



E-BOOK

Field Data Dominates APWA's Top 5 Trending Technologies: Key Facts & Figures

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Electric Vehicles (EVs)

The What

You have probably encountered your fair share of electric vehicles (EVs), whether it's your neighbor's Nissan Leaf or the sleek, spaceship-like interior of a Tesla.

The first all-electric vehicle was invented in the 1890s, but it wasn't until the early 2010s that consumer models like the Honda Fit, Nissan Leaf, and Chevrolet Bolt became popular and commonplace.

An EV is defined as a vehicle that can be powered by an electric motor that draws electricity from a battery and is capable of being charged from an external source, rather than one reliant on gasoline.

In a construction context, it might refer to the increasing use of job site EVs like mini-excavators, small wheel loaders, dump trucks, electric cranes, and more. As EV usage expands, there is also a growing need to prepare our infrastructure systems for increased consumer use of EVs through aspects like charger station availability and battery production costs.



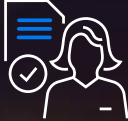
The Who



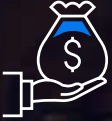
Equipment Operators



Maintenance Technicians



Sustainability Managers



Consumers

The Why

REDUCED EMISSIONS & SUSTAINABILITY

Electric material transport vehicles produce zero greenhouse gas emissions, contributing to cleaner air quality on construction sites and in surrounding areas. Some construction projects face environmental regulations or local policies that restrict or penalize the use of high-emission vehicles, so organizations leverage EVs to meet these requirements.

NOISE POLLUTION CONTROL

The quiet operation of EVs can bring a variety of benefits to the average job site. Reduced noise pollution can be very helpful in urban or residential areas, and can help to generate community buy-in to a project. Additionally, the reduced noise output of EVs may allow for an increased range of working hours since operation will not disturb sleep.

COST SAVINGS & INCENTIVES

Electric vehicles often have lower operational costs than their diesel counterparts, since diesel fuel is generally more expensive than electricity. Maintenance costs can also be lower for EVs due to simpler drivetrains and fewer moving parts. Of course, these savings only hold true in areas where the infrastructure can already support EV usage and not in areas where construction teams need to install their own charging station network. Organizations can also save through tax credits and grant programs that promote EV usage.

The When

TREND OUTLOOK

10-15 years

Expert predictions vary significantly when it comes to widespread adoption of EVs on construction sites. For example, Oslo, Norway, will require all construction sites to be emission-free by 2030. In the United States, EVs are expected to become the largest automotive market by 2035. Popularity is expected to skyrocket when EVs reach price parity with their gas equivalents.



The How

EVs are used on the job site and replace traditional gas-powered machinery, as well as by consumers to travel across our roads and highways at reduced fuel costs.

EV usage, both in construction and day-to-day life, is more common in urban areas for noise reduction and due to the obstacles facing long-distance travel in an EV.

In order for an EV to replace gas-powered machinery, the job site requires a strong utility network, charger station planning, permit coordination, and other challenges. It is rare to find EVs operating on a rural job site or in an area without a strong power grid. Despite these limitations, there are numerous ways that EVs are used in construction to promote sustainability, reduce emissions, and improve operational efficiency.

Use cases include:

- + Material transportation
- + Equipment operation
- + Concrete production and transport
- + Mobile power supply
- + Temporary power infrastructure
- + On-site maintenance and inspection

