

Technology Brief



e-Construction and Partnering: *A Vision for the Future*



Peer-to-Peer Exchange

Integrating e-Construction Technologies and Partnering Considerations

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Unless otherwise stated, FHWA is the source for all images and figures presented in this document.

Background

The Hawaii Department of Transportation (HDOT) is seeking to improve business practices by using integrated technologies and developing consistent processes. To learn from other State departments of transportation (DOTs), HDOT invited one representative each from four agencies to exchange ideas and solutions for overcoming e-Construction implementation challenges. HDOT hosted a 2-day, face-to-face peer exchange with the Arkansas DOT (ARDOT), Delaware DOT (DeIDOT), Virginia DOT (VDOT), and Alaska Department of Transportation and Public Facilities (DOT&PF).

The e-Construction and Partnering (eCP) peer exchange, sponsored by the Federal Highway Administration (FHWA) as part of round four of the Every Day Counts (EDC-4) technical assistance program, took place October 29–30, 2019, in Honolulu, Hawaii. HDOT, ARDOT, DeIDOT, VDOT, and Alaska DOT&PF were joined by staff from FHWA's Hawaii Division and the FHWA Resource Center. Information shared at the peer exchange regarding their policies, practices, and use of e-Construction technologies is summarized in this Technology Brief. See the final page of this Technology Brief for further information on certain limitations of this document and the non-binding nature of its contents.

At the onset of the peer exchange, FHWA provided an overview of e-Construction with insights on state of the practice, lessons learned from other State DOTs, and suggestions on implementation planning. It was noted that, to date, the e-Construction practices and technologies that agencies often see the most success with at the start of their e-Construction journey include electronic bidding (e-bidding), digital and electronic signatures, document management systems, construction management systems, mobile devices, and mobile solutions for assessment and reporting. Figure 1 shows the phased approach used at some agencies.

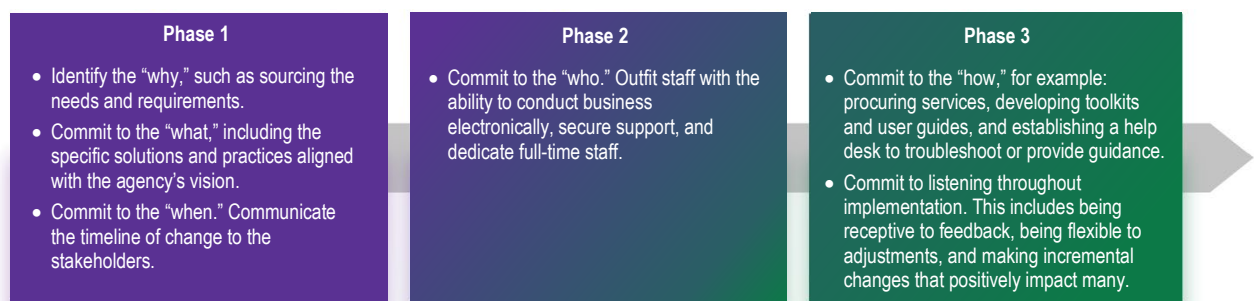


Figure 1. Illustration. Phased approach to implementing e-Construction initiatives. Source: FHWA

FHWA also noted that a challenge with implementing e-Construction is that no single solution meets the needs of all agencies. Rather, the solution will depend on what an agency wants to achieve, and often involves a suite of technologies and tools. Other challenges noted were enabling interoperability with legacy systems (especially financial



management systems) and securing management support. To obtain management support, FHWA suggested that a successful strategy may be to develop a business case that demonstrates a return on investment (ROI).

During the peer exchange, ARDOT shared information on its use of AASHTOWare® and e-Builder®. DeIDOT provided information on its e-Construction vision and on its implementation of Oracle® Primavera Unifier. VDOT also shared its e-Construction vision as well as its experiences with piloting PlanGrid® and HeadLight®. Alaska DOT&PF presented its AASHTOWare® implementation approach. Table 1 showcases different e-Construction technologies used at each DOT.

Table 1. e-Construction technologies at participant DOTs.

