e-CONSTRUCTION

HOW-TO GUIDE

Developed by:
FLORIDA DEPARTMENT OF TRANSPORTATION
TO SUPPORT FHWA EDC-3 IMPLEMENTATION ACTIVITIES

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INTRODUCTION

One of the most important services offered by state governments is the oversight and management of construction projects for roads, bridges, railways, seaports, and airports. Unfortunately, these projects can be characterized by excessive delays, unexpected expense, and frustration on the part of everyone involved - the state, contractors, and the general public.

All states have made significant efforts to improve their infrastructure and operations by incorporating the best available technology solutions across various departments and agencies. However, many states still manage their construction projects using processes, procedures, and technologies that have been in place for decades. The current technology solutions that are available have simply not been implemented.

The Federal Highway Administration (FHWA) understands that the transportation industry faces challenges with tighter budgets and a general public that demands higher accountability for how tax dollars are spent. To assist in addressing these challenges, the FHWA developed the "Every Day Counts" (EDC) initiative. The EDC initiative is an effort to bring a better, faster, and smarter approach to highway and bridge construction. The overall objectives of the EDC initiative are: shortening project delivery, enhancing the safety of roadways, and protecting the environment.

This e-Construction How-To-Guide was developed by the Florida Department of Transportation (DOT) to support the FHWA's EDC goal of helping state DOTs understand how to implement an e-Construction system in their states.

SOME EXAMPLES

Consider two examples of the "old" way of managing construction projects:

Example 1: The Inspection

How often do state resources have to travel to a construction site with all necessary construction documentation in tow, perform a routine inspection, then travel back to the office to fill out forms and complete paperwork? What if instead of travel back and forth from office to construction site, onsite inspectors could access all construction documentation from a mobile device and complete the necessary documentation while still onsite? What if, when the state inspector needs to confer with other state resources, he or she could do this using video chat and pictures directly from the site instead of having the additional state personnel travel to the construction site?

e-Construction can make this happen.

Example 2: The Signature

How often for each project do you have to print out paper documentation, have it signed and/or stamped by an individual, then either have it mailed to another individual for a signature, or scanned and emailed to that individual for him or her to print, sign, and then have it sent on to someone else in the process? How much paper, ink, and postage are consumed? How much time is used in this process? How much downtime is experienced while waiting on documentation to be delivered and signed? What if instead of using so much ink, paper, postage, and time this entire process could be managed by software that would allow an individual to add his or her signature and stamp with the click of a button? What if, as soon as this individual took action, the software alerted the next person in the chain that he or she needed to take action?

e-Construction can make this happen.

WHAT IS E-CONSTRUCTION?

The FHWA defines e-Construction as the collection, review, approval, and distribution of highway construction contract documents in a paperless environment:

- Electronically capturing construction data,
- Electronic submission of all construction documentation,
- Increased use of mobile devices,
- Increased automation of document review and approval,
- Essential use of electronic signatures by all parties throughout the process, and
- Secure electronic document and workflow management accessible to all stakeholders on any device.

e-Construction has the potential to dramatically change the way construction projects are managed in your state. It can make the management of your construction projects more efficient, more flexible, and more cost-effective.

DISCLAIMER: IT WON'T BE EASY

e-Construction will make the oversight and management of construction projects dramatically easier, but it will not be easy to get an e-Construction system in place. You need to know this going in. It will require additional effort and commitment from the team that works to implement e-Construction. However, once this is done, the time, energy, and expense saved going forward from that point will be worth the investment made on the front-end.

Some of the obstacles you may face include:

- Selling the concept to the decision makers,
- Finding the personnel to help build and implement e-Construction,
- Addressing information technology limitations,
- Uncovering operational limitations in your current processes, policies, and procedures,
- Answering legal questions and concerns regarding the acceptability of electronic signatures/stamps and document retention,
- Addressing personnel issues including the reluctance to change, training needs, and
- Buy-in from the various stakeholders.

We will discuss each of these potential obstacles at length later in this document.

WHY DO IT?