TYPES OF CONSTRUCTION EVS



Transportation Vans



Utility Carts



Construction Machinery



Concrete Mixers



Battery Packs



Bi-directional Charging Stations

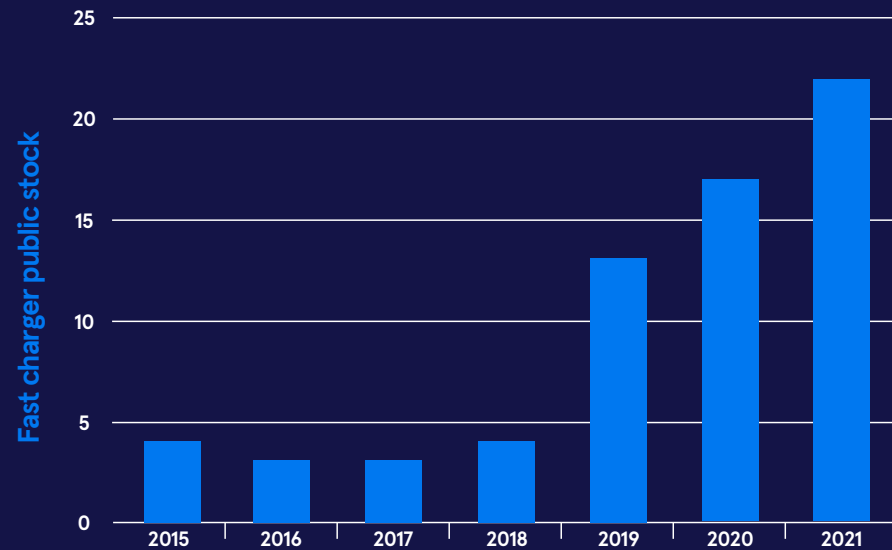
UNDERSTANDING CHARGING STATIONS

There are three levels of EV charging station types that are used by consumers and construction teams alike, aptly called Level 1, Level 2, and Level 3. The differences between these levels are broken down in the table below.

LEVEL	DETAILS
1	120 volts, two to five mph of charging
2	240 volts, 10 to 20 mph of charging
3	Direct Current (DC), 180 to 240 mph of charging

Stats to Know

CHARGER GROWTH



Publicly accessible chargers are on the rise, with an average worldwide growth rate of 40% per year. McKinsey estimates that by 2030, America will require 1.2 million public EV chargers.

ELECTRIC VEHICLE SALES

40%

Annual average growth of
EV sales in the United States

Insights via McKinsey, IEA.org

GROWTH BY USAGE TYPE, 2021



2.8M

Passenger Cars



24K

Light Commercial
Vehicles



3000

Buses



1000

Trucks

“You’re starting to get manufacturers that have a fully electric machine – from battery to drive motors for the tracks, to electric actuators for the boom or the bucket. The maintenance problems that you get with [diesel-powered] machines are burst hoses, something blown in the engine or an injector has dropped into the cylinder... [With all-electric], you have a much, much smaller component count to get the power to where it’s needed.”

CHRIS SLEIGHT
MANAGING DIRECTOR, OFF-HIGHWAY RESEARCH

Federal Funding Opportunities

INFRASTRUCTURE INVESTMENT & JOBS ACT: \$7.5B

The recent Infrastructure Investment & Jobs Act denotes \$7.5 billion for building out a nationwide charging network with the following priorities. The initial focus of this funding is on constructing fast chargers along the interstate highway system, but there is an additional focus on:

- + Upgrading the power grid
- + Deploying electric school buses and ferries
- + Electrifying our ports
- + Creating a domestic supply chain for battery production and recycling

CHARGING AND FUELING INFRASTRUCTURE DISCRETIONARY GRANT PROGRAM: \$2.5B

The Charging and Fueling Infrastructure Discretionary Grant Program (CFI Program) is a specific program created by the Infrastructure Investment & Jobs Act to strategically deploy publicly accessible electric vehicle charging and alternative fueling infrastructure in both rural and urban areas. \$400 million in discretionary funding will be allocated in 2023.

There are two funding categories for these grants:

- + Community Charging and Fueling Grants
- + Alternative Fuel Corridor Grants

ELIGIBILITY REQUIREMENTS

- + States or political subdivision of States
- + Metropolitan planning organizations
- + Unit of local governments
- + Special purpose districts or public authorities with a transportation function, including port authorities
- + Indian tribes
- + U.S. Territories
- + Authorities, agencies, or instrumentalities or entities owned by, one or more entities listed above
- + Group of entities listed above
- + State or local authorities with ownership of publicly accessible transportation facilities (applies to Community Program only)

Drones

The What

What's that up in the sky? A bird or a plane? An air traffic violation? It's not the first two, and while it's sometimes the latter for unlucky operators, that small mechanical craft whizzing around over your head is a drone.

Drones, or unmanned aerial systems (UAS), are aircraft operated without a human pilot onboard. Drones use cameras and LiDar to capture geographical data that can be processed with software.

Unlike some of the other technologies highlighted in this booklet, drones are equally popular with consumers. You may find more experienced drone pilots at your local hobbyist club than on the construction site. Still, drone usage is becoming increasingly prevalent in construction for its numerous benefits to the inspection process.

2

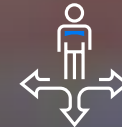
The Who



Inspectors



Surveyors



Planners



Photographers

The How

Drones assist with site analysis, equipment tracking, project progress reports, and site photography.