Application	HDOT	ARDOT	DeIDOT	VDOT	Alaska DOT&PF
e-Bidding	None	Info Tech® Bid Express®	Oracle® Primavera Unifier	Info Tech® Bid Express®	Info Tech® Bid Express®
Construction Management	Construction Project Management System (CPMS) Plotting Field Automated Communication System (FACS)	AASHTOWare® Project SiteManager™	Oracle® Primavera Unifier	AASHTOWare® Project SiteManager™	AASHTOWare® Project SiteManager™
Document Management System	None	Doc Express® (design-bid-build) e-Builder® (design-build)	Oracle® Primavera Unifier	Bentley® ProjectWise®	Custom
Electronic Daily Reporting	FACS PlanGrid® (piloting) HeadLight® (piloting)	Custom-developed SiteManager™ Access® Reporting System (SARS) and Change Order Generation System (COGS)	Oracle® Primavera Unifier	HeadLight® PlanGrid®	None
e-Ticketing	None	None	Earthwave Technologies® Fleetwatcher™ (piloting)	None	None
Mobile Devices	None	Standard-issue laptops or Dell™ Latitude™ 12 tablets with data plan	Apple® iPad®	Apple® iPad®	Microsoft® Surface® Pro

HDOT e-Construction Approach

Strategy and History

Since 2015, HDOT has been evaluating e-Construction and looking for opportunities to implement associated practices and technologies. HDOT believes that e-Construction presents a significant opportunity to transform business operations and processes and that an e-Construction transformation can result in more effective workforce development opportunities, easily accessible and digestible data through robust system interfaces, and empowered decision-making with project life cycle data transparency.

For nearly 20 years, HDOT has used a custom, Microsoft® Access®-based construction project management system (CPMS) for construction administration and management activities including project records, pay estimates, sample cards, and requests for information. HDOT recognizes that this system is obsolete. There are challenges interfacing CPMS with HDOT districts on other islands and limitations with using its database, including data interoperability, consistency, and flexibility.

Current Efforts

HDOT is evaluating its options for replacing CPMS with a system that benefits all its districts and enables the development of consistent processes that improve business operations. HDOT identified several requirements for a replacement system, including replacing CPMS entirely, integrating with PlanGrid® for as-builts and documentation, processing pay requests, and managing material certifications/sample cards. HDOT is piloting Field Automated Communication System (FACS) as a CPMS replacement in the Oahu District, but only for electronic reporting at this time. Additional functionality will be tested and evaluated on subsequent projects. HDOT is also piloting the integration of HeadLight® with FACS.

HDOT said securing support for implementing e-Construction practices, including the implementation of FACS, is not an issue; however, its leadership is seeking to understand the training, technology, and resource requirements for implementing e-Construction practices. To address this, HDOT intends to develop an implementation plan for its e-Construction practices, along with a business case for funding.

