use ArcGIS to automate much of the inventory.

In just under two years, the team documented the location and health of almost all the 2,000-plus trees located on county property—covering everything from the large groves in parks to the single rows of ornamental trees at the downtown Concord administration building. As of September, about 90 percent of the project was complete, according to James Collins, a certified arborist and grounds maintenance worker with the infrastructure and asset management department.

The finished inventory will help the county manage problem areas in the future, said Kyle Bilafer, area manager of operations for Cabarrus County. "The *[documentation]* functions allow us to categorize trees not just by location and species but *[also]* by health, which allows more precise tree removal and replacement budgeting," Bilafer said.

Customizing ArcGIS

Initially, the IT department explored specific software to perform the tree inventory. But after discussing logistics, it was determined that the project should be developed completely in-house using the Local Government Information Model, available via ArcGIS for Local Government, as a starting point.

↑ In ArcGIS Online, green dots indicate healthy trees, blue dots signify trees that are in bad shape, and red dots denote trees that are in fair health and require a follow-up visit.

Then came the roughly two-month setup process. First, county officials took a list of all tree types in the area and customized it so it only showed trees that are native to Cabarrus County (making the project more manageable). Meanwhile, the county's GIS administrator, Joseph Battinelli, took the street trees feature class from the Local Government Information Model and used ArcGIS Desktop to set up the initial map. He and the team also determined the data collection parameters—such as location, species, trunk circumference, and health—which contain useful classifications to help with budget planning.

Battinelli then published all this to ArcGIS Server and added it to ArcGIS Online. He gave Collins, his supervisor, and Bilafer permission to edit the feature class and the trees map in ArcGIS Online. With that, Collins and a colleague would be able to conduct the assessment using Collector for ArcGIS.

Being able to customize the app was crucial during the planning process, said Battinelli. "I really appreciate how we can set it up and let the experts handle the input of data," he remarked.

Visualizing, Analyzing Problem Areas

Here's how the inventory works. Armed with an iPad and a certified arborist's eye, Collins (or his colleague) goes into the field to conduct the assessments. Using Collector, he takes a photo of each tree, notes its location, identifies the species, measures the trunk's circumference at chest height, and assesses the risk that it could die or fall over and damage structures. For larger groves, Collins makes a general health determination for every 1,000-square-foot area.

Ultimately, the trees and sections of groves are assigned colors based on their health. On a map in ArcGIS Online, red dots signify trees that are in fair condition—and those are the first to receive a follow-up visit to see what, if anything, needs to be done. Trees that are in bad shape and likely need to be removed get a blue dot. And healthy trees get a green dot.

The data can be exported in a number of ways—including shapefiles, geodatabases, and Microsoft Excel tables—to provide county managers and managers in the infrastructure and asset management department with good visualizations of problem areas. That helps Cabarrus County plan for tree removals as well as replacements.

Having the ability to share data with other team members on various devices is a big plus, according to Battinelli. "It's a new way to solve an old issue," he said. "*[ArcGIS]* gives you the tools to implement the process in relatively little time."

About the Author

Jonathan Weaver is a multimedia journalist with Cabarrus County's communications and outreach department. For more information, reach out to him at jaweaver@cabarruscounty.us.

What's New in ArcGIS Online

The December release of ArcGIS Online gives users an assortment of additional options, including new administrative privileges, increased support for hosted feature layers, more imagery and demographic data, and even a new app. Read on to find out about all the exciting updates.

Administrative Privileges Get More Detailed

ArcGIS Online users and administrators now enjoy more intricate administrative privileges across their organizations.

Whereas previously, only default administrators could reset passwords for other members of an ArcGIS Online organization, now any member who is authorized to update member account information can reset passwords for other members.

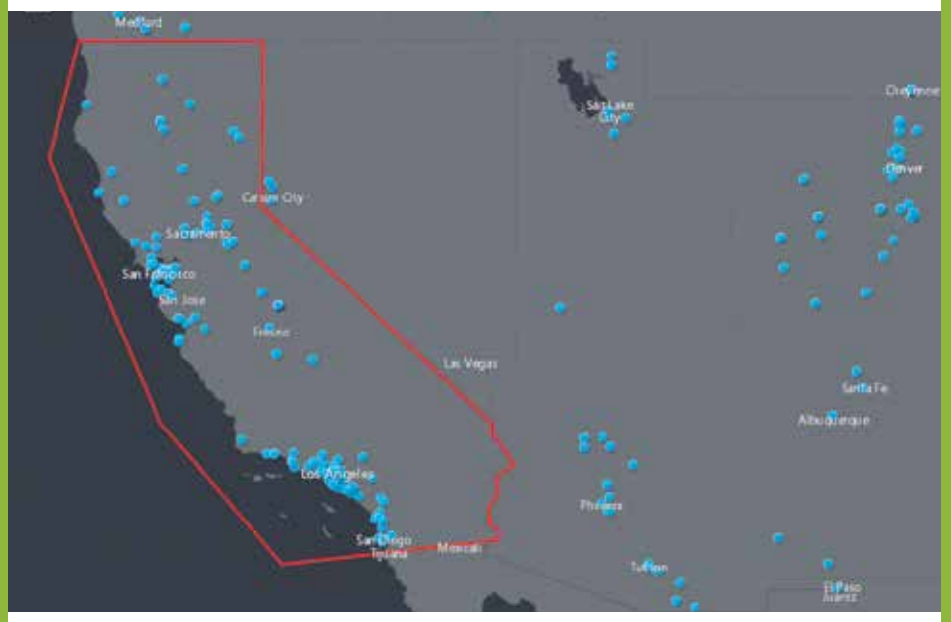
Administrators can enable Security Assertion Markup Language (SAML)-based group membership for their organizations. This allows organizations to link ArcGIS Online groups to groups they already have in their existing enterprise groups. Additionally, administrators can make web apps available to specific organization members by adding the apps to the app launcher. Then, when administrators provision premium app licenses to organization members, these apps will appear in licensed users' app launchers.

Landing Pages Get More Options

In the past, when users logged in to ArcGIS Online, they started at their organization's home page, while administrators started with their list of users. Now everyone in an organization—members at any user level and administrators—can customize their ArcGIS Online experiences to start wherever they would like, whether it's in the Gallery, Scene Viewer, Map Viewer, or the Content page.

Hosted Feature Layers Get Enhanced

Hosted feature layer views already offered users different styles, filters, and fields, as well as sharing and editing capabilities. But now they are even more useful, since they can be defined spatially based on the extent of the map. For example, if a company that sells products to golf courses in the United States has a sales group focused on California, it can set the extent of its map for just the state of California.



↑ Hosted feature layer views can now be defined spatially based on the extent of the map.

With the latest update to ArcGIS Online, hosted feature layers support users who want to make bulk updates to existing features and append new features without overwriting the entire layer. Consider a scenario where data was modified after it was published, and the user has a series of updates and edits to add to the dataset. The process for resolving this problem no longer requires multiple manual and time-consuming steps. Users are now able to append data to existing layers, update subsets of features without overwriting everything, integrate external data updates while data is actively changing, update only the geometry of features based on more precise surveying, and affix new records to an already large dataset. Supported formats for this workflow include CSV files, shapefiles, and file geodatabases.

Content Gets Freshened Up

This release emphasized imagery and demographic data for critical decision-making and other work that involves maps and apps.

Esri has released version 2 of its vector basemaps, which incorporate refined styles and contain additional content from the Community Maps Program. To take advantage of these and future enhancements, users need to update their maps and apps so they use Esri vector basemaps, version 2.

↑ Esri released version 2 of its vector basemaps, with refined styles and additional content.

The *World Imagery* basemap has been updated as well with fresh sets of DigitalGlobe imagery, including submeter-resolution *Basemap +Vivid* imagery for Australia and the United States. In addition, Esri has published DigitalGlobe's submeter-resolution *Basemap +Metro* imagery for hundreds of cities around the world.

Updates have been made to several demographic maps as well. Nexiga contributed the latest demographic data for Germany, and Esri partner Michael Bauer Research supplied the latest demographic data for several other countries. Detailed local boundaries—based on authoritative data from national government sources—have been published for Austria, Canada, and Germany, too. Users can employ these boundary layers to do more comprehensive visualizations and analysis.

ArcGIS Online Users Get New Insights

Insights for ArcGIS, Esri's web-based data analytics workbench, is now available in ArcGIS Online. Its drag-and-drop tools make working with spatial and nonspatial data simple, helping users easily understand and explain information. Complex algorithms running behind the scenes produce maps, charts, and tables that users can employ to visualize data and answer questions, solve problems, and quickly deliver powerful results. This iterative and interactive spatial analysis experience is great for seasoned professionals as well as those who are new to GIS.

↑ Insights for ArcGIS is now available in ArcGIS Online.

For more information about what's new in ArcGIS Online, visit the ArcGIS Online blog at **go.esri.com/new**.
Esri also invites all users to share product enhancement ideas at **go.esri.com/ideas**.

Selecting the Right Data Visualization

Visualizations foster understanding. They weave data points together to tell stories, and people take action based on what they understand from those stories. So visualizations need to be clear and accurate, giving decision-makers confidence in their choices.

Insights for ArcGIS makes it easy to create visualizations. The data analytics workbench, now available in ArcGIS Online, allows users to explore both spatial and nonspatial data in several different formats—various maps, charts, and tables.

But with so many options for visualizing data, how can you be certain that you're selecting the right visualization? Start by asking three key questions, and you'll be on your way.

1 Is the data qualitative, quantitative, or temporal?

Answering this question will help determine which visualization works best for the data at hand.

Qualitative data is categorical, meaning that the data values are descriptive. Examples of qualitative data include county names, soil types, and animal species. In Insights for ArcGIS, these data types are often stored in string fields.

Quantitative data contains values that show measurement—for example, total sales, the average grade of students in a class, or pipe length. In Insights for ArcGIS, these data types are often stored in number or rate/ratio fields. Because the numbers are measurements, they are often continuous rather than discrete.

Temporal data is collected over time. For example, it can show the number of lightning strikes that occur during a storm or car counts from traffic sensors. In Insights for ArcGIS, these data types are stored in date/time fields.

2 What story needs to be told?

Determine the purpose of the visualization. What question needs to be answered? What message needs to be communicated? Take a look at these six groupings of visualizations to help figure that out.

Measure

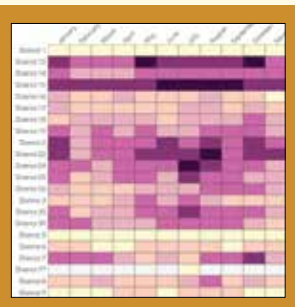
Measure visualizations are ideal when trying to ascertain the size, amount, or degree of a variable or phenomenon in an area, such as the amount of crime in a city or the value of sales. Charts are often a good choice for displaying this kind of data, and there are several types to choose from.

Bar graphs use either horizontal or vertical bars to show comparisons among categories. They make it easy to identify broad differences between groups at a glance.

Bubble charts represent numerical values by categories. Each bubble stands for a unique category, and the size of the bubble symbolizes the magnitude of the numerical variable, such as count or cost. These make it easy to compare categories.

Heat charts show total frequency in a matrix. Values in each cell of the rectangular grid are symbolized into classes, helping viewers see how the data is distributed into high and low values, trends, and more.

A crime analyst studying theft-related crimes in her city wants to find out which types of crime are happening most often and when. For this, she puts burglary data into a heat chart to visualize when these kinds of crimes occur most often. With this, she can see that District 12 has the most burglaries in May and October, while District 15 tends to have a large number of burglaries over the summer.

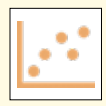


Treemaps also make it easy to see the different sizes of various categories compared to the whole. (See the "Part to Whole" section for more information.)

Relationship

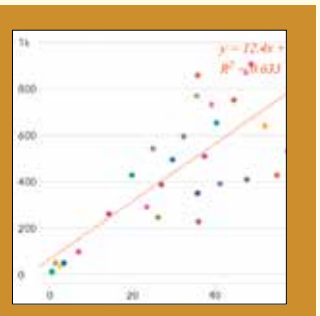
When demonstrating a link or similarity between two or more things—such as how much money a company spends on advertising versus the amount of revenue it brings in—relational visualizations work best. There are a number of great options for this.

Choropleth maps allow quantitative values to be mapped by area, enabling viewers to see the highs and lows. These maps use normalized or proportional values, not counts collected over unequal areas or populations.



Scatterplots enable viewers to look at the relationship between two numeric values with both axes showing quantitative variables. The level of correlation among values can also be quantified, making it easy to identify causation.

A public works department has noticed an increase in water main leaks. Employees suspect that the number of leaks is directly affected by the total length of the pipes. But in some districts, this correlation appears to be true to a lesser degree. For those, the employees use a scatterplot to look at the total number of leaks versus the total length of pipes in each water district. Given that the best-fit line goes from the lower-left corner to the upper-right corner of the chart, there is a positive linear relationship between the total length of pipe and the number of service requests called in for those pipes. Thus, pipe length is likely a significant factor in all the leakages.



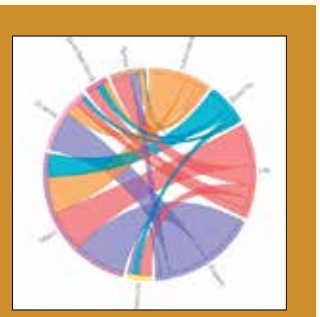
Chord diagrams and **spider**, or **desire**, **lines** work well, too.

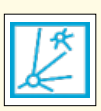
Interaction

Visualizing interactions helps viewers understand the flow of information or goods. Diagrams and charts in this grouping might show migration patterns or trade among different countries. Ideal visualizations for qualitative data include the following:

Chord diagrams best reveal the interrelationships between categories—that is, how each of several categories is related to the others. With chord diagrams, viewers can easily compare similarities within a dataset or among different groups of data.

An insurance agent is reviewing the types of policies her company offers. One step in the review process is to compare the total insured value (TIV) in each policy class across cities. Using a chord diagram, she can display the policy class values (property, life, disability, and automobile) and city values (Jacksonville, Miami, Orlando, Saint Petersburg, and Tampa) as differently colored arcs around a circle. The length of the arc and the thickness of the chords are determined by the sum of the TIV. The agent can see not only which city or policy class records the highest and lowest values, but she can also determine the policy classes that contribute to the TIV for each city. From this diagram, it is clear that Miami has the largest TIV in each policy class, while Saint Petersburg and Jacksonville only have policies in three out of the four policy classes.





Spider lines, also called **desire lines**, show paths between origins and destinations, illustrating connections between places.

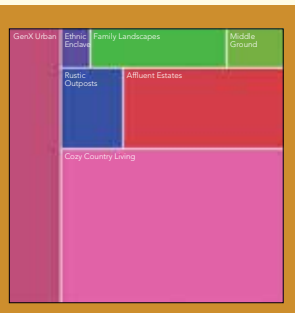
Part to Whole

It is simple to grasp relative proportions and relationships between parts and the whole—such as policy types or product categories—using the following visualizations.

Donut charts subdivide categorical data into unique values, with the size of each piece representing the magnitude of a numeric variable for each category, such as count.

Treemaps show the data's structure and hierarchy as a proportion of the whole. Using treemaps, viewers can easily compare the size of each category.

An online retailer that sells women's accessories wants to better understand its customers. An analyst creates a treemap to identify the segment profiles that occur most often in the retailer's sales data. He can quickly see that GenX Urban, Cozy Country Living, Affluent Estates, *and* Family Landscapes *make up the dominant Tapestry segments.*



Change

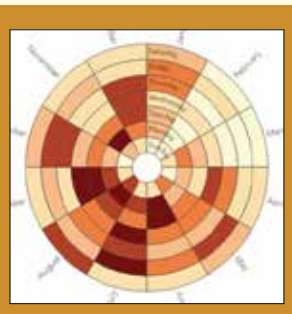
To decipher how things change, often over time—such as the number of traffic accidents per day, week, or year or population density across a region—there are several different visualizations to choose from.

Graduated symbol maps contain variously sized symbols (based on the magnitudes of the data) to show a quantitative difference among mapped features. This helps viewers see high and low values, various distributions of data, and more.

Density maps, or **heat maps**, calculate spatial concentrations of events or values. With these, viewers can visualize the distribution of variables as a continuous surface.

Data clocks, which create a circular chart of temporal data, are commonly used to see the number of events that have happened during different periods of time.

A police officer is looking to get a better idea of when drivers run red lights in his patrol area. In particular, he wants to see which days of the week and in which months they run the most and fewest red lights. Using a data clock, he can see that in June, July, August, and September, drivers run the most red lights on Mondays through Thursdays, while January and March see fewer incidents most days of the week. Knowing this, the officer can start digging into the root causes of the problem.



Line graphs display a sequence of continuous numeric values. Because they show overall transformations, as well as changes from one value to the next, they are primarily used to visualize trends over time.

Combo charts combine two graphs where they share common information on the x-axis, displaying two different charts with two different datasets at the same time. With these, viewers can see the relationship between the two datasets.

Bar graphs, **heat charts**, and **bubble charts** are great for visualizing relationships as well.

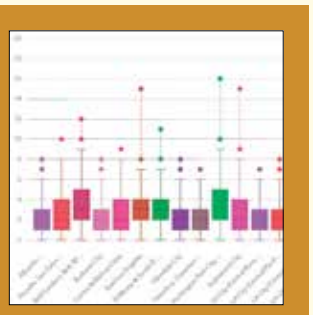
Distribution

To understand the numeric or spatial distribution of a phenomenon, such as the various sizes of pipe leaks or the locations of stores and their distribution centers, there are quite a few visualization options.

Histograms show the distribution of a numeric variable, such as height, age, or price. Each bar represents a bin, or a range of values, while the bar's height shows the number of data points in each class bin. These make it easy to see information about the distribution of data, like whether it skews one way or there are anomalies.

Box plots show the median, upper, and lower quartiles; minimum and maximum values; and outliers of numeric variables. Viewers can use box plots to compare numeric distributions among many groups.