Site Analysis

Since drones can capture high-quality visual data in a short period of time, drone use is becoming increasingly popular among surveyors for site analysis. Drone operators pilot the small aircraft over vast job sites to capture topographical information and identify hazardous terrain. That information can then be fed into asset management and planning systems.

Equipment Tracking

Certain drones can be programmed to fly in predetermined routes, a mechanic you may have encountered in popular platforming video games. It is equally useful in real-life at deterring potential theft, as drones can act as a digital, airborne surveillance force for expensive equipment. Advanced drones can even be programmed to recognize when an asset is missing from the picture.

Project Progress Reports

Inspectors and project managers can capture much of the same information they would through their typical inspection process at a greatly expedited rate through drone use. Having an “eye in the sky” to quickly capture site conditions, personnel, and even identify potential issues through data processing streamlines the entire inspection process.

Site Photography

Perhaps the most straightforward of drone use cases, these airborne cameras are used to produce stunning aerial photography that is often used to report progress to the public for increased engagement with the project.

TYPES OF DRONES



Fixed-wing drone

Better for mapping and scanning over long distance



Rotary drones

Better for inspection, short-distance, and pre-programmed surveillance

The Why



SAFETY

Drones do for construction teams what the first pair of binoculars did for wildlife explorers: the ability to view the lion from a distance. In this instance, the lion is all the hazards that can come with inspecting a construction site, including unsafe field conditions, hazardous materials, outdated structures, and heavy machinery. Sometimes, an independent drone operator will even conduct a safety audit through OSHA.

Drones allow inspectors to complete their jobs from a distance, avoiding the potential falls that account for 34% of worker fatalities.



ACCURACY

The human eye is fallible, but the drone's eye catches everything. Distances, surfaces, elevations, volumes, key geographic features, and more are captured by drone flyovers. Operators will take multiple passes over a job site to capture data from multiple angles to ensure accuracy. Then, data is processed through drone photogrammetry to produce an accurate map of the job site in either two or three dimensions.

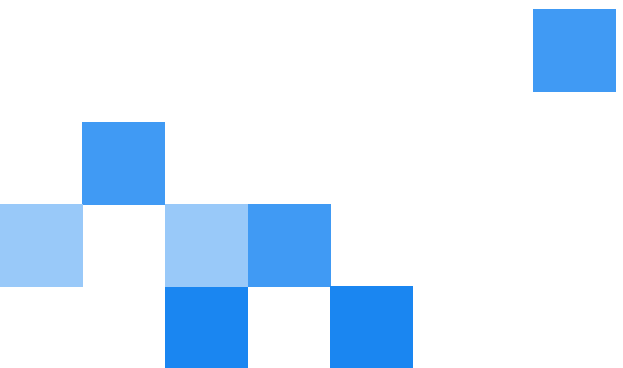
Increased job site data accuracy helps construction teams avoid errors and costly rework.



EFFICIENCY

If you can afford to fly, would you ever drive? That's the mindset of inspectors and surveyors who have access to drone technology, as it allows them to cover an immense amount of ground compared to traditional inspection and surveying methods. Drones lead to extreme efficiency increases for teams that leverage them for construction inspection, project monitoring, and initial site surveys.

The efficiency of drone inspections and surveys allows teams to cover 120 acres per hour, a 60x greater rate than average.



The When



TREND OUTLOOK

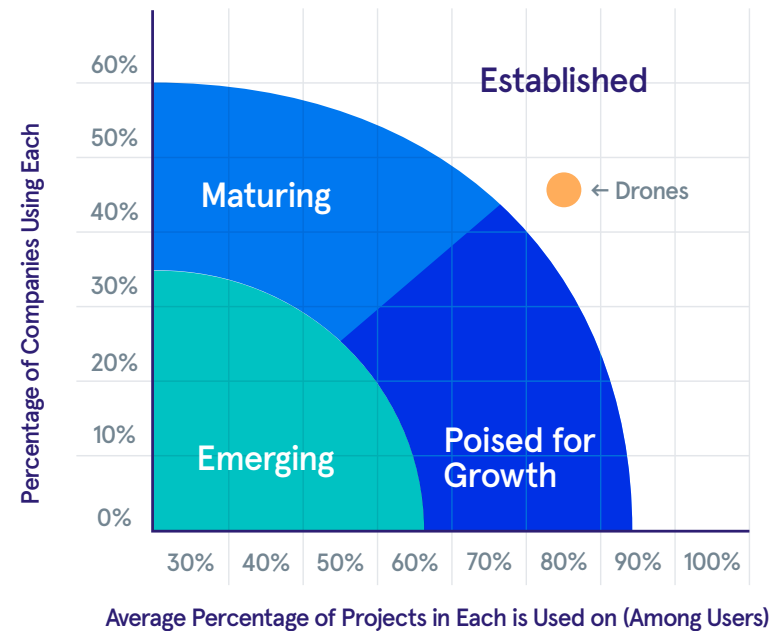
5-10 years

Experts predict we will see drones and the majority of job sites within 5-10 years.