ARDOT e-Construction Approach

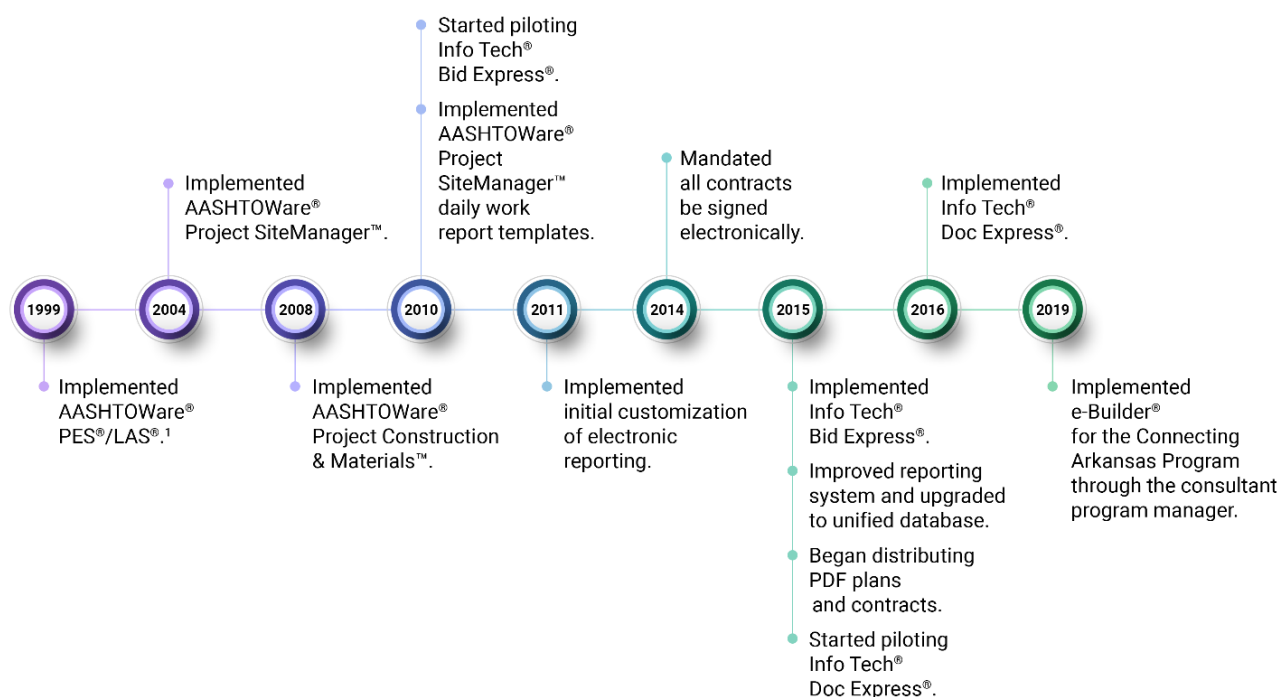
Strategy and History

ARDOT's e-Construction philosophy is to make the original source of information electronic, reduce or eliminate the need for printing, and streamline the document approval process. ARDOT has practiced e-Construction management since 1999 via AASHTOWare® and, in 2011, implemented the first customization of electronic reporting.



ARDOT started piloting Info Tech® Bid Express® for e-bidding in 2010 and in 2014 mandated all contracts be signed electronically. Bid Express® was fully implemented in 2015, which ARDOT said has allowed the agency to streamline processes and improve efficiency and transparency. In 2015, ARDOT also improved its reporting system to reduce paper by connecting it to a unified database and Web-based interface.

For construction activities, ARDOT implemented AASHTOWare® Project SiteManager™ in 2004 to enable electronic daily work reports, AASHTOWare® Project Construction & Materials™ in 2008 to capture testing data on electronic forms, and daily work report templates for SiteManager™ in 2010 for electronic pay item measurement forms. In 2015, ARDOT began distributing construction plans and contracts in electronic format only (i.e., PDF) and made all bidding documents available on its website. By the end of 2015, construction contracts were executed using Doc Express®. In 2016, ARDOT piloted Info Tech® Doc Express® for project document submittals, and the software was fully implemented by the end of 2016. In 2019, ARDOT implemented e-Builder® for its Connecting Arkansas Program (CAP). Figure 2 provides a timeline of ARDOT's e-Construction evolution for preconstruction and construction activities.



¹PES® = Proposal and Estimates System, LAS® = Letting and Award System

Figure 2. Timeline. ARDOT's e-Construction evolution for preconstruction and construction activities.
Source: Information provided by ARDOT.

Current Efforts

ARDOT has an ongoing effort to identify internal processes that can be handled in Doc Express®. The agency noted that the strengths of Doc Express® include its simplicity, mobility, and ability to handle account permissions. Because Doc Express® is intended for short-term needs, ARDOT exports project files to its long-term document repository after project closeout.

ARDOT's CAP required a system to manage project documentation throughout all phases of the program. The consultant program manager hired to administer and manage the CAP recommended using e-Builder® to meet the program needs. e-Builder® is administered by the consultant program manager on behalf of ARDOT. The consultant developed processes that aligned with ARDOT's policies and procedures. One of the strengths of e-Builder® is the simplicity of developing and controlling workflows (see figure 3) consistent with ARDOT processes.