A government agency is studying poverty, and as part of that analysis, its researchers want to understand if there are spatial differences in the number of people per household in each neighborhood. Putting the data into a box plot, they can see the median differences by neighborhood—so sections of the city that contain mostly apartments have high concentrations of people in a given area, while neighborhoods with more single-family homes have fewer people. The box plot also shows outliers on both the upper and lower ends of each neighborhood's range.



Unique symbol maps use different symbols—either various shapes or colors—to represent unique values. With these maps, viewers can see the spatial distribution of data based on distinct categories, such as the types of schools in and around a community.

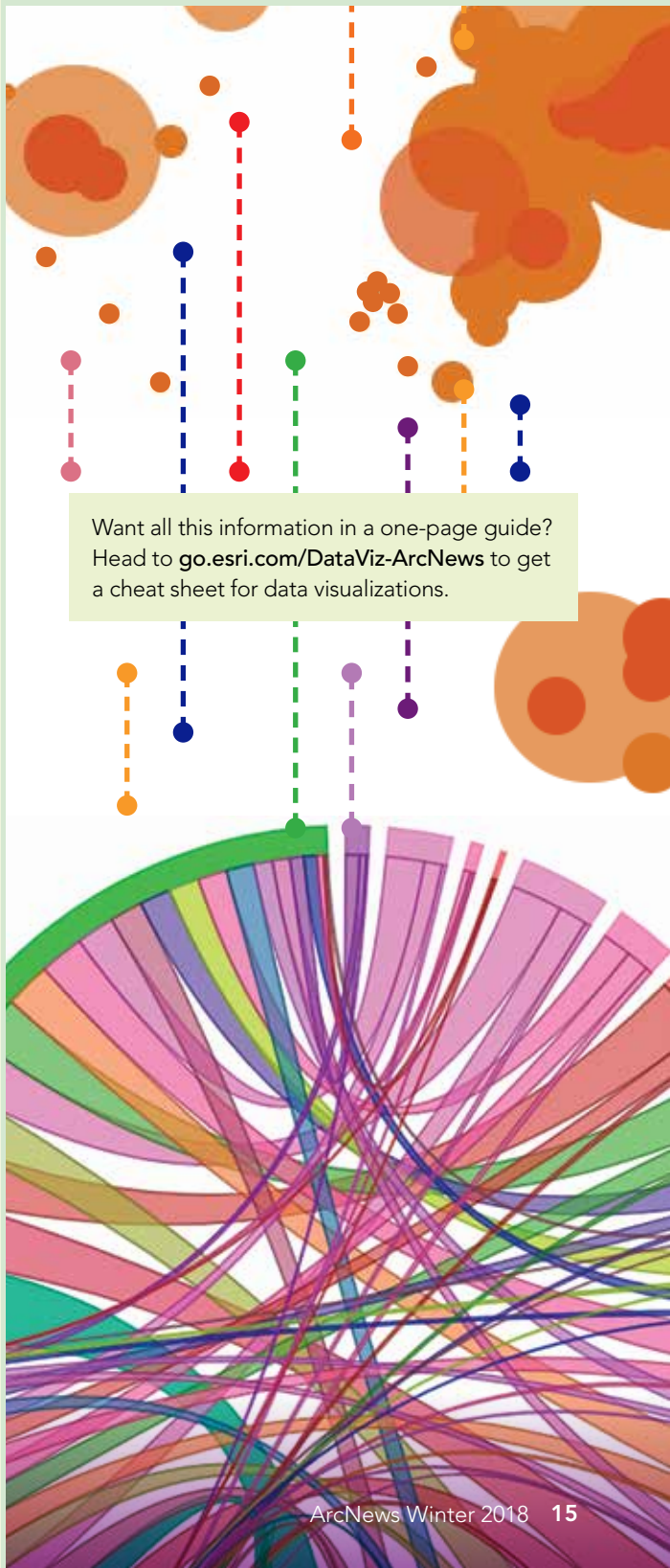
Choropleth maps; **graduated symbol maps**; and **density**, or **heat**, **maps** are good choices for visualizing distribution as well.

3 Is a map, graph, or table best?

Deciding whether to present data as a map, graph, or table depends on two things: the data being examined and the story that needs to be told.

When data has a location element to it—an address, a city, state, ZIP code, or custom geographic boundary—and the question that needs answering involves solving for *what*, *why*, and/or *how* in relation to *where*, maps are ideal. But a great deal of insight can be garnered quickly when maps are paired with other visualizations, especially when a lot of information is being communicated. This is when an accompanying graph or table can provide clarity. With graphs, users can more easily explore data values that show relationships, frequencies, distributions, differences in amounts, and changes over both time and space. And tables are useful for analyzing a small number of values—particularly when precision is important.

Now, help your data tell the story it is intended to tell.



Want all this information in a one-page guide? Head to **go.esri.com/DataViz-ArcNews** to get a cheat sheet for data visualizations.

The Relevance of Cartography

A Cartographer's Perspective

A column by Menno-Jan Kraak
President of the International Cartographic Association

Evaluating Maps for Usability

Cartographers design and create maps to communicate information about phenomena located somewhere on our planet. These could be relatively simple maps, such as those that pinpoint all the bookstores in a city or that display how intense traffic is during morning rush hour. They could also explore more complex topics, such as the relationship between a volcanic eruption in one place and the weather on another continent a week later.

In the past, cartographers did not worry too much about who was going to read their maps. Although some simple "usability" research was done—like comparing whether circle or bar symbols worked best—cartographers knew how to make maps. And in a bygone context, that was probably all right.

This has changed now, however, due to all kinds of societal and technological developments. Today, map readers are more demanding—mostly because of the tools they use to read maps. Cartographers, who are also influenced by these trends, are now more interested in seeing if their products are efficient, effective, and appreciated.

Based on what has happened in other disciplines such as industrial design, cartographers started to develop and apply methods and techniques to more seriously evaluate the usability of their map products. Modern mapmakers now try to evaluate a map's effectiveness (does it answer the questions asked?), efficiency (does this take a reasonable amount of time?), and satisfaction (is the map pleasant to work with?). Given today's interactive mapping environments, this is not an easy endeavor. For one thing, what do you test, the interface or the map?

During a map usability evaluation, cartographers give real people real-world tasks to complete with the map being tested. Researchers often use mixed methods—applying multiple quantitative and qualitative techniques to test a map's usability. Eye tracking is a rather popular method of evaluation these days, especially because all sorts of quantitative methods can be applied to the data gathered during one of these tests.

In an eye-tracking test, researchers can evaluate patterns in eye movement, showing that the map reader first looked at the legend and then continued to the main map, for example. They can also assess the duration of fixation—that is, how long the reader spent looking at a certain location on the map.

But numbers do not divulge everything. Did the reader remain fixated on a portion of the map because he or she had a problem understanding the map (and, if so, what was the problem)? Did the reader's eyes stay longer at that location because he or she appreciated what could be seen? Or did someone simply offer the map reader coffee?

In situations like these, it makes sense to apply quantitative methods in conjunction with qualitative ones. For example, let map readers talk while they are looking at the map to explain what they are doing. In the above example, if the map reader had said, "the visual clutter makes it difficult for me to follow the line that tracks the airplane," the cartographer would know right away why he or she remained fixated at a certain point for so long.

The challenges of executing a proper map usability evaluation have increased over time. We cartographers now think we can deal with assessing the usability of paper maps, controlling the experiment well enough. But because we currently have to evaluate interactive online map environments, this gets trickier. There are so many variables to control that it is difficult to interpret the results.

Using eye tracking as an example once again, on a static world map that shows a global airline's network of flights, an eye-movement evaluation might reveal that a map reader looks specifically at the airline's flight from Tokyo to Washington, DC, via Amsterdam. But how would a cartographer analyze a map reader's eye movement if the map being evaluated is an interactive 3D globe that the reader has to rotate? The flight path from Tokyo to Amsterdam to Washington, DC, would no longer be a long line across a page that a map reader follows from right to left. Rather, a plot of the map reader's eye movement would look like a squiggly dot at the center of a screen, since he or she would more or less be staring at the same location while rotating the globe. In this instance, the cartographer has to have context about the map-reading task and combine this information with the map reader's interactions during the actual map reading.

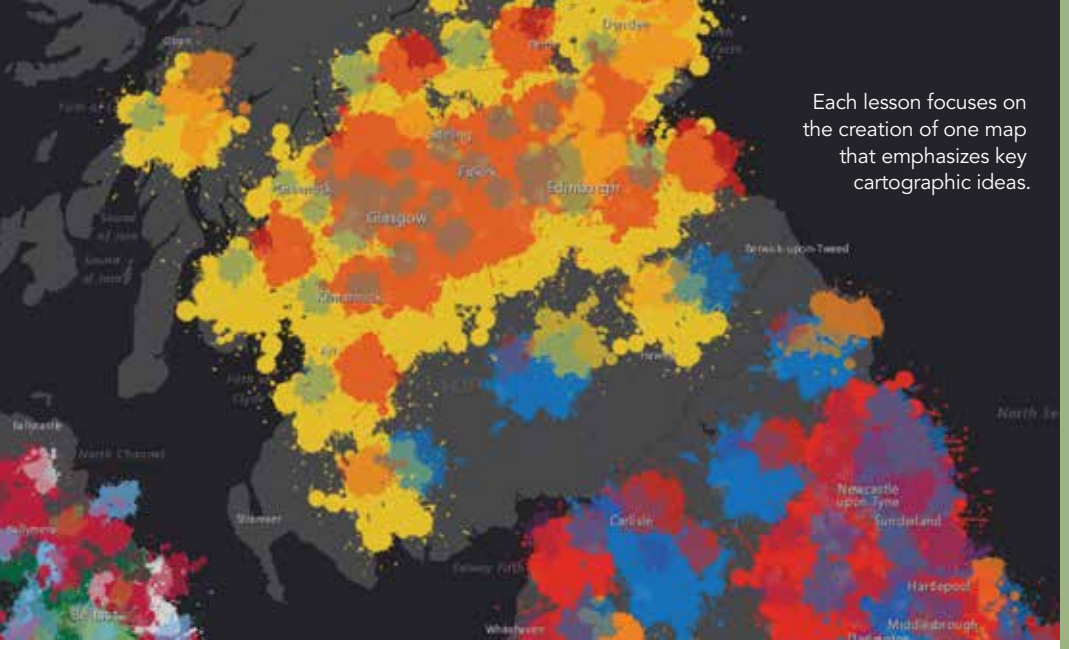
As if all that is not difficult enough, cartographers are also beginning to contend with yet another advancement in mapping: augmented and virtual reality. Virtual reality (VR) maps get especially interesting—particularly when combined with 3D mapping. That is because, while viewing a 3D map on a 2D screen still causes visual clutter, looking at a 3D map in a VR environment is expected to clear out some of this chaos. For example, it is easy to create our airline map in a 3D VR environment with some of the software that exists today. It is also easy to come up with tasks that map readers should execute during a usability evaluation. But how would a cartographer measure what happens in this virtual world, considering it is such an immersive experience? Finding out how a map reader's eyes follow that flight path from Tokyo to Amsterdam to Washington, DC, might not be that easy, since eye-tracking tests are not available in the virtual world (yet).

New technological developments have always stimulated cartographers to experiment with their maps by applying these new innovations to their designs. After successfully creating a map with new technology, like VR, a cartographer's job is not finished. We have to be able to judge whether the new map product makes sense. That is why we have to conduct map evaluations, which often require different approaches, as well as the development of new evaluation methods and techniques.

To find out more about cartographic usability research and join the conversation about how to tackle challenges in usability testing, explore the International Cartographic Association's Commission on Use, User and Usability Issues at use.icaci.org.

About the Author

Menno-Jan Kraak is professor of geovisual analytics and cartography at the University of Twente in the Netherlands, where he has been teaching since 1996. He has a degree in cartography from the Faculty of Geographical Sciences at Utrecht University and received his PhD in cartography from Delft University of Technology. Kraak has written extensively on cartography and GIS. His book *Cartography: Visualization of Spatial Data*, written with Ferjan Ormeling, has been translated into five languages. He also wrote *Mapping Time: Illustrated by Minard's Map of Napoleon's Russian Campaign of 1812*, published by Esri Press in 2014. Kraak is a member of the editorial boards of several cartography journals, including the *International Journal of Cartography*. He currently serves as president of the International Cartographic Association.



Each lesson focuses on the creation of one map that emphasizes key cartographic ideas.

Learn to Design Beautiful Maps

continued from cover

Each weekly lesson in the Cartography. MOOC focuses on the creation of one exemplary map that draws together key cartographic ideas. Lessons consist of about two hours of content, including video discussions, guided and self-guided exercises using ArcGIS Pro and ArcGIS Online, quizzes, interactions between students and instructors, and supplemental resources. Participants who engage with all the course content will receive a certificate of completion and a discount code to purchase *Cartography.*, the book, should they wish to continue their learning.

More than 10,000 students worldwide are expected to register for the first offering of the Cartography. MOOC this spring. To sign up, visit the Cartography. page at go.esri.com/cartographymooc.

The Cartography. MOOC joins four other Esri MOOCs: Going Places with Spatial Analysis, The Location Advantage, Do-It-Yourself Geo Apps, and Earth Imagery at Work. Together these MOOCs have attracted more than 105,000 enrollments since 2014. Twenty-five percent of students complete all their course content—a rate that's much higher than other MOOC providers. And nearly a quarter of the students are new to Esri technology.

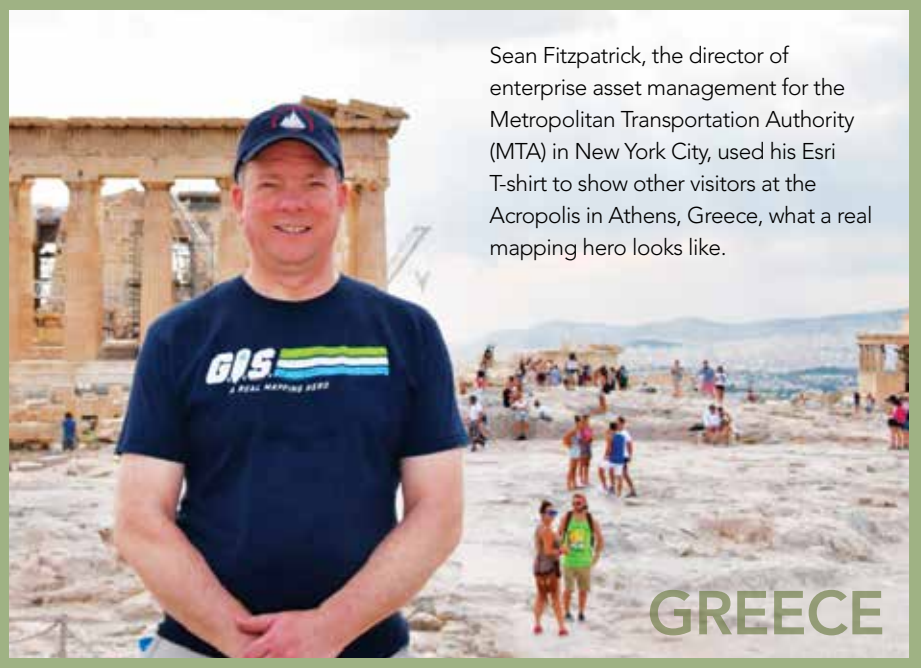
"Students in Esri's first MOOC, Going Places with Spatial Analysis, love Ken's guest lecture on cartography," said Esri's MOOC program manager Adena Schutzberg. "We're confident they'll love the new MOOC that he and his team have put together."

The MOOC program is just one aspect of Esri's commitment to education. The company supports thousands of K–12 schools with software, curriculum solutions, teacher professional development, and GeoMentors. A quarter of a million college and university students use ArcGIS every year. Students and GIS professionals alike benefit from instructor-led and e-Learning courses and seminars offered by Esri Training, self-study exercises available at Learn ArcGIS (learn.arcgis.com), and books published by Esri Press.

MOOCs offer an easy and fun way to discover the power of modern GIS. Anyone—from cartographers who want to test-drive ArcGIS Pro to those who are new to GIS and want to explore the discipline—can find an Esri MOOC to meet their needs and goals.

↑ From left to right, Esri's Ken Field, Nathan Shephard, and John Nelson film Cartography., the fifth MOOC that Esri has put together.

Esri T-shirts Tour
EUROPE



Sean Fitzpatrick, the director of enterprise asset management for the Metropolitan Transportation Authority (MTA) in New York City, used his Esri T-shirt to show other visitors at the Acropolis in Athens, Greece, what a real mapping hero looks like.

GREECE

ICELAND

Brian Hall, a GIS analyst with the Washington Department of Fish & Wildlife, and Kathryn Scott, the GIS coordinator for Washington State Parks, recently spent two weeks on Vestmannaeyjar Island in Iceland, where, as volunteers with Earthwatch, they helped collect data and assisted scientists from the Icelandic Orca Project.

UKRAINE

Brian Mladenich, the GIS operations manager for the Cow Creek Band of Umpqua Tribe of Indians in Oregon, wore his Esri best to Nevytsky Castle in Zakarpattia Oblast, Ukraine, while on a trip to visit a friend.

Real-Time Data Speeds Hurricane Rescue Efforts

Q&A with Jeff Dulin, International Association of Fire Chiefs

↑ Jeff Dulin

The International Association of Fire Chiefs (IAFC) represents the leadership of firefighters and emergency responders around the globe. Its members are the world's leading experts in firefighting, emergency medical services, terrorism response, hazardous materials spills, natural disasters, search and rescue, and public safety policy. Jeff Dulin, a retired deputy fire chief from the Charlotte Fire Department in North Carolina, serves as assistant director of the IAFC Research and Data Analysis Center.

To respond rapidly to recent hurricane events, Dulin, his IAFC team, and members from the National Alliance for Public Safety GIS (NAPSG) deployed a solution that used Survey123 for ArcGIS to collect data and Web AppBuilder for ArcGIS to share it with local first responders. Here, Dulin discusses this work.