“The next few years are absolutely critical for the United States to meet the exploding demand for drones in government and business. What the COVID pandemic has taught us is that this technology is essential for public safety. Steps have already been taken by the U.S. government to enable the national drone industry and President Biden has previously expressed support for additional investment in essential US technology.”

ROMEO DURSCHER
VICE PRESIDENT, AUTERION

MATURITY MATRIX



Stats to Know

	2022	2021	2020
DRONE USAGE OVER TIME	46%	50%	51%
CONSIDERING USAGE OF DRONES OVER TIME	24%	19%	17%
CURRENT APPLICABLE DRONE PROJECTS OVER TIME	55%	48%	36%

Insights via Dodge Data & Analytics

Federal Funding Opportunities

INFRASTRUCTURE INVESTMENT & JOBS ACT: \$500M

The recent Infrastructure Investment & Jobs Act denotes \$500 million for the Strengthening Mobility and Revolutionizing Transportation (SMART) discretionary grant program, with \$100 million appropriated annually through 2026.

Recent examples of agencies taking advantage of SMART grants include \$430,000 for the California Department of Transportation to use drones for construction site inspection and \$1 million to the North Central Regional Planning Commission in Kansas to develop a prototype GIS-based platform that integrates local infrastructure assets to provide innovative data.

FEDERAL AVIATION ADMINISTRATION BEYOND PROGRAM

The FAA BEYOND program launched in 2020 as a four-year initiative to understand the potential and realized societal, economic and community benefits of drone use and streamline the approval processes for drone integration. Lead participants in the BEYOND program currently include:

- + Choctaw Nation of Oklahoma
- + Kansas Department of Transportation
- + Memphis-Shelby County Airport Authority, Tennessee
- + Mid-Atlantic Aviation Partnership (MAAP), Virginia
- + North Carolina Department of Transportation
- + North Dakota Department of Transportation
- + The City of Reno, Nevada
- + University of Alaska Fairbanks (UAF)

DRONE INFRASTRUCTURE GRANT ACT (DIIG): \$200M

Passed by the House of Representatives and introduced by the Senate in 2022, the Drone Infrastructure Inspection Grant Act establishes programs within the Department of Transportation (DOT) to support the use of drones and other small, unmanned aircraft systems when inspecting, repairing, or constructing road infrastructure, electric grid infrastructure, water infrastructure, or other critical infrastructure. Other details include:

50%

Apportioned for training

50%

Apportioned for equipment

80%

Drone purchases and service contracts covered

Asset Management

The What

We all practice asset management in our daily lives. We keep track of household appliances, plan when to take vehicles for repairs and decide whether or not the driveway needs to be repaved this summer. Everyone has experienced the pain of an unexpected breakdown—whether it left you stranded on the roadside or wading through a flooded kitchen—and vowed that next time they will be more proactive about maintenance.

The stakes are higher when we're talking about bridges or other critical infrastructure, which is why asset management is such an important topic in public works. Using a systematic approach encompassing design, construction and maintenance over the complete asset lifecycle enables agencies to maximize safety, cost-effectiveness and total value of their infrastructure assets.

Asset management has always been a core part of public works, but historically a lack of real-time visibility has meant public works departments were largely limited to standardized maintenance routines and reactively fixing issues after they had already become problems.

The Who



Owners



Designers



Contractors



Consultants



Maintenance Crews



Inspectors

The How

Asset management involves a wide range of tools and activities. The key advances in technology in recent years have centered on the ability to capture and use data.

In the field, technology has enabled inspectors to capture increasingly comprehensive and accurate data. For example, detailed information about conditions during construction helps give a complete picture of the health of a road or bridge. In critical infrastructure, sensors can even provide real-time data to ensure risks are addressed in a proactive manner, before it becomes a costly or dangerous problem.