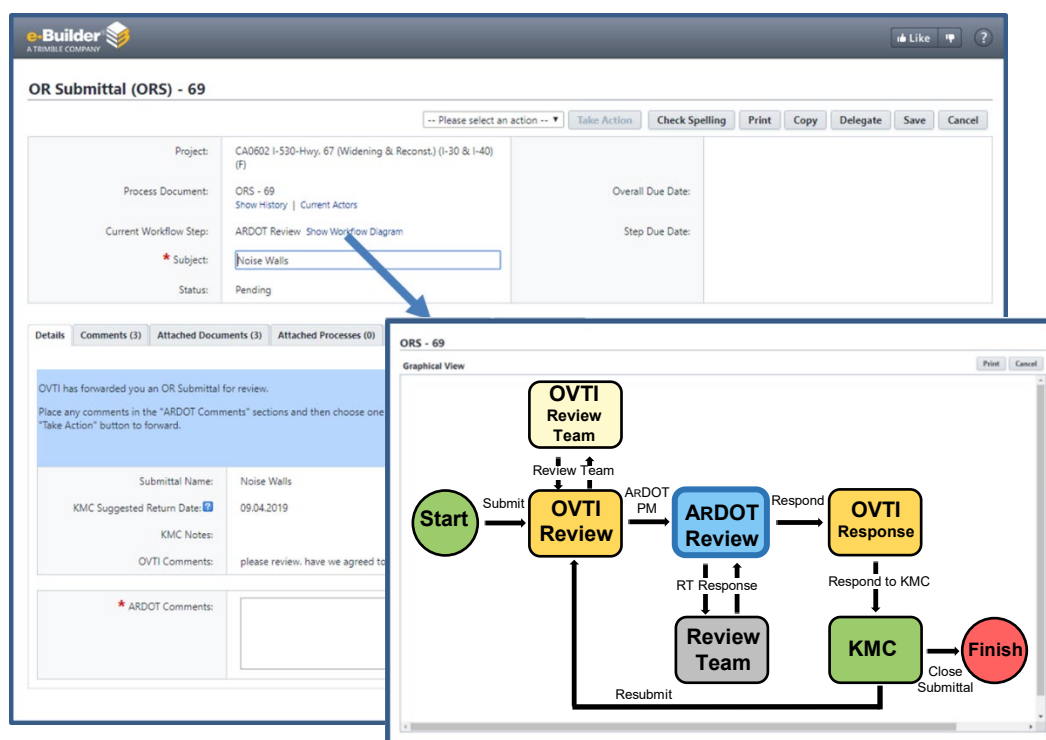


Figure 3. Screen Capture. e-Builder® submittal workflow. Source: ARDOT

ARDOT provided a unique comparison of implementation approaches led by the agency (for Doc Express®) and the CAP consultant (for e-Builder®). ARDOT said the advantages of agency-led implementation include the ability to control costs and secure support from all levels of the organization and the inherent capability to build institutional knowledge. The disadvantages of an agency-led implementation as reported by ARDOT include staffing for the technology and the human resources required for administering the system, as well as the limited ability to work across separate organizational groups. ARDOT said the advantages of consultant-led implementation include the ability for agencies to pass the system administration and resource requirements to the consultant

while retaining the vital documentation from which to build institutional knowledge. ARDOT said the disadvantages of consultant-led implementation include limited integration with internal agency systems, increased costs, and a limited ability to secure support from stakeholders.

DeIDOT e-Construction Approach

Strategy and History

In the fall of 2015, DeIDOT began evaluating mobile devices through a pilot effort. The 3-month pilot included distributing 60 tablets to construction inspectors and focused first on familiarizing staff with the basics of using the mobile devices before installing the specialized software applications. Staff were trained on the basic functions of operating the device, such as using a Web browser, downloading apps, and navigating the out-of-the-box interface. After staff became familiar with the device, they were encouraged to use the devices for completing inspector daily reports (IDRs) using PDF or spreadsheet forms for collecting data in the field. DeIDOT experienced an adoption rate of approximately 40 percent for the devices in the first year. However, because the field data collection program used to document field information was not mobile-enabled, data entry was duplicated once staff returned to the office.