Q: What prompted you to build this solution?
A: Hurricane Harvey was approaching, and we found out from Florida, North Carolina, and Tennessee that they were sending resources to Houston. We needed to give these teams a data collection tool that would record what they were doing in the field and push that data in real time to decision-makers. Since the rescue workers were unfamiliar with the Houston area, we needed an application that could geolocate their work.

Q: How did you develop it?
A: We started with prehurricane deployment on a Friday night and used Survey123 for ArcGIS to build the survey over the weekend. With the Web AppBuilder for ArcGIS dashboard template, we built a dashboard that could take the data we collected and show the number of rescues, contacts, impacts, and hazards. We got help from Esri's Disaster Response Program to pull everything together on Monday and Tuesday.

Q: What data did rescue workers need to collect?
A: The survey we built recorded the location of people in distress, who they were, when and how they were rescued, their condition, and where they were taken. It also recorded impacts to infrastructure at that location and any hazards. It's basically all the information you may need in an incident report, including photographs to show the extent of the situation.

Q: How was the solution deployed?
A: Rescue workers were using the app on smartphones from rescue boats and helicopters. They would search an area of impact, locate a victim or hazard, and collect and record data. In the pouring rain, it's much easier to work with a device rather than a paper form. During Hurricane Harvey, we had 20 teams, and during Hurricane Irma, we had 40 teams.

Q: What was the benefit of making this information available right away?
A: We were able to immediately upload information and photos to incident commanders, team leaders, and emergency operations centers. Normally, it would take 12 hours to get this information, as incident commanders would have to wait until the end of the rescue workers' shifts to see their reports. If the incident commanders can see the information right away, they can manage resources more efficiently. The feedback we got was that it lightened the load of people trying to track and document what was happening, when, and where. They didn't have to worry about going back later to track, which meant decision-makers had the real-time information they needed to make decisions.

Q: How did the geolocation capabilities of ArcGIS help?
A: We had real-time geoverification, and that gave everyone a geospatial awareness of resources. They could look at the situation on a map instead of on sheets of paper with data that may not be authoritative or accurate. Geolocation gave us that accuracy so we could properly locate each bit of reported data. By using the automatic geolocation of Survey123, everyone on the downstream side of the data could agree about where things were happening.

Q: How did you share the collected data?
A: We used the web app we built with the Web AppBuilder for ArcGIS dashboard template. The survey information collected with Survey123 fed data to the web app, which we called the Commander's Viewer. This gave us the flexibility to show layers of information. Task force leaders had a view of their individual task forces. High-level people could access a survey snapshot with graphs to break down levels of impact assessment. We had a relocation survey for hospital patients, showing methods of transport and how many people were still waiting for transport.

Q: Aside from disaster response, what are you working on at IAFC?
A: We are trying to create a National Public Safety GIS Viewer. We're a nation of 35,000 fire departments, and we do things 35,000 different ways. We are trying to come up with some national standards so we have consistency in response and decision-making. We want better real-time data and better service for citizens. We want to assist fire chiefs to ensure they have all the information they need to send the right resources to the right job and provide the fastest, safest, most appropriate response. We have been talking about building national standards on data collection for emergency services. The IAFC and NAPSG have been setting the stage to develop these standards. We have stood up an account with 1,000 named users to share with fire departments to collect data in the field and add it to national maps. We want to build national data layers, such as hydrants, target hazards, and infrastructure in the United States, that would be available during mutual aid events. We are currently using Survey123 to collect information on fire departments, fire stations, and fire resources to make a data layer for our new National Mutual Aid System. Mutual aid is how we move resources from one jurisdiction to another to help with an emergency situation.

← Using Web AppBuilder for ArcGIS, Dulin and his team built a dashboard that took the collected data and showed the number of rescues, contacts, impacts, and hazards.

The Eye After the Hurricane

continued from cover

affected areas, and in Esri to make available that critical data in a platform that can be broadly and easily accessed."

To get a clear picture of what was happening on the ground without having to be physically present in every disaster zone, the coalition collected 3-inch and 6-inch resolution top-down nadir imagery, as well as 45-degree oblique aerial views from four cardinal directions at 3-inch resolution. It focused its oblique imagery collection on concentrated areas that were directly in the path of each hurricane, as well as on locations that sustained considerable structural damage from winds. For larger areas where massive flooding occurred, the coalition used ultralarge-footprint UltraCam models to rapidly capture 6-inch nadir imagery. In addition to these aerial views, NICB equipped a vehicle with Vexcel's Mustang mobile mapping sensor system to capture streetside photography.

With this rich collection of imagery from multiple vantage points, rescue and recovery workers gained a clear view of which buildings had been destroyed, what streets were obstructed by fallen trees and electrical wires, and where the flooding made roads impassable—making it easier for them to get started with their work.

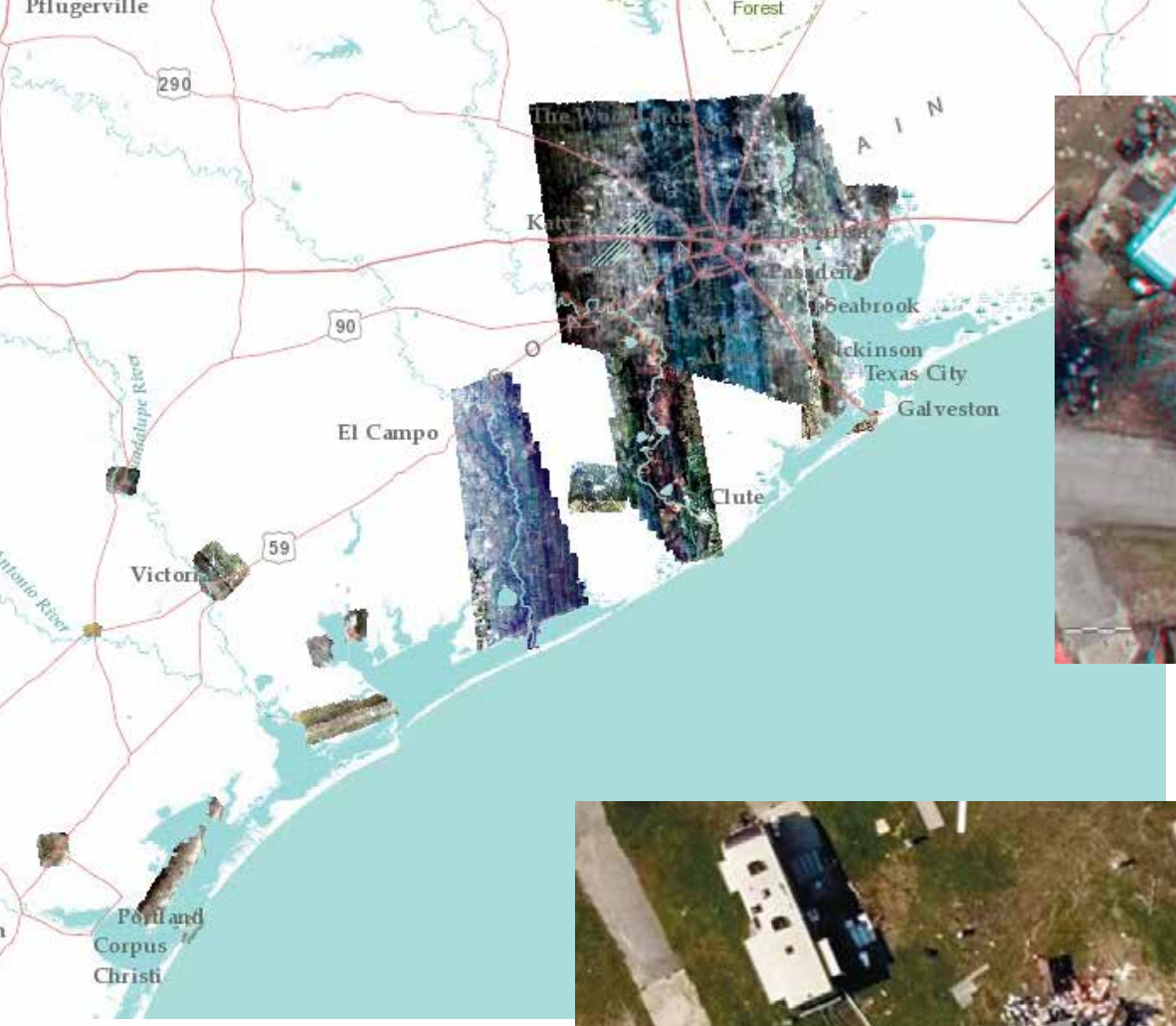
A Race Against Time

Aerial imagery collected in the hours and days that followed Hurricanes Harvey, Irma, and Maria provided the most precise and up-to-date depiction of features and conditions on the ground. It served as a crucial tool in determining how badly wind and flooding had affected coastal communities, major ports, waterways, coastlines, and infrastructure.

"Imagery is integral to disaster response and recovery, as it enables people to accurately determine how a location looked before the event and how it has been affected by the event," said Lawrie Jordan, Esri's director of imagery and remote sensing. "ArcGIS is a comprehensive platform for integrating all forms of imagery into GIS, and it plays a critical role in making such imagery accessible as quickly as possible."

After a storm, it is a race against time to acquire, process, and make hurricane event imagery available to end users. For this series of hurricanes, the coalition collected about 100 terabytes of source data. In traditional mapping workflows, it could take weeks or months to process this data and create a set of orthophoto mosaics to serve as basemaps in various apps. Yet in these cases, as soon as a processing facility received the raw data, Vexcel software transformed it into the individual camera image (the standard output file type for Vexcel Imaging) and directly uploaded it to cloud storage. Simultaneously, Vexcel acquired data from global positioning systems (GPS) and inertia measurement units (IMUs) and processed it to provide georeferencing information about the camera locations.

Additionally, Esri installed ArcGIS Image Server on a set of Amazon Web Services Elastic



↑ A coalition of leading geospatial firms, led by Vexcel Imaging, acquired and published high-resolution imagery for nearly 24,000 square miles across Texas, Florida, Puerto Rico, and the US Virgin Islands. (Imagery courtesy of Vexcel Imaging.)

↑ With stereo orthoimagery, which is viewed with 3D glasses, users got a better idea of where the storm knocked down trees or winds ripped the roofs off houses. (Imagery courtesy of Vexcel Imaging.)

↑ The coalition collected nadir imagery to provide rescue and recovery workers with a bird's-eye view of damage from Hurricane Harvey. (Imagery courtesy of Vexcel Imaging.)

Compute Cloud instances and configured it to provide the coalition with dynamic image services of all the available imagery. Vexcel and Esri staff used ArcGIS to perform on-the-fly orthorectification based on the best collected orientation data and digital terrain models from the US Geological Survey. The dynamic image services were then added to ArcGIS Online as items, which enabled credentialed users to have automatic access to them in their apps and viewers.

NICB also built a web app using Web AppBuilder for ArcGIS that allowed the public to enter an address or point of interest, immediately see imagery from before and after the hurricane, and take measurements—of fallen trees, the extent of flooding, and more—from both nadir and oblique imagery. In addition, the web app permitted first responders, insurance agents, the public, and employees from the Red Cross and the Federal Emergency Management Agency (FEMA) to add layers of public or private data, such as insurance policy information, on top of the imagery. This enabled them to see instantly which properties were damaged and which ones were okay.

Thus, with no time to waste, hurricane response and recovery teams were able to receive imagery, information, and insight immediately via web services that connected directly to their desktops and mobile devices.

Keeping Imagery Current

In the weeks following the hurricanes, the coalition acquired new aftermath imagery each day and added it to the service. Vexcel and Esri refined the aircraft orientation parameters and updated services with new imagery without having to make any changes to the apps, meaning that users continued to have a seamless experience. As people accessed the imagery, ArcGIS Pro and ArcGIS Image Server performed complex, on-the-fly processing so users could retrieve imagery more quickly and optimize the image display for their location. Unlike the traditional approach, where a user must orthorectify and mosaic all the imagery first, this new process took much less time and did not result in a loss of imagery detail.

In parallel to creating the dynamic image services, processing the imagery in the cloud allowed ArcGIS Pro to create traditional static orthomosaics as tile caches, which were served for public use in ArcGIS Online. For such image processing tasks, ArcGIS was able to immediately deliver the best fit-for-use imagery and then create the georeferenced imagery later.

"A cloud-computing environment using ArcGIS Image Server and ArcGIS Online enabled tremendous scalability in storage and processing power," said Peter Becker, Esri's imagery product manager. "The teams were able to quickly process and deliver a massive amount of imagery and provide quick, easy access to the first views of hurricane destruction."

To further improve image interpretability (the capacity of imagery to depict features such as trees, houses, and roads), Esri provided stereo orthos within the web apps. With the added height perspective, users could see overlapping imagery in stereo, or 3D, and get a better view of where the storm knocked down trees and recreational vehicles or winds ripped the roofs off houses.

A Whole New Level for Catastrophe Response

Furnishing imagery data within a GIS framework is making it easier to retrieve and use vital information for natural disaster rescue and recovery efforts. During Hurricanes Harvey, Irma, and Maria, coalition teams were able to quickly access and interpret imagery by using the Internet, cloud computing technology, and the ArcGIS platform.

NICB made available on its website high-resolution aerial images of the areas affected by each of the three hurricanes. Users can search for an individual location in the address bar to view a before and after comparison.

"GIS and cloud compute technology takes the industry response to a catastrophe to a whole new level," said NICB president and CEO Joe Wehrle. "We have received overwhelmingly positive feedback from emergency personnel, law enforcement, and our insurance company members in Texas. We believe it is also important to share this with those who have been impacted by the hurricanes."

Gaining a Clear View of Reality, Fast

With ArcGIS, Imagery Gets Processed and Served in Minutes, Not Days

When Disaster Strikes

During an emergency, knowing what's needed and how to find it is key to saving lives and protecting property. Being able to see what a place looked like precatastrophe and how it fared after the disaster can help first responders quickly understand what happened and what needs to occur.

In the aftermath of Hurricanes Harvey, Irma, and Maria—which all struck within a month of one another in August and September 2017—remotely sensed imagery provided this understanding. With ArcGIS, first responders were able to quickly manage and interact with substantial amounts of aerial and satellite imagery so they could compose damage assessments, draw up evacuation zones, and get aid where it needed to go.

ArcGIS works with real-time and archived imagery to supply response teams with new levels of intelligence across agencies and among stakeholders so everyone can deal with emergencies as rapidly as possible. Here's how.

Collecting Imagery

Before response teams even put boots on the ground, remotely sensed aerial imagery can provide the most current and accurate depiction of the damage a disaster has inflicted on an area.

Typically, commercial and governmental mapping organizations commission satellites, airplanes, and drones to collect imagery. These space and aircraft platforms record imagery and any associated location and orientation data via onboard cameras and sensors onto digital drives.

While archived imagery collections provide optimal "before" imagery for disasters, satellites, airplanes, and drones—which can be deployed quickly—are ideal for furnishing the "after" imagery. Each has advantages in terms of resolution, the amount of area that can be covered, and how much it costs—in both time and money—to mobilize resources.

Transferring, Developing, and Storing Imagery

The volumes of imagery that get collected can be substantial. Once the imagery is gathered, a data vendor or remote-sensing professional connects the digital drives to computers to process, or develop, the raw data into high-resolution images. He or she then swiftly uploads this to cloud storage. As part of this process, the information about each sensor's location and orientation is developed to establish the relationship between image coordinates and the ground.

The way the imagery is processed depends on how it is collected. Users can employ a vendor-provided system, Drone2Map for ArcGIS, or the orthomapping capabilities of ArcGIS.

Managing and Serving Up Imagery

With ArcGIS, it takes just minutes instead of days to turn collected imagery into a clear view of reality. But how is that possible?

Processing an enormous collection of imagery into one mosaic is typically computationally expensive and time-consuming. Instead, ArcGIS enables the imagery to be processed on the fly. The metadata about the imagery, along with references to the data sources, is loaded into a mosaic dataset and then served as dynamic image services. These yield a virtual view of the world. As users pan or zoom to any location, the server extracts and processes only the required pixels, providing nearly instantaneous access to processed imagery.

With such dynamic services, administrators can refine parameters, such as orientation or terrain models, while still having full access to the raw imagery's information content. In parallel, the imagery data can then be persisted to create a single uniform image suitable for generic viewing.

Accessing Imagery

Users working in desktop, web, or mobile apps can quickly interrogate any part of the imagery, since nearly any app can access image services through either REST-based image services or the Open Geospatial Consortium's (OGC) Web Map Service (WMS) and Web Coverage Service (WCS) interfaces.

ArcGIS also makes it easy to build custom web apps. For example, users can employ Web AppBuilder for ArcGIS to create a viewer that shows both before and after imagery to illustrate the extent and intensity of damage from a disaster. Apps like these can also integrate with an organization's asset records to share locations of interest—such as individual homes, buildings, or crossroads—with other companies and institutions. Additionally, organizations can control who has access to what information via ArcGIS Online and ArcGIS Enterprise.

Interpreting Imagery

To employ imagery for disaster relief and recovery, organizations and their employees benefit from having access to three types of imagery views: nadir, oblique, and stereo.

Nadir, or top-down, imagery captures images from a straight-down (bird's-eye view) perspective. It helps first responders do reconnaissance to get an indication of how badly a disaster has affected certain areas.

Oblique images are collected at an approximate 45-degree angle by low-flying aircraft. This type of imagery puts viewers closer to the ground in a more natural viewing environment, where they can get a better sense of how bad the damage is by discerning fallen trees, blown-away roofs, flipped vehicles, and more.

Stereo imagery, which is intended to give viewers an immersive 3D visual impression, offers added depth and realism to what is happening on the ground. Volumetric measurements place users nearly at street level, so they get even better image interpretation and can attain a more thorough understanding of the path of destruction.