The Why

Access to better data has enabled stakeholders from maintenance crews to capital budget planners to make better decisions about how to allocate their finite resources and attention. Understanding the true condition and risk associated with an asset ensures that the most important repair and replacement projects are prioritized, funded, planned and completed when needed.

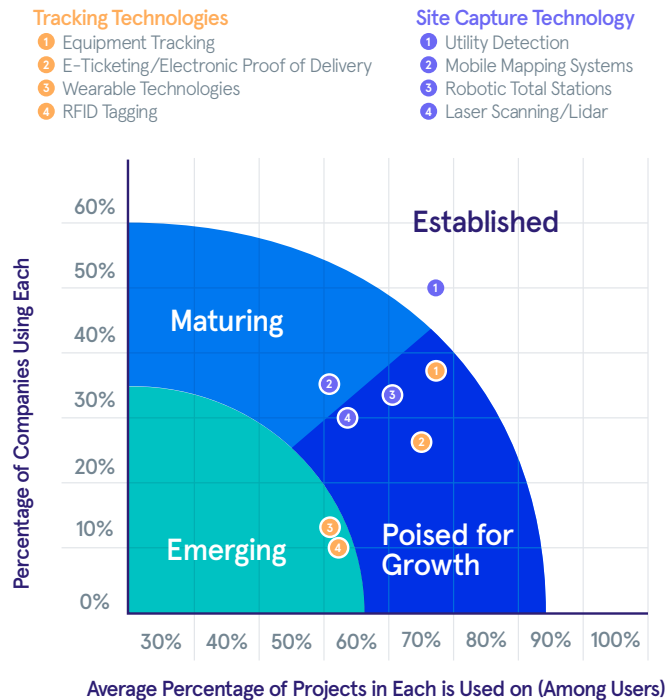
The When

TREND OUTLOOK

Asset management systems incorporate a variety of technologies intended to better capture and represent asset data. For example, **Building Information Modeling (BIM) is already used on 44% of projects in the European market**, as cited by USP's Architectural Barometer report. Digital twins, one of the most sophisticated versions of asset management that involves a complete, digital representation of an asset, are expected to become commonplace by 2035.

MATURITY MATRIX

The maturity matrix below depicts where many of the common technologies related to asset management are in their development.



Stats to Know

Surveys conducted by the Civil Quarterly identified some of the key emerging technologies in use today, including:

Mobile mapping systems	34% using	21% considering
Laser scanning/Lidar	30% using	17% considering
Equipment Tagging	37% using	29% considering
e-Ticketing	26% using	20% considering

TREND OUTLOOK

“There are tremendous opportunities in this industry to leverage digital data to inform decisions during the design, construction, operations and maintenance phases. We are strong advocates for open data standards to more efficiently connect the different business areas, which will make it easier to collaborate and provide digital information that can be used to improve the project delivery process from start to finish.”

ALEXA MITCHELL, BIM PROGRAM MANAGER, HDR

The Transportation Asset Lifecycle

Asset Management is not new to the infrastructure industry. For years, people could refer to the robust 3D renderings generated from BIM software. But at its core, Asset Management is about building a better blueprint with all the information and technology available to us today. Below, you can see all of the aspects of the asset lifecycle that involve crucial data points in each phase.



Infrastructure Funding Opportunities

The Infrastructure Investment and Jobs Act (IIJA) offers a mix of federal formula and competitive grant funding to support technology growth in states. The amount of funds denoted for Asset Management is over \$115 billion in funding, divided among areas like Highway, Aviation, Rail, and more.

Organizations in these areas can leverage IIJA funding to invest in platforms that support asset management efforts, like data collection and predictive maintenance, as well as data management solutions that integrate with intelligent infrastructure.

Geographic Information Systems (GIS)

The What

These days, everyone expects to be able to see things on a map. When you plan a trip, whether it's for work or to meet friends, there is an expectation that you will be able to instantly see the location on a map and answer a few basic questions. Where is it? How do you get there? What else is in the area?

GIS enables public works agencies to go further, visualizing and analyzing detailed geospatial data to provide a comprehensive view of their infrastructure. The ability to add a geographic dimension to construction and maintenance information enables public works agencies to better manage their assets and provide effective service to stakeholders in government, private sector partners and the general public.