It is important to note once again that after these various obstacles have been overcome and e-Construction is a reality in your state, the investment that you have made will be far outweighed by the ongoing benefits to the state, vendors, and general public. There are a few areas of benefit worth considering:

- **Savings:** The time saved on e-Construction projects will be transformative. Processes that could have taken weeks may only take days. Processes that took hours may only take minutes. This will translate to fewer hours used by state and contractor resources, which should result in a lower overall cost of the project. The cost savings for various expenses to your state and contractors can be significant, as you will see a reduction in the usage of fuel, postage, printing, etc. A reduction in these types of expenses will also provide a significant reduction of the environmental impact of your state considering the amount of paper and fuel consumed will be significantly diminished.

- **Efficiencies:** The implementation of e-Construction will create several efficiencies that will benefit the state and contractors. The e-Construction process will provide greater accessibility by all of the stakeholders to each project. It will provide greater transparency, which will result in more accountability. It will lead to a marked improvement in productivity, as resources may be able to carry out some tasks in minutes that previously would have taken hours. It will also lead to quicker payment to contractors. Ultimately, it will help you "close the books" more quickly on each project.

- **Following Best Practices:** Every organization, whether public or private, strives to follow best practices in every facet of their organization. If there is a better way to carry out the responsibilities of the organization, it should be done. While the benefit of following best practices is less quantifiable than some of the other benefits derived from e-Construction, it is no less important. Each state should recognize that technology, some of which has only been developed in the last few years, is now capable of dramatically improving virtually every aspect of the construction process. If improvements can be made, if efficiencies can be introduced, and if savings can be realized, then e-Construction should be implemented simply because it is the best practice to follow.

GETTING BUY-IN

It is very important that the first step towards implementing e-Construction in your state be obtaining buy-in from the various stakeholders in the process. If the stakeholders are on board and excited to be part of the process, it will be much easier to implement e-Construction. You should attempt to get buy in from the decision makers, the state information technology teams, the state CAD team, and the various contractor associations in your state. The eventual implementation of e-Construction in your state is inevitable, and stakeholders should be made aware of this fact, however your goal should still be to have consensus among the stakeholders about the transition to e-Construction.

WHAT OTHERS ARE SAYING

The states of Florida and Michigan have already made significant steps towards fully implementing e-Construction. They have found the benefits of e-Construction to be significant and well worth the investment. Consider what just a few key stakeholders have to say about e-Construction:

"e-Construction will take advantage of mobile application technology allowing those individuals working through field interviews with seamless, real time integration with key FDOT enterprise systems. This ability to stay connected will reduce the risk of errors from a disconnected process, and decreasing the turnaround time for critical construction project decisions. This goes hand-in-hand with current FDOT initiative to move to a paperless workflow environment and enhance investment by continuous productivity improvements. This puts authorizations in place to capitalize on the initiative while the current activities are being performed."

April Blackburn
CIO, Florida Department of Transportation

"We, like most other DOTs, are 'Drowning in paper in a paperless world' and this is a title of a recent presentation given at the Transportation Research Board in Washington D.C. Here at FDOT we are experiencing the improvements in efficiency, the reduction in paperwork and share savings with our consultants and contractors. Our team has taken the steps to put our agency in the position to levy as much of the new technology as possible."

Brian A. Blanchard, P.E.
Assistant Secretary for Engineering and Operations, Florida Department of Transportation

"There can be several thousand documents associated with any given construction project. With e-Construction in place, FDOT is able to electronically store all of these documents in one central location. This, combined with the fact that we use mobile devices in the field, means that stakeholders literally have access to thousands of documents at their fingertips. This has resulted in significant savings in time and effort. What used to involve printing, signing, scanning, and emailing now can be done simply by pulling up a document online, electronically signing, and saving."

Kenny Geisendorff
Construction Project Manager, Florida Department of Transportation

THE CONSTRUCTION PROCESS

When fully implemented, e-Construction will touch every aspect of your current construction process. Some of your processes will work virtually the same way, with technology simply increasing speed and efficiency. However, some of your processes may be completely changed or even removed altogether. Remember, it's likely that you may have some processes in place that were developed decades ago – well before today's technology solutions were even a consideration.