When new imagery is paired with imagery from before the event, users can compare what a place looked like predisaster to what it looks like postcatastrophe. Esri's *World Imagery* basemap, which is updated frequently, offers sound historical imagery, with one-meter or better satellite and aerial imagery for many parts of the world and lower-resolution satellite imagery for the entire globe.

Crowdsourcing Imagery

Crowdsourcing is another great way to keep imagery updated and maintain communication with the public.

Following Hurricane Harvey, for example, the National Alliance for Public Safety GIS (NAPSG) used Story Map Crowdsource to build an app that displayed geotagged photographs from people on the ground in Houston, Texas, and in other affected areas. Anyone—from rescue and relief workers to members of the public—could contribute photos to the story map via platforms such as Facebook and Twitter. This helped emergency managers identify priorities and plan rescues.

Helping Communities Recover

Amid the chaos caused by hurricanes and other natural disasters, remotely sensed satellite and aerial imagery can have a profound impact on communities that are responding to and recovering from these events. When every minute counts, being able to see multiple, detailed views of a situation—without having to first put boots on the ground—can provide decision-makers with a better and more accurate understanding of what they need to do.

For more information about imagery and remote sensing in ArcGIS, visit esri.com/arcgis/imagery-remote-sensing.

ESRI PARTNERS

Advance Real-Time, Digital Workflows

Combining the ArcGIS platform with industry expertise, Esri partners are contriving innovative ideas that solve complex problems. Discover how the following three Esri partners are harnessing location intelligence, real-time data collection, field mobility, and enterprise GIS to restore access to critical utilities and maintain runways and roads.

Expediting Posthurricane Utility Repairs

When Hurricane Irma bombarded Gainesville, Florida, with 12 inches of rain and gusts of wind up to 70 miles per hour in September, Gainesville Regional Utilities (GRU) prioritized restoration efforts by swiftly assigning various storm recovery roles to more than 800 of its employees. As a citizen-owned, multiservice utility, GRU had to ensure that its electric, natural gas, water, wastewater, and telecommunications services got back up and running quickly for its more than 93,000 retail and wholesale customers.

To do this, GRU used MIMS Mobile, part of **TC Technology's** (tctechnology.com) MIMS (mobile information management system) Field solution. Built with ArcGIS Runtime SDK for .NET, MIMS Field incorporates intuitive maps into forms that have to be filled out, helping organizations streamline both scheduled and unscheduled jobs and unify GIS-based data capture with analysis. Thousands of utility staff members across the United States use the solution to support service and work orders; help with system inspections; and make maintenance, compliance, and asset management processes more efficient.

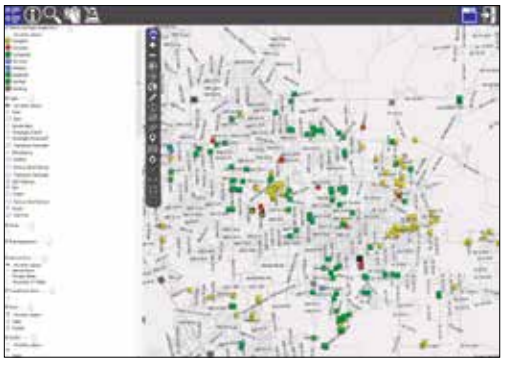
After spending just 30 minutes learning how to use MIMS Mobile, approximately 60 GRU staff members were able to collect and assess information on damages to the electric system, connect directly to the ArcGIS platform, and broadcast the details in near real time to everyone at GRU using ArcGIS Server, ArcGIS web apps, and Operations Dashboard for ArcGIS.

"From the damage assessments collected with MIMS Mobile, we were able to generate materials requests and determine estimated restoration times based on estimated man-hours," said Darris Friend, a technical system analyst for GRU. "Some of the top favorites with MIMS Mobile *[are]* the performance of the application—including the speed at which maps redraw—fast searches, and the capability of attaching photos to a damage assessment."

Additionally, MIMS Mobile allowed GRU to be flexible in the field. Based on feedback from end users, the utility was able to employ the MIMS Configuration tool to make configuration adjustments within minutes. From that, GRU used MIMS Sync to synchronize the configuration changes out in the field in near real time.

Thanks to this workflow, GRU restored service to 86 percent of its customers within 48 hours of the storm. And just a week and a day after Hurricane Irma deluged Gainesville, GRU announced that it had restored service for all its customers.

↑ About 60 Gainesville Regional Utilities (GRU) staff members collected information on damages to the electric system and used Operations Dashboard for ArcGIS to broadcast the details in near real time to everyone at the utility.



← With this workflow, GRU restored service for all its customers in just over a week.

Digitizing Airport Infrastructure Damage Reports

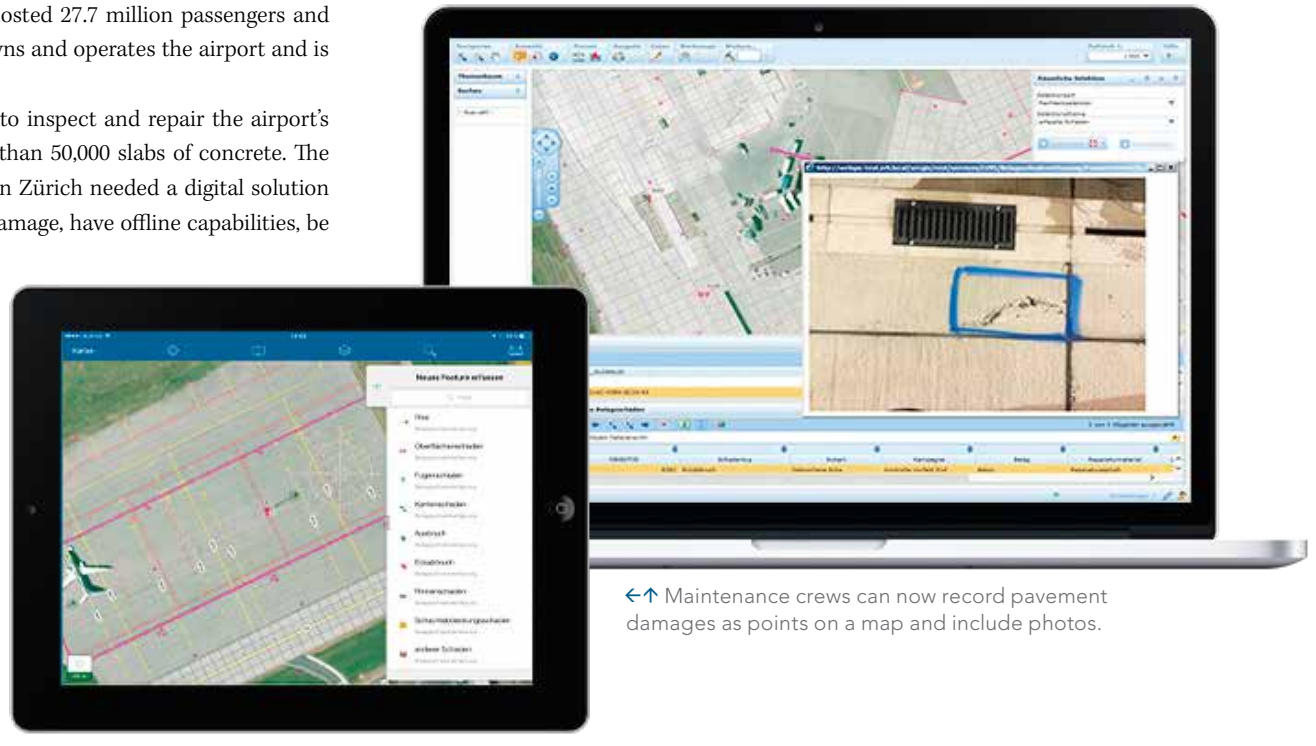
Zürich Airport, the largest international airport in Switzerland, hosted 27.7 million passengers and conducted almost 270,000 flights in 2016. Flughafen Zürich AG owns and operates the airport and is responsible for maintaining runways, taxiways, and service routes.

Until recently, Flughafen Zürich used a paper-based workflow to inspect and repair the airport's 2.5 square kilometers (1 square mile) of road surfaces and more than 50,000 slabs of concrete. The process was inefficient and often yielded outdated data. Flughafen Zürich needed a digital solution that would provide accurate locations of runway and pavement damage, have offline capabilities, be user-friendly, and record data quickly.

The company reached out to **Geocom Informatik** (geocom.ch/en), which implemented GEONIS—a comprehensive framework for integrating GIS into existing corporate systems—along with ArcGIS Enterprise. Additionally, Geocom incorporated several mobile capabilities of the ArcGIS platform, including Collector for ArcGIS, which the maintenance division uses out in the field with Trimble R1 Global Navigation Satellite System (GNSS) receivers for its iPads.

Now, maintenance crews use their iPads to record pavement damages as points on a map and can include photos with their reports. This field data automatically synchronizes with the rest of the airport's asset infrastructure data (such as utilities, roads, and signs) in ArcGIS Enterprise. Using WebOffice, an ArcGIS platform-based web app from SynerGIS (Esri's official distributor in Austria), Flughafen Zürich can quickly prepare the damage reports and evaluations used to authorize construction contracts for renovation.

With this new, completely digital workflow, Flughafen Zürich can make its near-constant repairs to runways, taxiways, and service roads much faster. Considering that every project has to be done ASAP—sometimes even in the 30-minute gaps between takeoffs—the company is saving time and money while continuing to guarantee safe flight operations.



←↑ Maintenance crews can now record pavement damages as points on a map and include photos.

Keeping Up Road Maintenance, Despite Winter

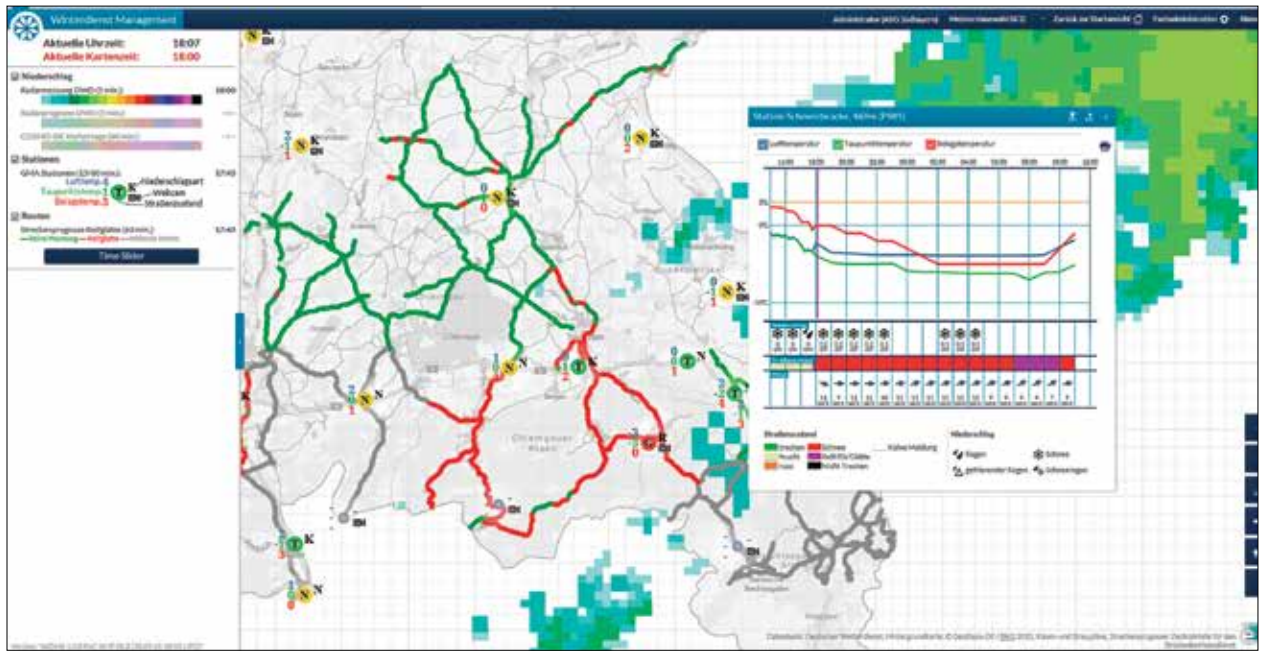
In the German state of Bavaria, extreme weather conditions make it challenging to perform road maintenance during the winter. To address potential hazards, clear roads quickly, and ensure the safety of drivers and maintenance crews, operational planners on the Bavarian Road Administration's motorway and road maintenance teams need to be able to react quickly to icy conditions on the state's network of autobahns.

Working with **con terra** (conterra.de/en), the teams implemented a near real-time solution that could track the 600 public and 700 private service vehicles they regularly deploy to keep traffic moving along Bavaria's 22,000 kilometers (13,670 miles) of road. Built with con terra's map.apps framework—a modular system for creating easy-to-use geoapps—the motorway and road maintenance teams were able to incorporate a range of temporally enabled map services. These include precipitation and forecast data from Germany's weather service; more than 300 street weather stations across Bavaria that record things like ground and air temperature, street conditions, and ice warnings; and real-time data from the service vehicles out in the field.

All these near real-time data inputs now automatically feed into a special alarm and forecast module that warns operations managers which routes are likely to have icy road surfaces within the next 18 hours. This is a massive improvement from the old system, which was only capable of providing two-hour warnings.

Based on ArcGIS API for JavaScript (and enhanced using REST, JSON, JavaScript, and HTML5 extensions, as well as other standard development tools), con terra's map.apps solution gives users access to a range of functions that meet their development needs, including integration with smart devices, which makes it easy to use GIS on a daily basis.

Now, the Bavarian motorway and road maintenance teams can better plan how to deploy both personnel and resources in the winter season. Being able to coordinate maintenance services proactively not only makes wintertime road maintenance more efficient, but it also has environmental advantages, since the teams can use salt more effectively to keep icy roads safe.



↑ The Bavarian motorway and road maintenance teams' map displays weather stations with custom symbology, a chart with weather predictions for specific stations, and routes where dangerous conditions are expected.

Fishing Startup Takes Anglers Straight to the Action

With a Social Networking Mobile App, Fishermen Can Nab That Big Catch in Both Familiar and New Waters

Finding the best fishing hole is now just a few taps away. **Fishidy, Inc.** (fishidy.com), offers a location-based social networking app that keeps tabs on well-stocked waterways and helps anglers avoid unproductive waters by heading right to the action. Used by more than 750,000 people for saltwater, freshwater, and stream fishing throughout the United States, the Fishidy app features interactive mapping technology, accurate fishing maps, and a social network to help anglers of all abilities maximize their fishing potential.

Working with Esri partner GeoDecisions and Fishing Hot Spots (the industry leader in researching and making fishing maps), Fishidy's developers created the app for the Android and iOS platforms. Using basemaps from ArcGIS Online, ArcGIS Runtime SDKs for Android and iOS, and Esri's World Geocoding Service, Fishidy's developers made sure that users could customize their searches and find specific waterways or points of interest within a default radius of their device's current location. The app also provides users with directions to the places of interest they have selected, and the ArcGIS Android Geometry Engine API (which is part of ArcGIS Runtime SDK for Android) sorts the list of places based on their distance and bearing from the device's location.

With this functionality, users can discover and share their local fishing hot spots, stay up-to-date with the latest fishing reports, be better prepared by having detailed information about various waterways (such as large rocks, depth contours, bathymetry, and types of bottom composition) at hand, and track not only where they caught fish but also where they prefer to position their boats along waterways' depth contours.

"One of the challenges of creating our interactive maps is the number of layers and symbols associated with our mapping content," said Fishidy CEO Brian Jensen. "ArcGIS gave us the tools to build a complex map that is easily consumed by our end users."

In addition, users can follow certain waterways (like a Twitter user would follow another account) to connect with other fishermen who are interested in the same lakes, rivers, streams, and coastal saltwater areas. Following various waterways also allows users to easily see local fishing reports from expert fishing guides or avid anglers who frequent the area, contour maps, current weather, moon cycles, and water depths.

In the app's Catches section, users can store photos of the fish they've caught and record the species, where they caught it, and which tackle or bait they used. Fishidy users can also connect directly with other users and view their catches; ask them questions; and get to know their favorite waterways, fish species, and gear.