The Who



Data Analysts



Owners



Project Managers



Surveyors



Inspectors

The How

GIS is widely used at the state and local levels for a variety of purposes: tax mapping, stormwater management, traffic analysis, and much more. In public works, GIS can be used to help manage infrastructure construction projects, and contribute valuable as-built location data to support effective planning for future maintenance, repair and replacement projects.

Construction crews and inspectors can use several different types of hardware to capture GIS data, depending on the nature of the project. Drones, specialized rovers and even mobile phones all have useful applications for capturing location data. The key is integrating the geospatial information with the as-built details for the assets under construction.

The Why

Pairing inspection data from construction sites with detailed location information promises to enable more efficient management of infrastructure assets across their full lifecycle.

When decision makers have access to maps with detailed inspection information, they're in a better position to understand the true condition of roads, bridges and other assets. They can more effectively determine when rehabilitation is needed to ensure public safety and plan maintenance activities efficiently to maximize the value of tax dollars and other funding

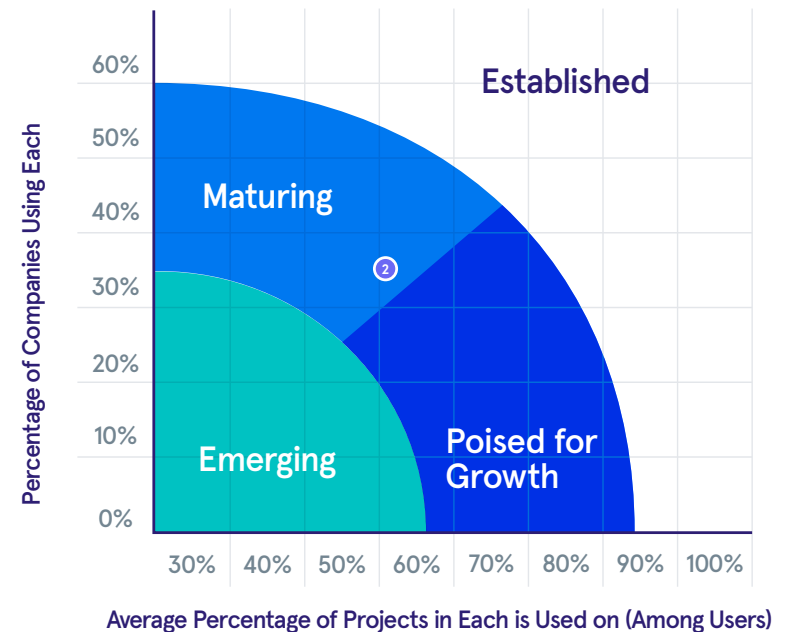
The When

TREND OUTLOOK

GIS is already a mature, widely adopted technology. However, utilization of GIS in construction is still in the "early adopter" phase. As cities and states pursue the development of digital as-builts and digital twins, in coming years there will be increasing demand and requirements for capturing location data during construction inspections.

MATURITY MATRIX

Site Capture Technology
② Mobile Mapping Systems



Stats to Know

A recent survey by the Civil Quarterly found that **34%** of construction teams are using mobile mapping systems, with another **21%** considering usage.

The global GIS market is expected to grow at a rate of **12.2%** between now and 2030. Unsurprisingly, the government sector represents **24.1%** of that emerging market.

“There is a rapidly growing demand for location and geospatial data to be associated with items during inspection and assets at final phases of digital project delivery. Infotech is not only addressing this functionality, but we’re helping our users embrace Esri tools like ArcGIS Dashboards and ArcGIS StoryMaps that can be populated with Infotech application data in real-time.”