As a result of its legacy construction management systems being largely outdated and insufficient for modern needs for mobility and interoperability, DeIDOT wanted a more sustainable software solution. In 2015, DeIDOT initiated procurement for an enterprise construction management solution, ultimately selecting Oracle® Primavera Unifier. In 2017, DeIDOT began processing IDRs on roadway and bridge projects through Primavera Unifier as the first step in its implementation. This process initially took about 8 months to complete due to inconsistencies with completing IDRs and validating requirements that have since been resolved. The processing of IDRs for maintenance projects started in 2018 and was fully implemented by early 2019. Concurrently, DeIDOT implemented Primavera Unifier for supporting several other business processes, including requests for information and submittals, progress meeting minutes, price approvals, and quantity adjustments.

Current Efforts

DeIDOT continues to add functionality and process improvements to the Primavera Unifier construction management system. Specifically, the agency plans to add automated processes for electronic submittals and contract execution, contractor submittals of construction documentation, and project closeout.

DeIDOT's e-Construction program focuses on distribution of electronic plans using Bentley® ProjectWise® for plan review, field inspection and data collection using Oracle® Primavera Unifier, electronic review and approval (using a combination of ProjectWise® for design phase review/approval and Primavera Unifier for construction phase review and approval of various document types), and communication tools. DeIDOT uses

Primavera Unifier for collaboration between multiple DelDOT business groups and partners such as FHWA and contractors and uses Apple® iPad® devices to communicate between the field and office or with other construction personnel.

DelDOT selected the iPad® devices as a result of the pilot project for construction inspectors (consultant inspectors provide their own devices). The Oracle® Primavera Unifier mobile application is compatible with iPad® and Android® devices and is capable of working without internet connectivity. Primavera Unifier use involves internet connectivity for other devices; however, Delaware has very limited areas without internet availability.

VDOT e-Construction Approach

Strategy and History

VDOT implemented e-bidding and advertising in 2001, becoming one of the first States to do so. The agency employed e-Construction practices for the pre-construction phase, but challenges with funding and stakeholder support led to delays with e-Construction plans for the construction and post-construction phases. In 2012, VDOT hired a consultant to develop a project document management system (PDMS) based on the Microsoft® SharePoint® 2010 platform. The initial vision included automated workflows for proposal creation, advertisement, and bid letting through contract award and execution. However, overly ambitious expectations and other challenges led to the termination of the information technology (IT) contract before the software development could be finished.

In 2018, the agency established a small team to oversee all e-Construction initiatives. The team's strategy is to prioritize activities to evaluate best value efforts for potential investment. VDOT's e-Construction program vision (see figure 4) includes exploring emerging technologies such as digital strategies (e.g., analytics and dashboarding, evaluation of current systems and business processes, and seamless integration), tablet-based inspection using PlanGrid® and HeadLight®, document management systems, jobsite technologies (e.g., HeadLight® data usage, radio-frequency identification [RFID], e-ticketing, augmented reality [AR], and three-dimensional [3D] printing), unmanned aerial systems, and further research and development. Over the next 2–3 years, VDOT will focus on technology deployment efforts to improve inspection and testing, construction management, and acceptance and closeout.



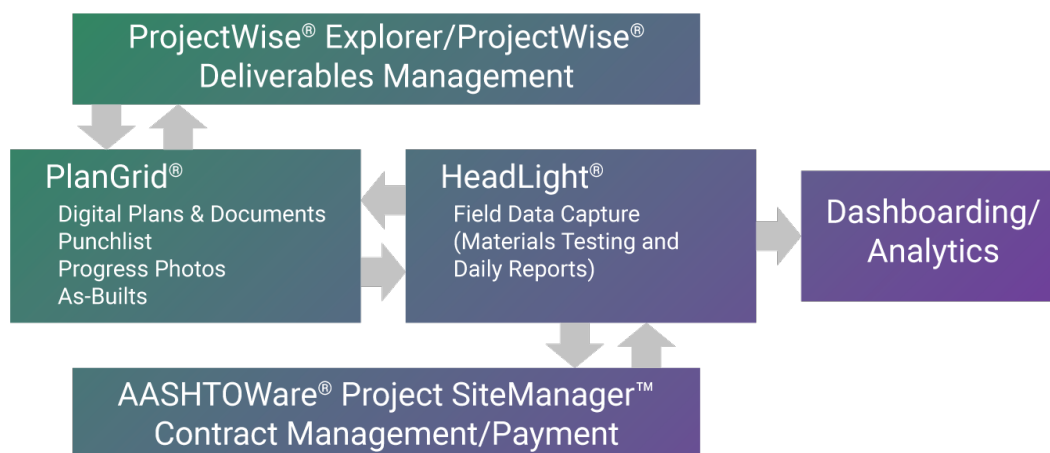


Figure 4. Illustration. VDOT's vision for seamless integrations. Source: Information provided by VDOT