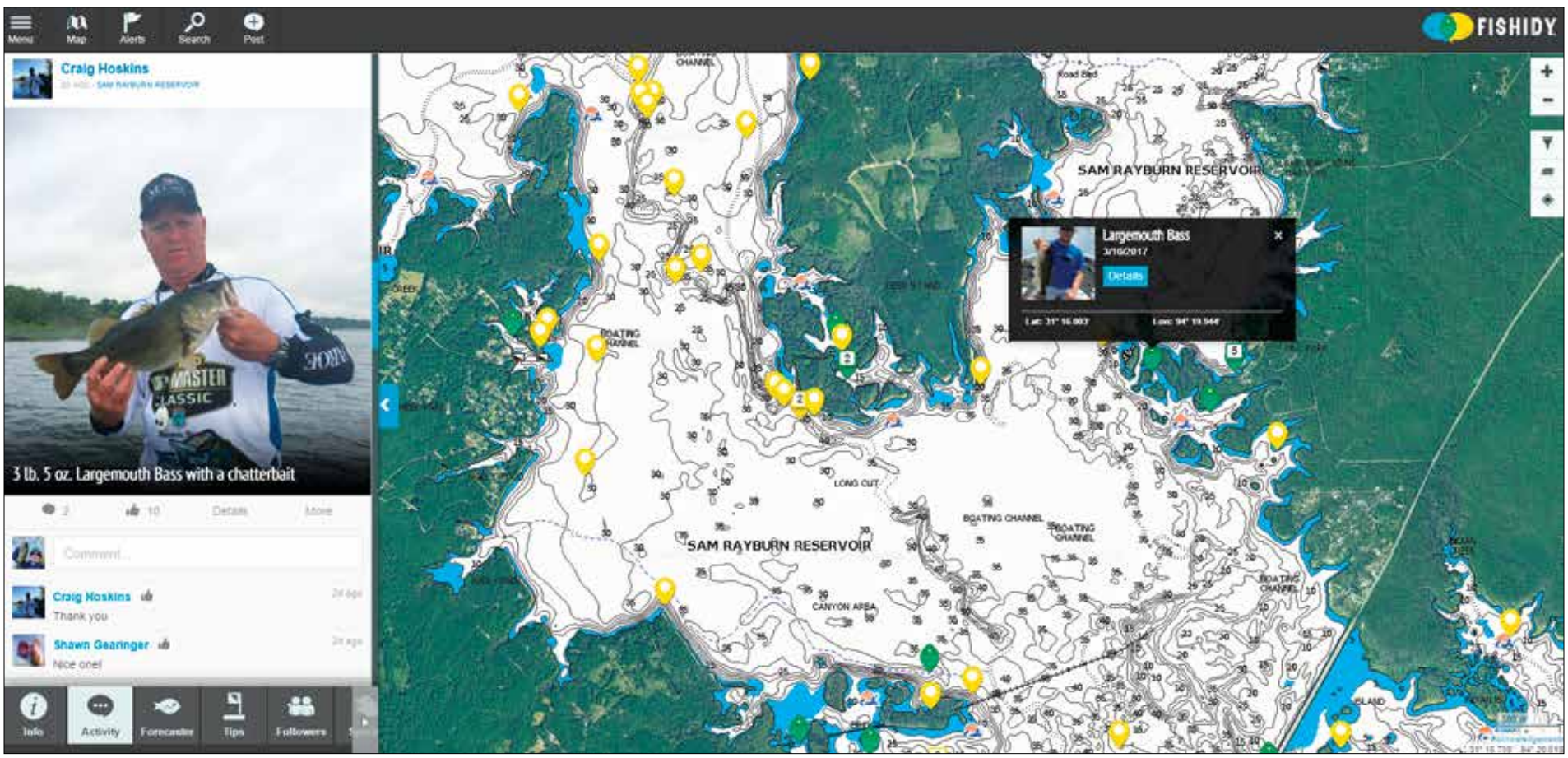
The app can provide all this data in real time or forecast the weather, tides, and potential hot spots up to a year in advance. All this is made possible by ArcGIS Enterprise, which Fishidy employs not only for its data management, storage, and geoprocessing capabilities but also for its ability to identify and query data and create dynamic caches.

Anyone can sign up for a free Fishidy account, though the startup also offers a premium version of the app that provides users with direct access to detailed maps and waterway information from Fishing Hot Spots. This includes hot spots that the company has field verified; digitized drawings that detail shorelines and depth contours; and icons that identify boat landings, marinas, flooded timber, weed beds, and other types of underwater structures that attract certain fish.

By keeping track of fishing conditions for thousands of bodies of water throughout the United States, Fishidy is ensuring that all types of fishing—from conventional fresh- and saltwater angling to fly fishing—are more accessible. Perhaps it can encourage more people to go out and try the sport.

← With Fishidy, users can find and share their local fishing hot spots, stay up-to-date with the latest fishing reports, and track where they catch fish.

The Esri Startup Program gives emerging businesses an edge by helping them integrate spatial functionality into their products and services. Program participants receive ArcGIS platform technology, training, support, and marketing opportunities to help them succeed. To learn more about the Esri Startup Program, visit developers.arcgis.com/en/startups.



↑ The maps on Fishidy—such as this one from the Sam Rayburn Reservoir in East Texas—are dynamic and interactive.

With 3D Maps, Athletes Relive Their Global Adventures

Cycling Trips and Runs Come Alive on Esri's *World Imagery* Basemap

↑ Relive's quite athletic team includes (from left to right) Ralf Nieuwenhuizen, Yousef El-Dardiry, Joris van Kruijssen, Ronald Steen, and Lex Daniels.

A new, free app lets cyclists and runners relive their athletic adventures and show their experiences to friends, relatives, or the public. Built by Relive, a Netherlands-based startup company, the Relive app lets athletes share their rides and runs via virtual 3D video tours on the Esri *World Imagery* basemap.

Combining performance tracking data with digital maps from Esri, Relive makes short 3D animation videos that exhibit about a minute's worth of highlights from a runner or cyclist's trek. The animation includes the route the athlete took (traced in yellow on the basemap), metrics such as terrain elevation and the length and average speed of the ride or run, and pop-ups with photographs taken during the activity.

Relive, which currently has 1.2 million users around the world, creates the 3D video stories of bike rides and runs using GPS data collected from its users' activity tracking apps, such as Strava and Garmin Connect, as well as their personal photographs.

"People love to share *[the videos]* with their family and friends," said Joris van Kruijssen, who cofounded Relive with developers Lex Daniels and Yousef El-Dardiry.

The three friends came up with the idea for the Relive app during a bike trip they took in the Canary Islands in 2016. "We were cycling in Tenerife and figured it would be amazing if there was an app to capture our cycling holiday in a movie," said El-Dardiry, now Relive's technical lead.

Although van Kruijssen, Daniels, and El-Dardiry were using Strava to record performance metrics on their rides, the visual aspect of their adventures was missing. "It didn't fully capture the experience we had—the nice views, discovering the terrain, and the fun we had," van Kruijssen said. "We saw a great opportunity."

Talk soon turned into action. After fleshing out the idea during a barbecue in Tenerife, Daniels and El-Dardiry began writing code, and the app started to take shape later that same day.

Back home in the Netherlands, they built what van Kruijssen called "a good working prototype" within two months and shared it with a few friends. "After a week, a thousand people were using our app," he said.

Today, Relive employs a team of seven people and continues to refine its mobile app, available for download from the App Store or Google Play. The app takes activity-tracking data from apps such as Strava, Garmin Connect, Endomondo, and Polar Flow and maps it on satellite imagery from the *World Imagery* basemap, which Relive obtained from Esri Netherlands. (Users who sign up for Relive accounts give Strava, Garmin Connect, Endomondo, and Polar Flow permission to share their data with the Relive app.)

During the app's development phase, El-Dardiry searched for digital map technology to visualize the adventures. He found Esri's *World Imagery* basemap in the Living Atlas of the World to be a great fit.

"We wanted to give everyone the opportunity to create a beautiful video of their adventures, so it was important to find a high-quality map with global coverage," said El-Dardiry. "Esri's Living Atlas of the World was the best solution. And the involvement of Esri is great. They understand the unique needs and challenges of our startup and are always thinking of how they can help us."

During a recent trip to San Francisco, California, van Kruijssen, an avid bike rider, said he tracked his performance metrics as he cycled across the Golden Gate Bridge to Marin County. Within a half hour after his trip, he had used the Relive app to create a video of the journey to send to his mother in the Netherlands.

"I immediately shared it with my mom to show her what great views I had," he said.

Relive is already a success, with more than 200,000 new videos being made each day around the world, from countries as distant as South Korea and Brazil. The company recently launched a premium service as well called Relive Club, which lets paying members do more with their videos, such as add music.

Maps, however, are a staple in the app. And because Esri's digital maps are scalable, the Relive founders feel confident that their company can continue to grow.

"Every adventure starts with a map," El-Dardiry said. "We want to provide people with the opportunity to relive their adventures, whether they're cycling, hiking, running, skiing, or going on a road trip. It's great to see our idea spread globally…and it's just the beginning of our adventure."

Watch a Relive video of a cycling trip at http://p.ctx.ly/r/5tz6, and make your own virtual tour with Relive at http://p.ctx.ly/r/5tz7.

← Videos display statistics about cycling trips and runs, including the distance covered and how long it took.

Using the Relive app, athletes can share their rides and runs via virtual 3D video tours on the Esri *World Imagery* basemap.

GIS: No Longer the Wild West

By Jeff Griffin, Macon-Bibb County Government

When I started my career in GIS, there weren't many people who considered themselves GIS professionals. In a way, it was the Wild West of GIS: most of us who roamed into this field had to make up our own rules and defend our projects one by one until we could stake a claim on what the technology was able to do.

There wasn't much in the way of strategic or sustainability planning, and there were certainly no succession plans in place in case someone left. Most of the managers in those days were former planners or IT folks, with the occasional degreed geographer thrown in for sport.

I was the IT guy who got recruited when the old GIS manager walked out one day after lunch. I'm serious. I felt like the newcomer in town who gets handed the sheriff's badge with the still-smoking bullet hole in it.

I'd like to say that I knew exactly what I was doing, that I had a plan going in and just executed it. But all too often, that's not how GIS works.

What I can say is that I hit the ground running—and promptly fell flat on my face. One of my first solutions was to replace our 200-page paper tax map atlas with a PDF version that was easier to update and share. I made the maps as big as possible so employees could see what they were doing. While it was a pretty good idea, none of the maps were made to scale; I didn't even know what the term meant.

Once I picked myself up and got back on the horse after that mistake, it took me well over a year to get things pointed in the right direction. I had to get data and files out of people's hard drives and filing cabinets so we could develop a proper workflow management system. Along the way, we learned how to make the work the GIS division did accurate, accessible, and adaptable so that, ultimately, the department was accountable.

On this drive to move my team forward, I learned three golden rules for management that can help anyone get going more quickly in a GIS career than I did.

Solutions Save Time and Treasure—and Sell GIS

These days, everybody is being asked to do more with less. And those who have money to dish out don't usually want to spend their limited budget on GIS.

To get colleagues on board with using GIS, it is important for you to expose—in easy-to-understand, measurable terms (preferably dollars)—what their returns on investment will likely be. Before even scheduling a meeting with your boss or another department, do some homework and have a GIS-based solution ready to go to solve one of their real-world problems. Look at the department's website and find out what its vision is. Explore your boss's social media pages to learn a bit more about his or her perspective. Ask around to find out what struggles their colleagues are facing. Your job as a GIS professional is to find a solution.

And here's the gold nugget: during the meeting, actually show your colleagues how GIS can fix these problems. Have the solution in your hands—ideally on a smartphone or tablet—and demonstrate how GIS technology will save them time and treasure.

If You Can Lasso a Great Employee Once, You Can Do It Again

I had a boss whose number-one criteria for hiring people was, How long will they stay? Well, the answer was always, Way too long if we hired the wrong person for the job.

The very best people are in high demand. More often than not, innovative thinkers and problem solvers are lured away to greener pastures. So when it comes time for them to ride off into the sunset, let them go.

Don't get me wrong, employee retention and treating staff well should both be high priorities. But it's better to have a high performer for one year than an average performer for ten.

The golden rule is to attract the very best staff and take care of them for however long they're with the organization. Capture their innovation, even if it's only for a short time, and encourage their growth. It's a no-lose situation because the organization gains these employees' knowledge, skills, and enthusiasm while everyone learns from each other.

The very best situation, of course, is that the whole team works so well together that the best people want to stay for many years. That should always be the objective. But if your big guns do find themselves needing to wander, wish them well and get ready to lasso that next great employee.

Consultants Require Wrangling, but It Can Work

The GIS industry moves so fast that it's difficult to keep up. Chances are, at some point, your GIS department will need to get some outside assistance—and this help usually comes in the form of consultants.

Like waddies—hired cowboys who wandered from ranch to ranch to help out during busy times—consultants can be saviors or the bane of an organization's existence, sometimes even on the same day. The goal is clearly to make the consultant the former. And the way to strike gold is to be broad in scope, specific in requirements, and the inspector of what is expected.

When a consultant comes in, describe the desired outcome in general terms and let him or her propose some solutions. Then choose the best proposal and work with the consultant to define very specific deliverables that will be easy for both the GIS team and the consultant to adhere to. (Be careful to avoid the urge to expand the scope of the project after everyone has agreed on its parameters. That can easily derail a great working relationship.) During the project, inspect the consultant's work to ensure that it meets your expectations. Finally, only pay the consultant once he or she has delivered the agreed-upon end results.

These experts have a vested interest in making organizations look good. Wrangle them early in the process, and that will be simple for both parties.

Taking On the Frontier, and (Maybe) Leaving It Behind

Adhering to these golden rules can not only jump-start your career in GIS management, but it can also make you one of those highly sought-after innovators and problem solvers. If you're the one who ends up venturing off to mine new claims, make sure to leave your organization with a strategic plan for building and maintaining a sustainable GIS. This should include a well-trained successor to take your place so your organization is not left in the GIS hinterland.

Managing GIS

A column from members of the Urban and Regional Information Systems Association

URISA® Fostering Excellence in GIS

www.URISA.org

About the Author

Jeff Griffin is the GIS manager for Macon-Bibb County Government in Georgia. When he's not making strategic plans and solving problems at the local government level, he can be found hiking, kayaking, and attending home football games at Auburn University. For more information, email him at leadershipgis@gmail.com.

Crossing Borders

A column by Doug Richardson
Executive Director, American Association of Geographers

Find a Job, Then Build a Career

Over the next decade, geography and GIS will move to center stage in society as most large-scale private and governmental organizations adopt mobile, real-time, and interactive geographic technologies and systems as core operations management tools. Consider the following trends:

- According to the Occupational Information Network (O*NET), professions such as geoscientist and geospatial information scientist and technologist are considered to have a Bright Outlook, meaning that they are expected to expand over the next decade.
- Geographers, geoscientists, cartographers, urban and regional planners, and other geographic professionals are expected to see average to much-faster-than-average job growth, with projected needs of at least 10,000–15,000 additional employees in each of these fields through 2026.
- Geospatial technology is considered a high-growth industry. Between 2017 and 2023, the market is expected to grow at an annual rate of 9.6 percent.

Jobs in geography and GIS are booming. And employers are clamoring to find well-trained and educated employees in nearly every sector of the economy.

What Employers Seek

Although written and oral communication skills are valued in all types of workplaces—as are research, finance, and budgeting expertise—geographers and GIS specialists possess a multitude of additional abilities valued by employers across a wide range of careers. Some of these unique skills and perspectives are

- Spatial thinking.
- A sense of how complex interactions are between humans and the environment.
- Competence in GIScience, cartography, and visualization.
- Experience in field research and analysis.
- An interdisciplinary approach to projects.
- Sensitivity to the distinctiveness of place.
- A global frame of mind.

Geographers and GIS specialists are well prepared to meet the rapidly evolving demands of today's industries given their big-picture perspective, eye for detail, and ability to integrate and synthesize information at a variety of scales.

Finding a Job

The American Association of Geographers' (AAG) Jobs in Geography Center website (jobs.aag.org) is an excellent starting point for job seekers. There, they will find openings for geography and GIS positions in a variety of industries spanning the academic, public, private, and nonprofit worlds. Job postings are searchable by sector, location, and topical specialty, and new postings are constantly being added. Other leading industry resources for finding jobs in geospatial technology and GIS include the Esri Careers website (esri.com/careers), GISLounge.com, GISjobs.com, GIS GIG (gisgig.com), and the GIS Jobs Clearinghouse (gjc.org).

Students at all levels will also be interested in AAG's new Student Opportunities Site (SOS), a free resource featuring a wide variety of graduate assistantships, internships, and postdoctoral research positions in geography and related disciplines. Young people interested in geography, GIS, and GIScience will find no shortage of opportunities, as new positions are added regularly. The SOS (accessible at aag.org/studentopportunities) is also a great resource for professional development opportunities for those who are already employed, as there are often postings for professionals looking to advance their careers and education in geography and GIS.

Students and job seekers who are interested in learning more about the job market for geographers should also consider attending the AAG Annual Meeting, which will be held in New Orleans, Louisiana, April 10–14. The Jobs & Careers Center will feature drop-in career mentoring services plus dozens of panel sessions and workshops that provide hands-on opportunities to learn about and apply various ideas and get advice from experts in their fields. Attendees can also go to the center to browse dozens of job postings and student opportunities at their leisure.

Building a Career

The AAG's Jobs & Careers website (aag.org/careers) offers a broad selection of resources for current and aspiring geography and GIS professionals. The website features profiles of professional geographers; pages with salary data and trends that contain information about earnings, projected growth, demand for key skills, and job titles for more than 90 geography-related occupations; and the Ask a Geographer page, which includes contact information for experts from a variety of subfields who will answer questions about geographic issues and topics.

As part of its long-term commitment to enhancing diversity in geography and the GIS field, the AAG will also be working with the Congressional Black Caucus Foundation to recruit high school and community college students from underserved communities to attend the AAG Annual Meeting. This initiative is part of AAG's Emerging Workforce Scholars program, which brought students from underserved areas in Boston to the 2017 AAG Annual Meeting.

We hope that many students and job seekers will take advantage of the sessions, activities, and events happening around the Jobs & Careers Center in New Orleans this spring. Our ultimate goal is that top-notch talent continues to find jobs—and eventually careers—in geography and GIS as these fields become even more central to people's daily lives.

Doug Richardson and Mark Revell from the American Association of Geographers coauthored this column.

Contact Richardson at **drichardson@aag.org**.

Photo courtesy of the Community College of Philadelphia.

Pioneer in Enterprise GIS Education Makes Sure Each Student Succeeds

GIS Hero

↑ Jennifer Swift

Every year at the Esri Developer Summit (DevSummit) in Palm Springs, California, Jennifer Swift can be seen ducking in and out of user presentations, sitting rapt in technical talks, and talking shop with colleagues while walking the halls of the convention center. She often has two or three wide-eyed conference neophytes in tow—her students from the University of Southern California's (USC) Spatial Sciences Institute (SSI). In a conference center full of strangers and people who only see each other once a year, their esprit de corps can be infectious. Yet sometimes, it's the first time these students have ever met Swift or each other.

Swift, an associate professor of spatial sciences (teaching) at SSI, teaches undergraduate students in the residential USC GeoDesign program, as well as Geographic Information Science and Technology (GIST) courses to USC master's students—all online. Her graduate students, who are generally a few years or more out of college and have significant work experience, span the United States. But with a dose of persistence, Swift convinces a handful of them to travel to Palm Springs each year to present their GIS work at DevSummit.

"I encourage them by explaining what the DevSummit is," she said. "It's so cool. It's geek heaven!"