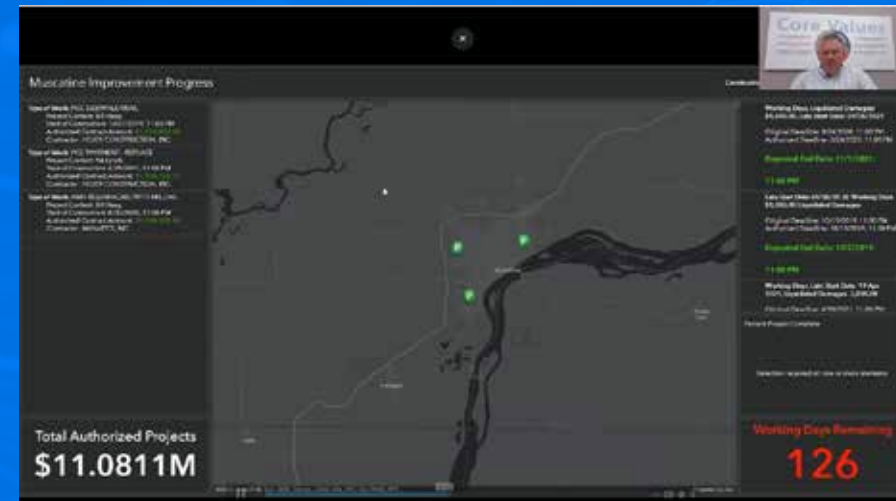


WILL MCCLAVE
PRESIDENT OF SYSTEMS,
INFOTECH

Use Case Example

Infotech has partnered with Esri to integrate our Appia construction administration application with ArcGIS Field Maps, bringing inspection reports and other data from the field into users’ GIS. Leveraging construction data visualization has led to better data capture, increased transparency and improved collaboration for agencies and engineering firms. For example, the City of Muscatine leverages an integration between Appia and Esri for their project management activities.

The project management team sends project information from Appia into Esri for display in intuitive and shareable dashboards. Since the integration is built into Appia, the team simply had to turn it on and start configuring



their dashboards on the Esri side of things. Now, whether it’s a citizen looking for an update on a project timeline or someone in the local government checking on the budget, information is easy for anyone to access.

“Most of the time people ask about the budget and the schedule. How far are we into it? Are we under budget? All of that information is readily available in Appia,” said Yerington. **“It helps people better understand the money being invested in the community and get real-time status updates and projects. And they don’t have to call us, which frees up time for field work.”**

Infrastructure Funding Opportunities

The Infrastructure Investment & Jobs Act offers a number of competitive grant opportunities for organizations seeking to leverage GIS technology. These grants also require increased oversight and reporting, which in turn necessitates GIS usage on many projects. Teams are even using GIS to show how funds are being distributed, like in [this handy ArcGIS map](#).

Learn more about the grant process in the chart below:

GRANT PHASE	U.S. DOT	STATE DOTs
Planning	Set strategic goals	Identify needs and growth opportunities
Opportunity	Evaluate regulations and advertise	Evaluate grant options and engage technology partners
Application	Accept and evaluate applications	Prepare and submit applications
Award	Award and pay grant	Receive grant revenue
Execution	Monitor and evaluate performance	Execute grant and report on progress
Close out	Close grant	Close grant and final reporting

Technology for Field Crews

The What

It's a dark, rainy Friday afternoon and you're worried about critical infrastructure. Whether you're deep in the city or out in a rural county, you have a limited number of field crews and equipment available—and you want to ensure both that any essential work is completed and that everyone returns from the job safely.

Field crews in public works use a vast number of technologies to build and maintain infrastructure assets, encompassing hardware, software, mobile applications and specialized equipment of all kinds. From tracking crew and equipment locations for effective management of resources to capturing accurate as-built data to support the longer-term maintenance and management, technology is driving increased accuracy and efficiency across the entire asset lifecycle.

The Who



Contractors



Consultants



Inspectors

The How

Advances in technology—especially mobile computing and network connectivity—are driving adoption. Field crews have dramatically increased their ability to access information and capture new data directly from the job site.

The Why

In a world where almost everyone has a mobile device on hand during the workday, the potential for introducing new systems and tools is virtually limitless. The key is implementing the right technologies to increase efficiency and create useful new capabilities—without causing excessive complexity, creating a disjointed work environment or fragmenting critical data.

The When

Field crews are more connected than ever. While new opportunities continue to emerge, this is an area of technology where it's appropriate to say that we are already living in "the future." Less than 20 years after the introduction of the first iPhone, smartphones have become ubiquitous, with sophisticated capabilities for both consumer and business users. This has driven a rapid shift in fundamental expectations about how, when and where it's possible to work and communicate.