Current Efforts

Key priorities for VDOT include focusing on enabling projects to be delivered on time, within budget, and to a high level of quality. This involves business process reengineering to reduce complexity, employ effective change management practices, and strengthen core competencies. Also, digital transformation that is user focused, reduces fragmentation, integrates data-driven decision making, and eliminates paper processes needs to happen in parallel. VDOT said its priority needs include the following:

- Digital plans and documents.
- Punch list tools.
- Progress photos.
- Field collaborations and reporting.
- Field data capture.
- Single source of truth.
- Data integration.
- Uniform document management system.
- Submittal workflow processes.
- Cradle-to-grave solution.
- Process integrations.

VDOT is currently conducting an 18-month pilot project to evaluate the PlanGrid® mobile application. The project, funded through the Virginia Transportation Research Council, started in 2018. This pilot project aligns with VDOT's objectives to have digital plans and make better use of iPad® devices in 2020. VDOT is also exploring the implementation of HeadLight®.

VDOT is also enhancing the use of Bentley® ProjectWise® as its document management and digital project collaboration tool. VDOT envisions ProjectWise® as a replacement for the file cabinet, the single source for project documents, and a cross-cutting

collaboration tool for its divisions. This enhanced capability is expected to improve the quality and time of design and constructability reviews while improving the transition of asset data to its asset management group.

Alaska DOT&PF e-Construction Approach

Strategy and History

Alaska DOT&PF operates under a decentralized business model that provides its three regions with significant autonomy to deliver projects. As such, the agency said cultivating support for establishing consistent business processes, as well as implementing innovative practices and technologies, involves significant outreach and engagement. The agency said these reasons, coupled with budget constraints due to an economic downturn from reduced oil prices and a paper-heavy organization with challenges exchanging documents between regions and project sites, highlighted challenges with legacy systems and inconsistent business processes.

Alaska DOT&PF decided to pursue implementing the AASHTOWare® suite of products and, after approval from its Commissioner, initiated statewide implementation in August 2016. The agency said the implementation started with significant outreach, evaluation, and assessment to ensure all perspectives were integrated early in the process. The business and technical implementation project managers focused on the data to understand who created data, who used data, and what the data needs were. The emphasis was on thinking outside the system and business group capabilities to bridge organizational gaps and maximize functionality. The implementation project managers then held stakeholder analysis workshops and mapped Alaska DOT&PF business processes.

To secure support from each of the Alaska DOT&PF regions, the Northern Region initiated testing of AASHTOWare® Project SiteManager™ as a proof of concept. The Northern Region found success with faster closeouts, better access to data, customized reporting, and an integrated audit trail. Its experience served as a catalyst for garnering support from the other regions to implement the AASHTOWare® Project™ Web-based software.

Current Efforts

In July 2018, the first of the four phases of AASHTOWare® implementation started with the AASHTOWare® Project Preconstruction™ module, Bid Express®, and the first deployment of the AASHTOWare® Project Civil Rights & Labor™ module. The second and last deployment of the Civil Rights & Labor™ module is expected to be launched in January 2021. The AASHTOWare® Project Construction & Materials™ module is expected to be launched in January 2022. The AASHTOWare® Project Estimation™ and Data Analytics™ modules launch is planned for January 2024.

Alaska DOT&PF uses the Web-based AASHTOWare® Project™ portal to access each module and to facilitate workflows for specific roles. The Web application is role-based,



so the visible information is tailored to specific roles rather than individuals; however, individuals are able to have multiple roles.