By taking the time to talk her students into going—sending a mass email first, then personally following up with all her best programming students from the previous year—she can usually persuade four to six of them to attend the summit.

"It always amazes the other faculty because we don't pay—the students have to pay for everything," she pointed out.

Even so, over the years, Swift has had 20 students present at DevSummit, 38 demonstrate their work at the Esri User Conference, and many more exhibit at other conferences across the United States.

"Her students are special," said Esri's global education manager Michael Gould, who usually goes out to dinner with the group during DevSummit. "They've chosen, as working adults, to…get a master's in GIS at USC and apply it to their work. They realize that *[attending these conferences]* is a networking opportunity. They know that this is where the action is and where they may get a job and…make some professional contacts."

Swift ensures that they get those opportunities as well, facilitating meetings between her students and Esri staff from around the world and posting photos of the job boards online for them to peruse. She also fosters camaraderie among the normally geographically dispersed students, encouraging them to attend one another's presentations and, once, even participating with them in the summit's much-anticipated closing activity: a curiously competitive dodgeball tournament.

"A couple years ago…we all had evaluated so many sessions that we got to skip the first round," Swift recalled. "So we made it to the second round—and we got creamed!"

Their sporting missteps notwithstanding, Swift is devoted to making sure that all her students flourish.

"Rather than teaching to the top and letting the rest of the students fall off the bottom, she wants every student to succeed," said Karen Kemp, a professor of the practice of spatial sciences at USC's SSI. "She works very, very hard to make sure that her materials are thorough and complete."

"And she's doing it online, which is even more difficult," said Gould.

But Swift, who is currently the program director of the institute's Esri Development Center, seems to be a natural at facilitating distance learning.

"Online students are happy if you just respond…if they don't feel like they're alone out there," she said.

Her ability to give students this kind of attention, despite not being in the same location, may very well stem from how she got her PhD. After completing her undergraduate degree in geochemistry at Bowling Green State University in Ohio, attaining a master's degree in geology from the University of Northern Illinois, and getting some work experience in consulting, Swift jumped at an opportunity to get her PhD in geophysics at one of Turkey's top universities while studying the North Anatolian Fault—without knowing a lick of Turkish beforehand.

"I was young, and I could simply do it," she exclaimed. "My parents had a heart attack, but I'm good at staying in touch."

Jennifer Swift (front right) with some of her USC master's students at the 2016 Esri Developer Summit dodgeball tournament.

She took Turkish language classes on weekends and eventually gained fluency. But all the curriculum at Bogaziçi University was in English. Her research team spoke English, too.

And that's what really drew her to Turkey—the chance to study the fault zone, which is similar in structure and behavior to Southern California's San Andreas Fault system but, by comparison at the time, offered new and unique opportunities for earthquake studies. Whenever there was an earthquake in the area, she and the team from the university's Kandilli Observatory and Earthquake Research Institute would pack all their stuff up and drive, for example, to eastern Turkey, where they would conduct field reconnaissance for weeks, using GIS for some of the work. Other teams would be flown in from all over the world, especially the United States.

"I would start making friends with these people," Swift recalled. "It was unusual for them to see a female American graduate student studying there."

After receiving her PhD and teaching in the observatory at the university for three additional years—spending a total of nine years in Turkey—she used the contacts she met there out in the field to get her first projects when she returned to the United States.

"The path of a career, if you're lucky, follows your heart through your own creativity," said Swift. "And it's just as often based on opportunities. A research opportunity will come up through networking that you never anticipated."

Which is exactly what happened. After tossing up a few employment ideas, she ended up taking a postdoctoral research position at USC.

"The professors who were inviting me were very well-known, and I thought, if I don't do this now, I may not get another chance," she said.

Swift started out doing small research projects in USC's civil engineering department, where she learned and kept up with Esri technology. She ended up also team teaching an online course for the geography department and then switched to it altogether—just as geography at USC was undergoing a major transformation.

The department only had a few full-time faculty at the time, and in lieu of rebuilding it, the university elected to establish SSI in 2010. In 2011, Swift became its founding director of graduate studies.

"The position was based largely on my effort to support *[SSI director]* John Wilson and all the faculty in the initial creation of the institute," she said.

Being extremely well versed in USC's online learning platforms, such as Blackboard, plus Esri technology, Swift wrote a great deal of documentation to make it easier for faculty to teach.

"For example, we started hosting all our Esri software on virtual machines," she said. "I wrote all the documentation for our instructors and students so everyone had the same documentation to work from."

According to both Kemp and Gould, that is where Swift really shines—not only in setting up enterprise systems, though, but in teaching enterprise GIS as well.

"She's been essential in having our enterprise GIS roll out as well as it does and in making sure that it addresses the needs of our students, which is what it's for," said Kemp.

"She's been a pioneer in utilizing cloud computing and virtual machines so that each student has their own environment to experiment with," remarked Gould.

And somehow, Swift has figured out how to teach such a complex subject to students no matter where they're located or how competent they are in coding.

"She believes it's possible to teach this stuff—this really difficult, abstract, technical material—to everybody," added Kemp.

"It's been great. Lots of fun," Swift reflected.

Students Travel the Globe with ArcGIS Earth

Educators Can Bring Geography to Life Right from Their Classrooms

↑ Using ArcGIS Earth, Hollie Duran's students were able to zoom in and explore different regions of the world.

↑ Duran's fifth graders were thrilled to see landmarks in 3D.

From elementary schools through universities, students and educators alike are finding ArcGIS Earth to be a valuable and fun learning resource. Without leaving the classroom, they can zoom to anywhere in the world.

Students can look at different types of map data, sketch drawings or notes, and measure distances in an interactive, globe-based experience. Grade school teachers use ArcGIS Earth to display 2D and 3D map information and help their classes learn about and explore geospatial content and geography. At the university level, professors use ArcGIS Earth to introduce students to GIS visualization capabilities and spatial analysis. ArcGIS Earth is also a free gateway to the wealth of content in ArcGIS Online—basemaps, high-resolution imagery, and demographic data, plus curated maps and layers in the Living Atlas of the World that cover hundreds of topics.

Geography for Curious Kids

At Victoria Groves Elementary School in Rancho Cucamonga, California, Hollie Duran recently introduced her fifth-grade class to ArcGIS Earth.

"The classroom applications for ArcGIS Earth are limitless," said Duran. "It piques their interest in geography in a way that textbooks simply can't. The students were thrilled to see global landmarks, such as the Sphinx and even Disney World, and excited to see 3D representations of mountain ranges and deserts."

One of the key social studies standards for Duran's class is to gain an understanding of US states and major landform regions. Using ArcGIS Earth, her students were able to zoom in and explore each state and region, rather than simply reading about them or pointing to them on a printed map. Students also learned how to search and add information from the Living Atlas of the World to ArcGIS Earth.

"We used ArcGIS Earth to travel around the world and had some fun with virtual reality," said Sebrina Pustam, a student at Victoria Groves. "We learned that geography is also a science and great for kids like us who are curious and want to learn more about the world we live in. We can use ArcGIS Earth at home and in our class for our research and projects."

Teaching Students from All Majors

Joseph Hupy, an associate professor in the Geography and Anthropology Department at the University of Wisconsin in Eau Claire also uses ArcGIS Earth in his classrooms.

"I like to tie ArcGIS Earth into applied examples in the business world," said Hupy, who shows students how to use ArcGIS for drone mission planning. "What I like about ArcGIS Earth is that you can bring in tiled orthomosaics, KMLs such as a mission plan, and you can change your basemaps."

As an example, Hupy introduced his students to a recent drone mission in Honduras that aimed to capture high-resolution imagery of a production gold mine. Geologists needed the aerial imagery to determine the best places to expand the mine. Drones made an ideal solution for working in rugged terrain to help the team create a digital surface model and digital elevation model.

"This project allowed students to see the true capabilities of GIS to engage in proper mission planning," Hupy said. "I have students coming from all majors, not just geography, so I like using ArcGIS Earth because it's not intimidating. It's a way for students to view a lot of content and types of geospatial data."

Working with ArcGIS Earth helps university students learn the fundamental concepts of map navigation and interaction, which enables them to move toward higher-level geospatial techniques such as setting up buffers or queries in ArcGIS Online, creating story maps, or editing and managing GIS content with ArcGIS Pro.

In recent releases, ArcGIS Earth gained the ability to create and exchange data using KML files. Students can now share KML files as email attachments with anyone, even those without access to ArcGIS technology. Sharing data and map images is a critical element of capturing research, saving work, and communicating with peers and professors.

"Perusing the students' assignments, I can tell they like ArcGIS Earth for the hands-on component and interaction with the data," Hupy said. "And ArcGIS Earth is free, so they can install it on their laptops."

Accessing Learning Resources

ArcGIS Earth, which works with Windows 7 and above, is available to download for free at http://p.ctx.ly/r/5trk. Additionally, Esri provides instructional activities similar to what Duran and Hupy have put together. For K–12 instruction, every public, private, home school, and youth-serving club can request an ArcGIS for Schools Bundle for free at http://p.ctx.ly/r/5trl. And students and teachers of higher education can access more advanced ArcGIS learning resources at http://p.ctx.ly/r/5trp.

Turning Pro

Esri Partner in Russia Migrates ArcMap Extension to ArcGIS Pro

Based in Novosibirsk, Russia, Esri partner Data East, LLC, provides software and professional services to help its clients create innovative GIS and spatial database management solutions. Specializing in GIS implementation and customization, digital spatial data creation, development, and processing services, Data East has more than 10,000 software customers and approximately 20 partners around the world.

One of the products that Data East develops is XTools Pro, which has more than 80 features to extend the capabilities of ArcGIS Desktop. More and more, Data East's clients began asking when the company planned to migrate XTools Pro from ArcMap to ArcGIS Pro, Esri's multithreaded, 64-bit desktop GIS app. About two years ago, Data East set out to do just that.

"We decided that we were all ready to finally do this," said Eugene Moiseev, chief technology officer at Data East.

Because the company had an in-depth background with code migration services, plus necessary experience with ArcObjects development, the team was well-equipped to make XTools Pro work with ArcGIS Pro.

The Migration

To migrate its XTools Pro solution tools to ArcGIS Pro, Data East used ArcGIS Pro SDK for the Microsoft .NET Framework. For users like Data East that have built custom apps for ArcMap, they can now build those same apps in ArcGIS Pro using ArcGIS Pro SDK for .NET. It works in the Microsoft Visual Studio development environment with the .NET Framework, allowing developers to create custom tools and workflows that extend the functionality of ArcGIS Pro with add-ins.

As the Data East development team worked on the migration, it found that ArcGIS Pro SDK for .NET offered many advantages over Esri's traditional ArcObjects SDK, which is what the company used before to develop XTools Pro.

"Working with ArcGIS Pro SDK is much more comfortable, as *[a]* number of…procedures are easier and more intuitive," said Moiseev. "Just to name a few, there are not so many COM interfaces, and there is no need to determine the version for any implemented interface."

Data East's migration of its XTools Pro functionality to ArcGIS Pro was a success. The company's new product, XTools AGP, an ArcGIS Pro add-in, took just nine months to develop. And Data East continues to extend the capabilities of ArcGIS Pro by using ArcGIS Pro SDK for .NET to develop new functionality in XTools AGP.

The Effects

Now that the company is on the other side of its initial development project, it is evident that the multithreaded capabilities in ArcGIS Pro and the asynchronous programming capacity of ArcGIS Pro SDK for .NET were beneficial.

"Generally speaking, the proper use of the asynchronous operations and the 64-bit nature of ArcGIS Pro made many things easier," said Yuri Tkachov, chief software architect at Data East, calling attention to updating geodatabases, editing features, changing symbology, and more. "We are now starting to develop our own techniques for using the SDK."

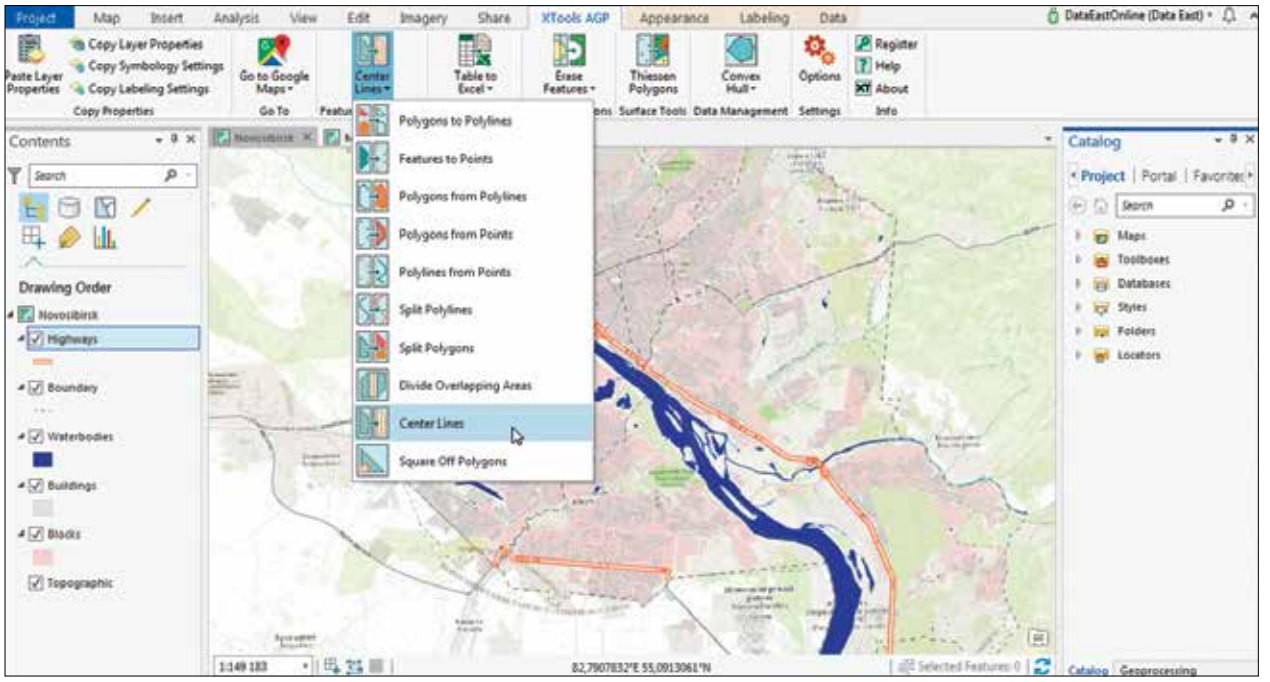
Already, more than 2,500 current XTools Pro users have downloaded, installed, and started using the new XTools AGP extension.

"The number of…XTools AGP users increases with every new release of ArcGIS Pro," said Andrei Elobogoev, head of sales at XTools, LLC, the Data East affiliate that distributes XTools Pro and provides maintenance services for it. "Many of our customers know that we successfully migrated part of the XTools Pro tools and features to ArcGIS Pro. They really like the idea that they can keep using their favorite and familiar tools in the new environment. Now they are asking how they can migrate their own products and services to ArcGIS Pro."

After developing the XTools AGP, Data East decided to create a new service migrating customers' ArcObjects SDK code to ArcGIS Pro SDK for .NET.

"Today, migration to ArcGIS Pro seems to be a quite promising service," said Tkachov. "We are experienced enough to handle any issues that may arise during the development."

For more information on how Data East employs ArcGIS Pro SDK for .NET, email Tkachov at ytkachov@dataeast.com.



↑ More than 2,500 current XTools Pro users have already downloaded, installed, and started using the new XTools AGP extension.

Evaluating Tobacco Use on a Tobacco-Free Campus

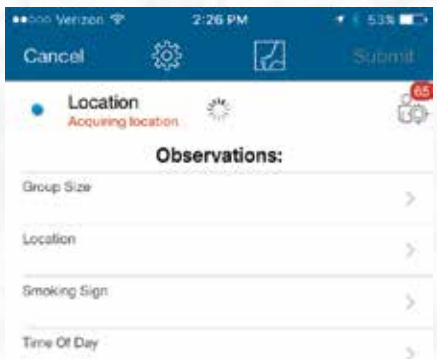
Team at University of South Carolina Uses Collector for ArcGIS to Assess When, Where Smoking Happens

By Dr. Jan M. Eberth, Kevin Remington, Geoff Schwitzgebel, and Jackie Knight, University of South Carolina; and Sarah Powell, University of South Florida

Self-reported smoking rates among college students range from 9 to 25 percent, with rates in the United States highest among universities in the south. Studies show, however, that smoke-free restrictions in public buildings—including schools—have been associated with decreased smoking frequency in adolescents.

In 2009, the American College Health Association released a position statement recommending nine actions that colleges and universities should undertake to address tobacco policy, prevention, and cessation issues on campus, including strongly worded policies prohibiting tobacco use on all college and university property. Following these guidelines, the University of South Carolina (USC) in Columbia, South Carolina, implemented a campus-wide ban on all tobacco products, including e-cigarettes, in January 2014. The university announced its policy through the USC Healthy Carolina tobacco-free website; added references to the policy in student handbooks; and put up conspicuous signs around campus on buildings, trash cans, and posts along walking paths. The Carolina Community—which consists of students, faculty, staff, and volunteers—enforced the tobacco-free policy rather than university police or security.

Despite all these efforts, there were continued reports of tobacco use on campus. Seeing this as an opportunity to engage students in participatory research, a team of faculty and staff from several departments, together with a number of graduate and undergraduate students, set out to evaluate the presence of tobacco use at USC using GIS. The idea was to have students participate in all phases of the research, including designing the data collection forms they would use in Collector for ArcGIS, gathering the locations of observed smoking violations, and mapping the data in ArcGIS Online.



↑ The team customized Collector for ArcGIS so it could record how many tobacco users were observed, the location's proximity to a no-smoking sign, the time of day, and more.

↑ Student volunteers observed an abundance of cigarette and cigar butts, prompting the study team to develop another customized Collector app to gather data on those.