TREND OUTLOOK

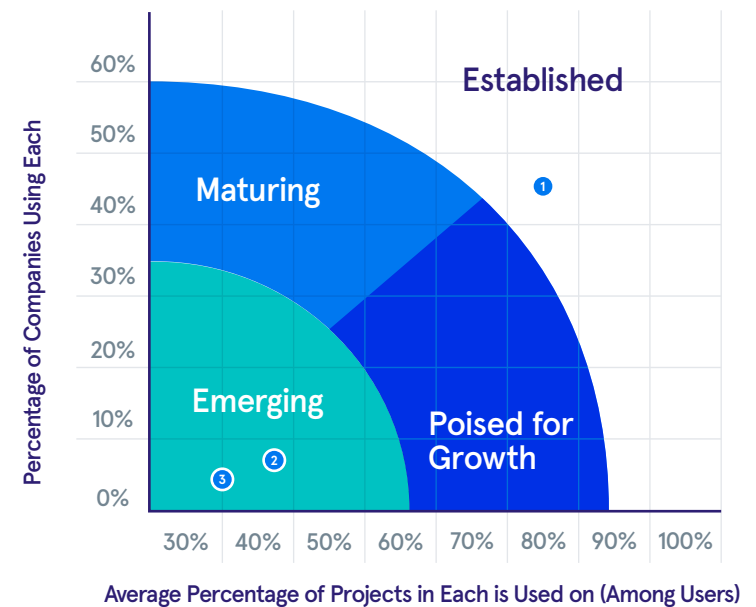
Increasingly powerful mobile devices and expanding network availability will continue to drive deployment of new solutions in the field. The adoption curve for new applications is getting steeper as ubiquitous connectivity makes it easier to deliver data from construction sites to GIS, asset management and other systems.

The key trends to watch are integration and automation of data capture in the field. Eliminating manual data entry is contributing to more accurate, complete information about construction and maintenance activities, and combining inspection reports and other data with GIS visualizations facilitates a wide range of decision making, planning and management tasks for local agencies and other asset owners.

MATURITY MATRIX

Other Technologies

- 1 Ruggedized Tablets
- 2 Virtual Reality
- 3 Augmented Reality



Stats to Know

A recent survey by the Civil Quarterly Surveys conducted by the Civil Quarterly identified some of the key emerging technologies in use today, including:

Ruggedized tablets	46% using	20% considering
Mobile mapping systems	34% using	21% considering
Laser scanning/Lidar	30% using	17% considering

Use of technologies that support field crews also bring a wide range of benefits. Users have reported:

75% more time in the field	50% faster payment generation	\$100K+ in travel savings
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“Inspectors with cellular coverage can be out in the field working in an app. Anyone else on the project team can see information more quickly in real-time, as opposed to that person in the field having to drive back to the office the next day, print it out, and put it in a book.”

TOM NEAD, REGIONAL MANAGER, FHU

Use Case Example

Infotech's Appia construction administration software enables field data to be digitized from the moment of capture—bypassing slower and less reliable processes for recording inspection details on paper and entering it into a digital system after the fact. This both saves time and reduces the potential for error.

In one example, Consulting firm Smith Seckman Reid, Inc. (SSR) was selected for a complex heavy highway project in Tennessee that was to be constructed across an area with sensitive environmental concerns. It was a large project using a mix of federal and local funding. On the job site, field crews faced complications with material testing that could have resulted in delayed payments.

The consulting firm leveraged a web-based platform that enabled real-time collaboration and field data collection on a tablet. The software improved efficiency, kept inspectors in the field and allowed for successful completion. The project achieved Audubon International Silver Signature Certification for accomplishments in sustainable design, construction, and management.



“The iPad allowed the field staff to enter daily work reports in the field which saved valuable time that it would have taken them to come into the office to enter their reports.”

NICK TAYLOR, PROJECT MANAGER, SMITH SECKMAN REID, INC.



Infrastructure Funding Opportunities

Infotech's Mobile Inspector app enables field data to be digitized from the moment of capture—bypassing slower and less reliable processes for recording inspection details on paper and entering it into a digital system after the fact. This both saves time and reduces the potential for error.

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Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program

\$100m in the Infrastructure Investment & Jobs Act is set aside for the promotion of construction technology on IIJA-funded projects. This number is relatively small when compared to the scope of the bill, but will enable DOTs to use project-specific tech language as they set their requirements for project management.

Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program

Strengthening Mobility and Revolutionizing Transportation (SMART) is a discretionary grant program with \$100 million appropriated annually for fiscal years (FY) 2022-2026.

The SMART program was established to provide grants to eligible public

sector agencies to conduct demonstration projects focused on advanced smart community technologies and systems in order to improve transportation efficiency and safety. A SMART grant may be used to carry out a project that demonstrates at least one of the following:

- + Coordinated automation
- + Connected vehicles
- + Sensors
- + Systems integration
- + Delivery/logistics
- + Innovative aviation
- + Smart grid
- + Traffic signals

Technologies that support mobility, accuracy, operations, and logistics can all be funded by SMART program grants.

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