Cost and Benefits

In 2017, FHWA sponsored a study that addressed the challenges and the ROI for paperless project delivery. Table 2 provides the planning-level estimates of the ROI from that study, which show that the initial outlay of funding for some e-Construction practices and technologies can be recovered within the first 3 years of investing.

Table 2. e-Construction ROI planning-level estimates. Source: FHWA¹

Improvement Opportunities	Breakeven Year	7-Year ROI
e-Bidding	Year 3	700%
Digital plans, specifications, and estimates	Year 3	325%
Digital review of project documents	Year 2	775%
Project construction management	Year 4	250%
Project collaboration	Year 5	250%
Digital as-builts	Year 3	125%
Mobile devices (for daily inspection)	Year 3	200%

¹ [Addressing Challenges and ROI for Paperless Project Delivery](#), FHWA-HIF-17-028, May 2017.

VDOT's pilot project strategy includes assessing the value of implementing HeadLight® and PlanGrid® through a formal ROI analysis and usability assessment. This assessment has not been completed; however, VDOT has collected PlanGrid® user data from 75 users on 70 projects across 8 participating districts. The use of PlanGrid® has resulted in users saving 3.5 total hours per week. Also, VDOT has collected HeadLight® user data from 45 users on 9 projects across 8 participating districts. The use of HeadLight® has saved 4.4 hours per week on data entry and provided a total time savings of 5.4 hours in the field.

Alaska DOT&PF noted the costs for implementing AASHTOWare® include license fees and labor time for Info Tech® and Alaska DOT&PF staff. The license fees are reinvested into software development and improvement and include one to two full upgrades per year. The staff resources required for implementation of this magnitude were a business project manager, technical project manager, database administrator, application server administrator, Web developer, data center staff, subject matter experts, module administrators (trainers), and Info Tech® staff. The funding resources were inconsistent due to the budget constraints and were a major challenge to overcome; however, the implementation team had the support from leadership to complete the necessary activities. Some of the benefits Alaska DOT&PF noted include sunseting legacy systems, reducing errors, improved efficiency, and reallocating time to other tasks. Also, AASHTOWare® improves transparency, accountability, and data quality and accessibility. AASHTOWare® development and improvements are directly influenced by State DOTs through an AASHTOWare® Project™ users' group.

Key Takeaways

Participants put forth the following suggestions based on experience with their State programs.

Engage key stakeholders early on to secure support for implementation.

Deliberate and continued outreach to key stakeholders will help integrate perspectives and feedback early in the process. Providing stakeholders with the ability to contribute to the implementation activities is an effective change management strategy. Also, this ensures long-term support for implementation and helps justify consistent funding.

Educate information technology (IT) staff on intricacies of construction systems.

It is important that the appropriate construction staffers are educating and informing IT staff responsible for system administration or integrations. This improves system performance and grows a culture of trust.

Test systems and applications frequently throughout implementation. Many different workflows and processes can be automated or improved through e-Construction technology, so it is important to test the functionality frequently throughout implementation before releasing to the users. This improves the likelihood of successful adoption.

Identify, appoint, and empower champions. Champions are vital to successful implementation and adoption of e-Construction practices and technology. These champions exist at all levels of the organization, including the end-users, and allocating support and resources for these champions will empower them to cultivate a culture of innovation.

Dedicate staff and funding resources. Dedicating resources is important to get the necessary focus on implementing a successful program. Look for staffers who seek efficiencies in their work and for those prone to volunteer for additional duties. Characteristics such as high motivation and good attitude are more important than technical skills.

Prioritize needs and requirements over the technology. Prioritizing technological capability over, or without clear connection to, an agency's needs and requirements presents a clear risk of failure. Instead, the technology should be selected to address specific needs and requirements.

Involve and enable decision makers. Deploying e-Construction technologies involves engagement with several stakeholders, including the agency IT authority. Those decision makers should be a part of the process to deploy and implement technologies to ensure rules and standard practices are considered. Enabling IT staff to visit with the business users to capture contextual requirements is important to help translate subject matter terminology.

e-Construction and Partnering: A Vision for the Future

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FHWA e-Construction and Partnering innovation resources

<https://www.fhwa.dot.gov/construction/econstruction>

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