Customizing Collector, Then Gathering Data

To get the project started, the team first customized Collector to ensure that it recorded the appropriate information. In addition to being able to save the x,y coordinates of where individuals were observed using tobacco products on campus, GIS staff in the Department of Geography modified the app so it contained optional notes to record other variables, including whether there was more than one tobacco user in the area, the location's proximity to a no-smoking sign, the time of day, and any additional comments.

Once the app was ready to use, a group of trained student volunteers spent October 2015 to March 2016 observing and recording tobacco use on USC's main campus. Using a weighted, random number generator (which focused on the center of campus, where there's a greater population density), each volunteer was randomly assigned two locations on campus that they had to monitor for 30-minute to 1-hour blocks of time twice a week for 14 weeks. If they saw anyone smoking cigarettes, cigars, e-cigarettes, pipes, or hookahs, they used their own devices to record the tobacco-use violation in Collector. The app saved and pinned locations to the campus map in ArcGIS Online, where the team could then view and analyze the data.

Accruing and Delivering Valuable Information

At the end of the observation period, student volunteers had completed 54 hours of observation time. They recorded a total of 24 smoking violations—approximately one per 2-hour observation period.

Of the 24 violations, 83 percent were lone smokers (versus smokers congregated in social groups). Tobacco violations took place within sight of signage stating that smoking is prohibited on campus property, as nearly 17 percent of observed tobacco-use violations occurred within view of a no-smoking or tobacco-free campus policy sign. Additionally, approximately 13 percent of observed violators appeared to be external university contractors.

What surprised the team most was the abundance of cigarette and cigar butts found in some areas of campus compared to the relatively small number of smoking violations observed during data collection. This suggests that cleanup efforts are done too infrequently or that violations often occur outside the observation window—at night or on weekends. Based on these sightings, the study team subsequently developed another customized Collector app to gather data on cigarette and cigar butts.

Honing Interventions, and Maybe Creating New Ones

Using Collector and ArcGIS Online, the team at USC obtained the preliminary data it needed on where tobacco-use violations were occurring on campus so the university can hone the smoking interventions it already has in place and perhaps come up with new ones. Furthermore, the students who participated in the project got to use GIS to collect and analyze real-world data, which they used to provide university administration with valuable information about one of its policies.

For more information about using and teaching geospatial data collection for public health research, contact USC assistant professor Dr. Jan Eberth at jmeberth@mailbox.sc.edu.

↑ The University of South Carolina is a tobacco-free campus, though student volunteers recorded 24 tobacco-use violations during its 54 observation hours.

About the Authors

Jan M. Eberth, PhD, is deputy director of the Rural Health Research Center and an assistant professor in the Department of Epidemiology and Biostatistics at USC's Arnold School of Public Health. Kevin Remington is the campus GIS coordinator in USC's Department of Geography. Geoff Schwitzgebel is the GIS manager in USC's Department of Geography. Jackie Knight is the assistant director of Healthy Carolina Initiatives at USC. Sarah Powell is a graduate student in the University of South Florida's Department of Epidemiology and Biostatistics. This project was funded in part by an undergraduate research award that Powell received through USC's Office of Undergraduate Research during her time as a student there.

City of Madison
Revamps Open Data Site

Madison, Wisconsin, recently made its open data site more user-friendly for city residents and staff alike. The refresh of its original site, built in 2012, turns what was a simple data repository into a robust open government resource. The effort was driven in part by Madison's inclusion in Bloomberg Philanthropies' What Works Cities, an initiative that is helping 100 midsize American cities amplify how they use data to refine services, engage residents, and better inform local decision-making.

Through its City of Madison Open Data site, the city puts data into the geographic context of a map, making it easier for everyone to find and interpret information. The site is organized around important issues such as budgets, boundaries, facilities, projects, and plans. Madison's open data portal also serves developers, who can access raw data to build apps for businesses, educational institutions, nonprofit organizations, and citizens.

Madison uses its open data site to share tools for planning and decision-making related to sustainability, city services, and other vital issues. These tools include an option to view Neighborhood Indicators that illustrate the quality of life in various Madison neighborhoods. The site also links to Healthy Dane, a resource that provides health and population data for all of Dane County. Users can view the Active Living Index as well to find out about nearby walking, biking, and transit routes. They can also review the city's budget to understand where funds are being invested, explore a map of planned capital improvement projects, and see how the city is adding resident feedback to its comprehensive plan.

To provide better resources to its citizens, Madison intends to use its open data site as a way to implement data collection and data management throughout the city. City staff will be able to contribute and access real-time data about city services such as public works, parks, and transportation.

For the site revamp, Madison officials decided to move away from the city's previous, costly open data solution and build one using the ArcGIS platform, which was already deployed across the organization. Given that ArcGIS Open Data was included in Madison's existing ArcGIS investment, the city was able to reduce costs. Additionally, the switch in software meant an upgrade from a simple data repository to a more robust open government resource.

"We wanted to see a stronger use of data among city staff and residents," said Sarah Edgerton, web manager for the City of Madison. "We looked at where most of our data was collected, and it was mostly in ArcGIS. We realized that we should use the ArcGIS toolsets that our staff is comfortable with and that they like to use."

Developers and designers working for the City of Madison employed ArcGIS to create apps that help put popular datasets into interactive maps. For example, the city implemented Esri Story Maps to provide a visual context for important city initiatives, such as its 2018 Capital Improvement Plan. The story map is a geospatial depiction of the city's capital budget, which covers one-time expenses, such as infrastructure projects, and lays out construction plans for the next six years. Budget information is grouped into four general categories: facilities, transportation, parks, and utilities. Data within the maps links to the city's project pages, which have additional information such as schedules and renderings. This level of detail helps engage the public in the budget process at an entirely different level.

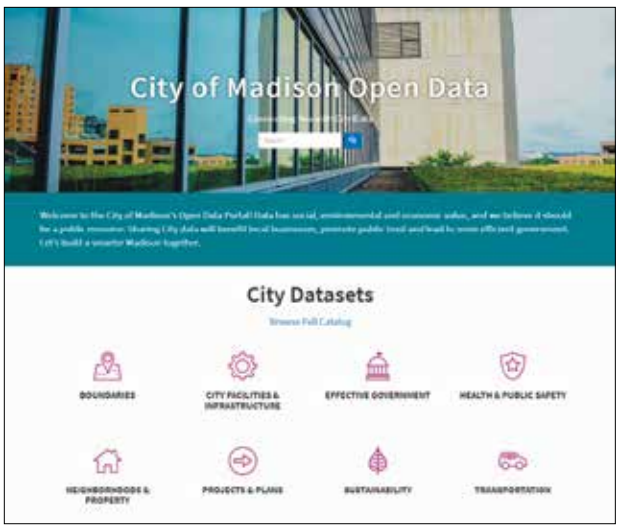
Madison's IT web team and GIS team collaborated with the city's data coordinator for about two months to build the new open data site. Esri provided the guidance, strategy, and tools that city staff needed to do the work in-house. So far, the response from internal and external users has been positive. The city's GIS group is excited about the new project, and developers like the look and feel of the new site. Many users report that the new categories serve as beneficial guides and that they like receiving information in the form of an Esri Story Maps app.

"Our internal customers were already using ArcGIS," Edgerton said. "ArcGIS Open Data has such strong mapping capabilities but still allows us to use tabular data. The clerk's office, for example, just needs to upload Excel spreadsheets with their data, whereas utilities, public works, and transportation departments are really interested in mapping. We also like that we can build applications with ArcGIS."

After working with ArcGIS Open Data and researching various options, Madison is looking into implementing ArcGIS Hub. As a two-way engagement platform, ArcGIS Hub uses open data and communication tools to rally communities around issues and initiatives. ArcGIS Hub helps government agencies, developers, and citizens apply data to make their community a more efficient, livable, sustainable, and smart place to live.

"We are interested in using ArcGIS Hub to engage residents in our data that we are using to build a smarter Madison," said Edgerton.

To learn more about how to take your open data even farther by connecting it directly to community priorities, visit esri.com/hub.



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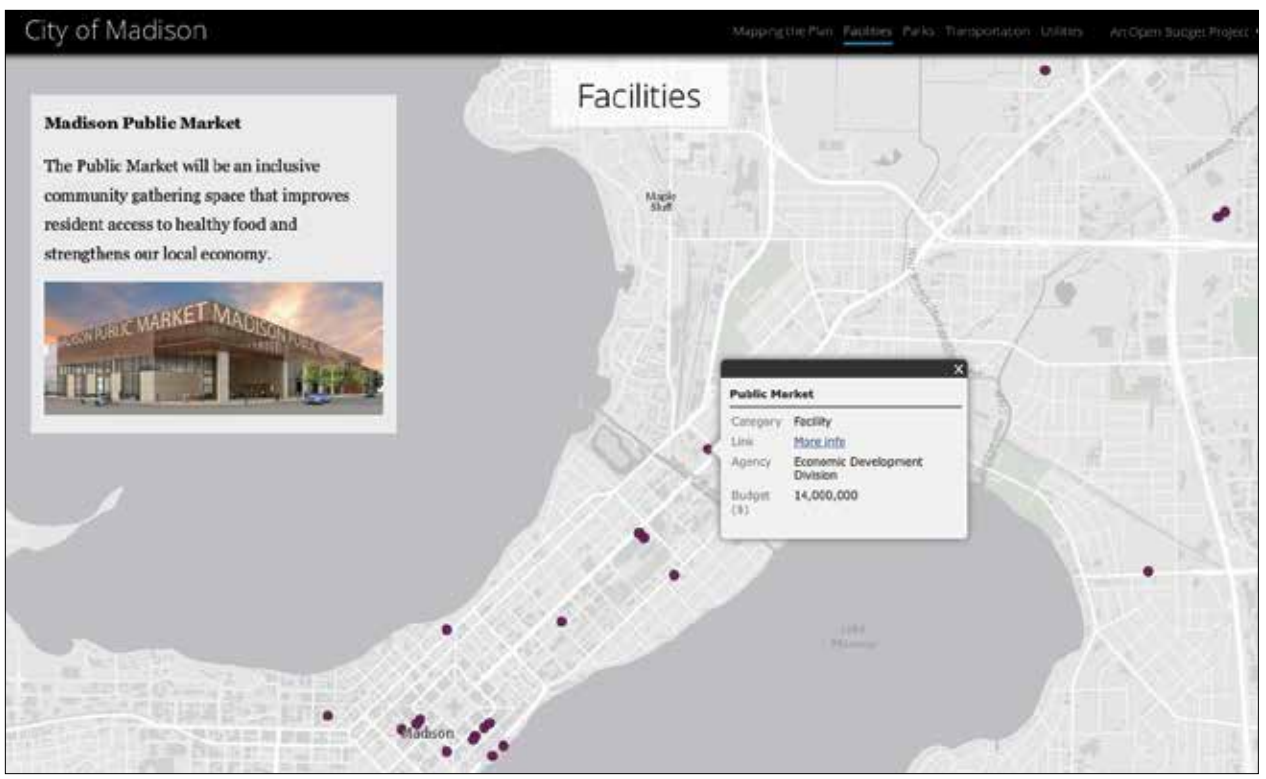
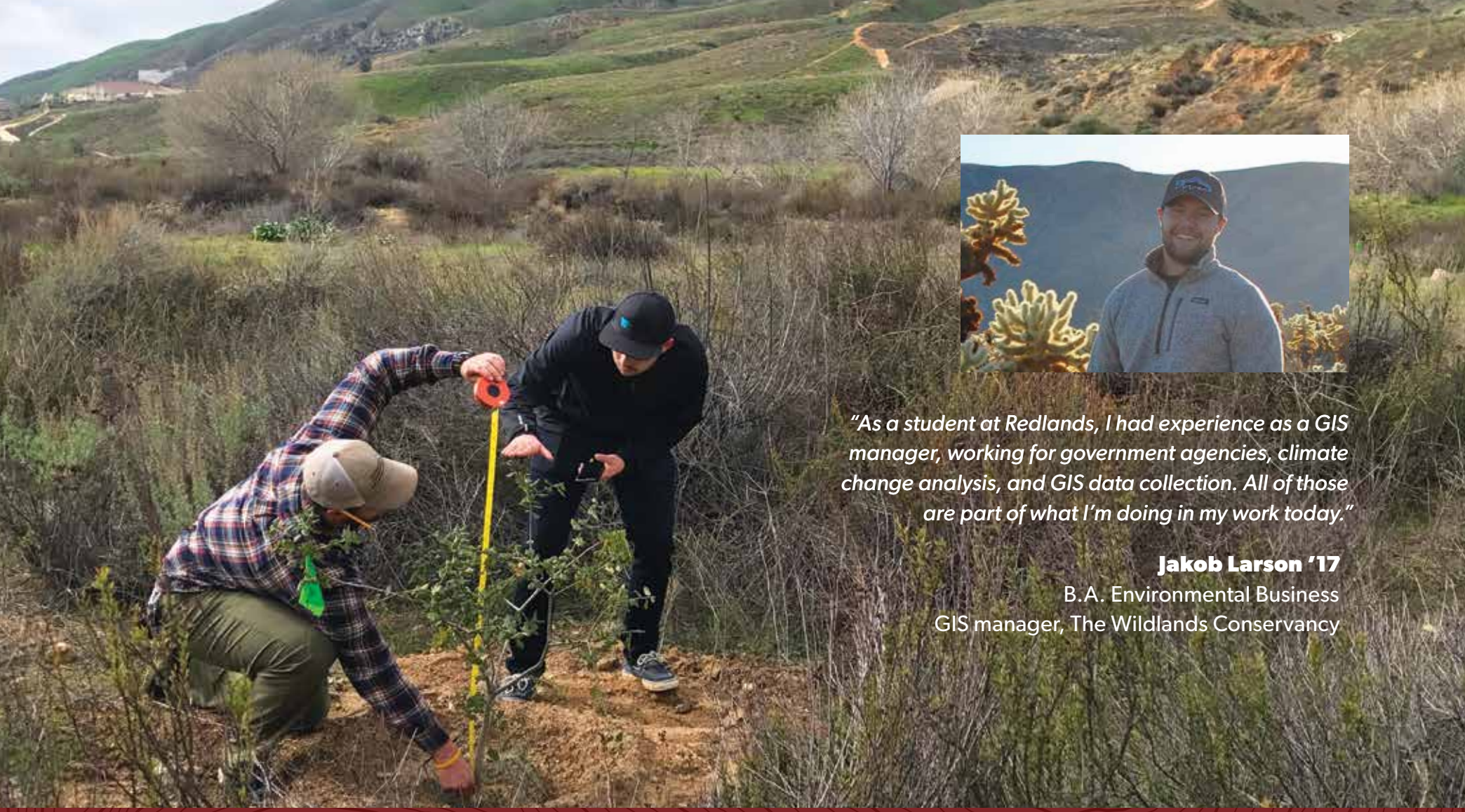
↑ The city used an Esri Story Maps app to provide visual context for its 2018 Capital Improvement Plan.



← The story map is a geospatial depiction of the city's capital budget, which covers infrastructure and community projects and lays out construction plans for the next six years.



"As a student at Redlands, I had experience as a GIS manager, working for government agencies, climate change analysis, and GIS data collection. All of those are part of what I'm doing in my work today."

Jakob Larson '17
B.A. Environmental Business
GIS manager, The Wildlands Conservancy

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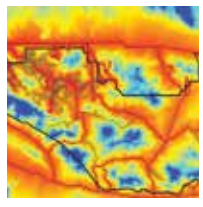

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Battling Buyer's Remorse with a Map

By Jim Phipps and Jerry Corum, City of Chandler, Arizona

This is a common scenario for local governments: Someone buys a home in a neighborhood near (insert one of the following: a landfill, an airport, or a sewer plant), and before long, the homeowner considers the already existing facility to be a blight on his or her new investment.

While residents are ultimately responsible for knowing what exists around them, could cities also provide greater access to such information? In Chandler, Arizona, the answer is yes. But that was not always easy to accomplish.

Thirteen years ago, the proposed expansion of a solid waste transfer station prompted months of spirited community debate (and election fodder, as the issue morphed into a political football). Although the city had held public meetings and the plans had been on the books for more than a decade, nearby residents were alarmed and somewhat surprised by the facility.

As the dialog continued, staff from the city's communications and public affairs department met with colleagues in the information technology (IT) division to develop an online map where the public could find information about city projects and facilities—both existing and proposed. It was an effort to eliminate buyer's remorse for those looking to live in the Chandler community.

Called InfoMap, the first version was very basic. It consisted of a PDF-based map of Chandler with numbers denoting the locations of various facilities. When a user clicked a specific number, a separate PDF document would open that contained a description of the facility or project, along with an aerial photograph of the site. While workable, this PDF-based map did not allow users to select viewable areas, and adding to the map required special efforts from the IT team rather than having revisions be part of regular GIS data collection and maintenance activities.

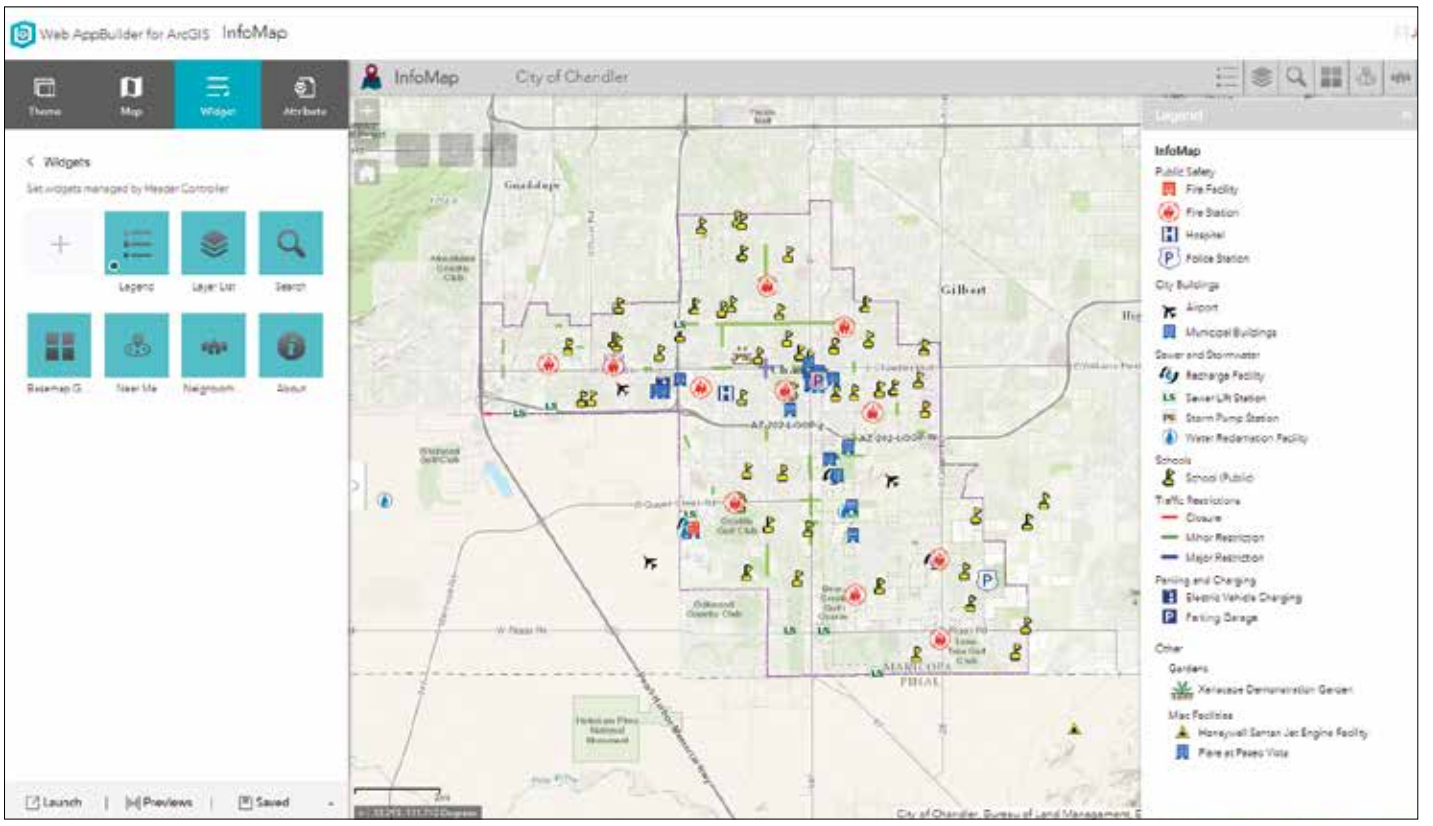
Fast-forward to today, at which point Esri products have transformed InfoMap into an easy-to-use interactive tool that helps residents view information in ways that foster quick understanding. The newest iteration of InfoMap, accessible at chandleraz.gov/infomap, was built with Web AppBuilder for ArcGIS (Developer Edition) and provides a locally hosted solution that the city can both manage in-house and scale when needed.

The City of Chandler's IT department was able to enhance its app development capabilities by motivating division stakeholders from utilities, traffic engineering, development services, and other groups to participate in nearly every discussion about the app's required features. They had to make decisions about what information would be most useful to share with the public without overwhelming users with too many features or too much data.

What the city ended up with is a thorough, yet very clean, mapping app. It has a legend that lists the various facility types that are displayed on the map. Each facility type has a specific icon—an airplane for airports, a water droplet for water reclamation facilities, a plug and an outlet for electric vehicle charging stations, and so on. When a user selects an icon on the map, that activates a pop-up window with the facility's description, address, phone number, and website.

A diverse group of GIS technicians from many of the city's divisions maintains the data using ArcGIS Desktop and a custom web app built using ArcGIS API for JavaScript. Employing spatial views, they have combined several of the feature classes and related tables to allow for more user-friendly and well-formatted pop-up windows. This also enables them to update any pop-ups that link to PDFs or images dynamically when new data is added. Additionally, it was important that neither the app nor the data had any hard-coded URLs so IT staff could easily update a URL if the resource gets moved.

With a basemap selector, users can change the basemap from a topographic map to aerial



↑ The City of Chandler, Arizona, used Web AppBuilder for ArcGIS to develop InfoMap, which displays information about the city's facilities on a digital map.

imagery. And a search tool helps them locate addresses and facilities. Additionally, the Near Me widget, which employs the Esri World Geocoder for ArcGIS, allows users to type in an address and see which facilities are located around it.

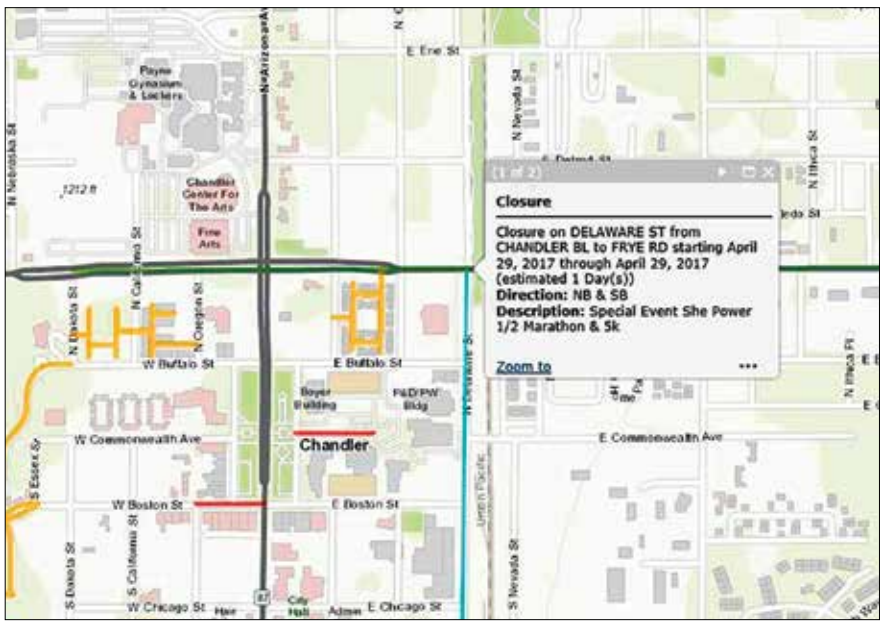
The Neighborhoods widget is especially useful, as it shows the locations of city-registered neighborhoods, of which there are more than 300. Selecting a specific neighborhood opens a pop-up window that displays the number of homes it contains, the date it was established as an official neighborhood, any contact information (for a property management company, for example), and links to neighborhood maps that users can print out. If users can't find their neighborhoods on InfoMap, they can contact the city's Neighborhood Programs Office to get them registered.

To support this widget, the app's developers combined data from many tables into a spatial view. For example, merging the neighborhood contact information table with the neighborhood polygon allows users to view contact information without having to click a related table link.

Traffic information is new to InfoMap. Any road restrictions now appear on the map as red, green, or blue lines, depending on their severity. To keep the data current, developers created a Python add-in that helps those who maintain the data in ArcGIS Desktop access the city's traffic restriction data (which is housed in a custom database) and refresh the traffic restrictions feature class. Now, when users select a specific traffic restriction, an easy-to-read pop-up window opens that describes the restriction and estimates how long it will be in effect.

Also new to InfoMap is the layer that indicates which streets are privately owned and, therefore, not maintained by the city. This data layer appears as users zoom in to the map, and it disappears when they zoom out.

↑ The Neighborhoods layer in InfoMap shows the location of each neighborhood that is registered with the city.



↑ In InfoMap, any road restrictions appear as red, green, or blue lines—depending on how severe they are.

Although not part of the app, InfoMap also links to the city's Planning and Zoning Signs Tool (https://chandleraz.gov/gis/planning). From InfoMap's initial splash page, users can click View Current Zoning Cases, which leads them to the planning division's home page. That's where they can access the tool, which shows the locations of current requests to change land use on specific pieces of property. The proposed land-use changes are highlighted in orange, and approved cases are purple (though those only remain visible for a short time). Users can select a case to see, via a pop-up window, the project's name and case number; the city planner assigned to the case; his or her phone number; and, if scheduled, the dates of any public hearings. Users can also follow a link to the staff memo for each case, which details the city's findings and recommendations for it.

To quote EnvironmentalScience.org, an organization that advocates science education and careers, "whether we understand and appreciate it or not, geography is vitally important in our everyday lives and understanding the geography around us and its importance is essential."

Making information about Chandler's "geography" easily available through InfoMap is a great way for the community to learn more about the city and advances Chandler's commitment to greater transparency. Hopefully, it also helps residents avoid buyer's remorse on one of the biggest purchases they may make in their lives.

About the Authors

Jim Phipps is the public information officer for the City of Chandler, and Jerry Corum is an IT programmer and analyst at the city. For more information, contact Phipps at jim.phipps@chandleraz.gov or 480-782-2224.

Land Survey Searches Made Simple

By Quinn Hazelton, PTFS

↑ Public users of the County of San Diego's browser-based Survey Records System (SRS) can search the county's survey and land records geospatially, via full text, or through a combination of both and then download the documents they need.

Property and land surveys are crucial resources for anyone who plans to purchase or develop property. Surveys, parcel maps, and subdivision maps can all be used to determine the boundaries of a piece of property, which can be critical should a land dispute arise.

Construction and engineering companies that use survey and land records daily understand the financial and legal advantages of obtaining a property survey and doing some historical research before buying land. But since neither of these is required by law, many home buyers and title companies skip this essential step prior to closing on a property deal. One of the main reasons is because it is not easy to access previously recorded surveys and information about property.

But the County of San Diego is changing that. Working with Esri partner PTFS (Progressive Technology Federal System), the Southern California county developed and deployed a new, web-based cloud solution to manage all its survey records and map documents—and make them easier for the general public to find.

The browser-based Survey Records System (SRS), which replaces a slower, antiquated system, integrates ArcGIS Desktop and PTFS's Knowvation GS content management system (CMS). The app allows users to find land documents by searching geospatially, via full text, or through a combination of both. To search something geospatially, users draw a box or polygon around an area of interest on the map. For full-text search, users can have the SRS scour every word of every document—including the metadata—to find the specific surveys they are looking for. A combination of the two search functions allows users to really refine the parameters to quickly and easily track down the documents they need.

While the primary users of the SRS are members of the public who need to identify property lines, the system also contains topographic maps, floodplain maps, maps that detail subdivision road improvements, and many other map documents that can provide internal users at the County of San Diego with useful information about public and private property in the area.

The document side of the SRS is powered by PTFS's geospatial CMS, Knowvation GS. As a browser-based, full-text search and retrieval system for digital libraries and repositories, Knowvation GS allows organizations to more easily manage digital data collections. And when paired with the mapping and layer capabilities of ArcGIS, it makes it easy to find the right surveys for the right parcels of land.

The public can openly search and view the county's land documents for free. But because the County of San Diego charges small fees for procuring property information (mainly to cover administrative costs), downloading watermark-free materials involves a few extra steps. For example, if a home buyer's lender requires a property survey, the prospective property owner would go to the county's SRS, find the survey for the property under consideration, add it to the shopping cart, pay for the download via PayPal, and send it to the lender. This integrated process takes just minutes, and if the correct documents are in the SRS, there is no need for the home buyer to obtain a new survey.

Since having a cloud-hosted solution was a primary goal for the County of San Diego, integrating Knowvation GS with ArcGIS was the most critical step in the development process. To make it possible for users to search the documents by location on the SRS's basemap, developers used ArcGIS Desktop to georeference the existing survey data and converted the original TIFF files into GeoTIFFs. Surveyors for the County of San Diego now import these GeoTIFFs into Knowvation GS, which links the documents to ArcGIS Server and ties the survey records to map coordinates. From there, users can type in an address, a parcel number, or coordinates to search and retrieve documents in the app, using its intuitive graphical user interface (GUI).

In addition to creating such comprehensive search, discovery, and dissemination capabilities, PTFS helped the County of San Diego migrate its entire collection of land and survey records to a secure cloud environment. This makes the SRS more flexible, faster, and easier to use across all browsers.

"Many of our customers have commented about the helpfulness of these seemingly simple improvements over the previous system," said Scott Redlin, a GIS analyst from the County of San Diego who worked on the project. "Since the Survey Records System went live, use of the SRS has so far been successful, with a number of users commenting on how they appreciated the higher speeds and the new Esri GUI features that were not available in the old system."

Building on all the positive feedback, the County of San Diego expects to see expanded use of the app.

About the Author

Quinn Hazelton is a senior account executive at PTFS. For more information about the County of San Diego's new SRS, email him at qhazelton@ptfs.com.

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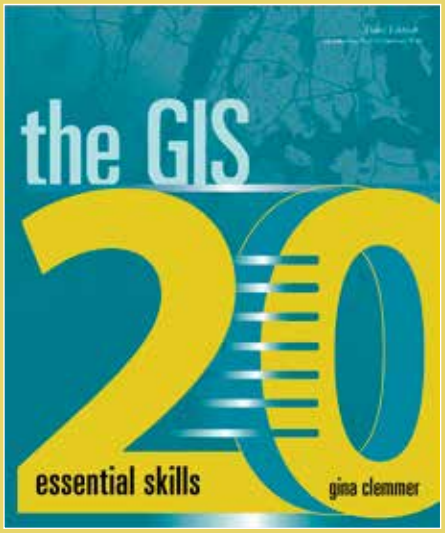
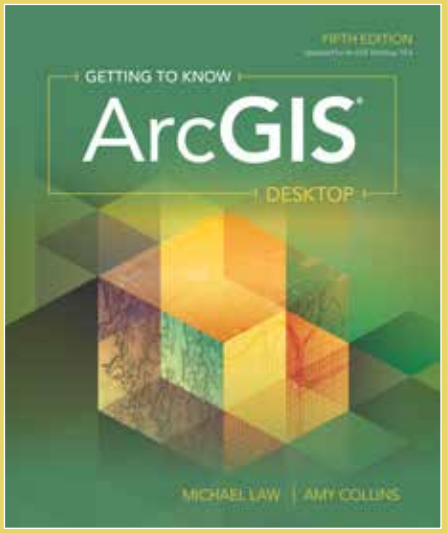
The GIS 20: Essential Skills, Third Edition
By Gina Clemmer

If GIS is your tool rather than your career, how can you quickly begin applying the technology in your work? The third edition of *The GIS 20: Essential Skills*—updated for ArcGIS 10.6, with a new chapter on geocoding—acquaints readers with the top 20 skills they need to successfully use GIS today. With step-by-step instructions, detailed illustrations, and practical tips, *The GIS 20* shows readers how to find and edit data, query GIS maps, create reports, share and publish maps, and more. January 2018, 180 pp. E-book ISBN: 9781589485136 and paperback ISBN: 9781589485129.



Getting to Know ArcGIS Desktop, Fifth Edition
By Michael Law and Amy Collins

Are you becoming your organization's go-to person for ArcGIS Desktop? Start here. *Getting to Know ArcGIS Desktop*, Fifth Edition, offers an extensive introduction to the features and tools of Esri's foundational GIS software. Through hands-on exercises, readers will discover how to use, make, and share maps with meaningful content. They will also learn how to build geodatabases and query and analyze geospatial data. The latest edition of the book has been updated for ArcGIS Desktop 10.6. It is suited for classroom use and independent study and can also be used as a reference. March 2018, 768 pp. E-book ISBN: 9781589485112 and paperback ISBN: 9781589485105.



New Training and Certification Offerings

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  GIS maps and apps—and all the decisions based on them—require accurate data. This course is a deep dive into the geodatabase, the native data storage format for ArcGIS. Attendees will learn how to configure key geodatabase features that ensure their organization's data integrity and accuracy over time and will leave with a thorough understanding of file and enterprise geodatabase capabilities.
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E-Learning Spotlight: Story Maps, Tutorials, and Videos—Oh, My!

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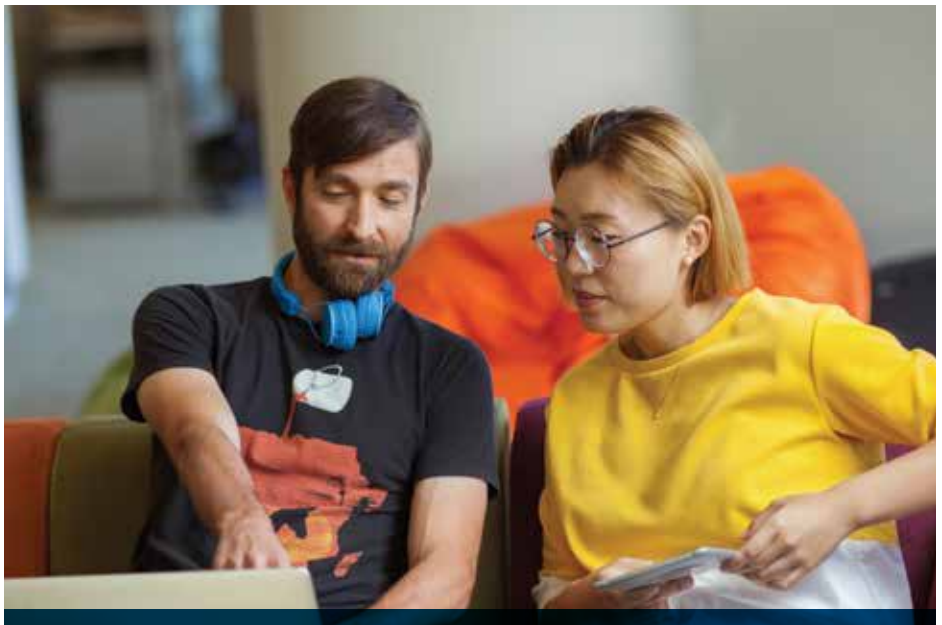

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Platform Configuration Engineer: Work closely with Esri users and partners to identify, design, and certify key GIS workflows for the ArcGIS platform while providing guidance on configuration and best practices.

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