It is understood that each state has its own way of managing construction projects. Every state has its own methods, policies, and procedures that it follows throughout each construction project. However, there are some general phases of every construction project that states work through. Each of these phases can be improved upon by the implementation of e-Construction.

The phases we will consider in this section include:

- Design
- Contract Award
- Documents in Field
- Material Certification
- Construction
- Sampling/Testing
- Public Outreach
- Inspection / Survey / Reporting
- Pay Estimates
- Document Submittal
- Change Orders
- Project Completion / Final Acceptance
- Closeout

In the next few pages we will briefly discuss how e-Construction can impact these phases.

DESIGN

The design phase of a construction project is essentially controlled by the Plans, Specifications, and Estimates (PSE) Package. Your state most likely presently has specifications in place to guide contractors in the bidding process. This would include specifying if the project will be Design/Build or Design/Bid/Build as well as specifying if the designs will be done in 2D or 3D. In an e-Construction system, the entire PSE Package would be hosted in electronic format on an e-Construction collaborative site that is used by both state and contractor resources.

CONTRACT AWARD

Once a contractor is selected and the contract is to be awarded, the e-Construction system would be used to manage the chain of signatures required of both parties. No longer would contracts need to be printed, signed in triplicate, scanned, and mailed back and forth.

DOCUMENTS IN FIELD

There are several documents that contractors in the field must rely on, including plan sets and specification packets. Formerly contractors and state personnel alike had to print these documents out in order to access them at construction sites. When using an e-Construction system, these documents are managed, housed, and accessed using an e-Construction collaborative site.

MATERIAL CERTIFICATION

Most, if not all, states will have an approved products list (APL) for contractors to refer to when bidding and selecting materials for construction projects. When an e-Construction system in place, the APL can be accessed in the collaborative site. This will make crosschecking materials with the APL much easier for state and contractor personnel.

CONSTRUCTION

At the core of the construction process, there are six basic components:

1. Sampling / testing
2. Public outreach
3. Inspections / surveys / reporting
4. Pay estimates
5. Document submittals
6. Change orders

1. Sampling/Testing

During the course of a construction project, sampling and testing of materials will be done per the requirements of the PSE package. An e-Construction collaborative site will manage the scheduling, documentation, signatures, and approval of all sampling and testing.

2. Public Outreach

Public outreach regarding construction typically involves meetings to inform the public of potential projects, notifications about lane closures, notices about delays in projects, notices about items that may affect the project price, and the handling of public complaints. These public outreach items may not necessarily be the responsibility of the team that oversees and manages construction projects, instead they may fall to Public Relations office. An e-Construction system could be utilized to help manage elements of the public outreach efforts.

3. Inspection / Survey / Reporting

During the course of a construction project, there will be numerous points at which inspections and surveys must be performed and reporting must be filed. One of the greatest strengths of an e-Construction system is its ability to mange this component. Inspections can often be carried out via remote video-chat so that state inspectors do not have to physically travel to construction sites. All reporting documentation can be completed, signed, and stored on the collaborative e-Construction site. Technology, such as density testing tools, is even being developed so that some types of testing can be completed entirely with technology solutions.

4. Pay Estimates

State Departments of Transportation almost universally provide monthly progress payments to contractors on each project. This process formerly could have taken days to work through the chain of responsibility as documents were printed, filled out, signed, scanned, and sent on to the next person in the chain. An e-Construction system can manage this process and allow for the approval and signing of the monthly estimates shared between the contractor and the state DOT. What formerly could have taken days to accomplish can now be completed in minutes or hours with an e-Construction system.

5. Document Submittal

On any given construction project there may be over 100 different forms that are assigned to the project. Various stakeholders routinely submit documents as part of the construction process. The documents cover a wide scope of categories, ranging from engineering to payroll. It is often the case that these documents are tied to workflows, such that the submittal of one document initiates an action. Given the number of documents submitted and the complexity of some of the workflows, this component of the construction process can be very cumbersome. An e-Construction collaborative site allows for the easy submission of documents. An e-Construction system can easily account for the workflow logic to ensure that all documents are handled correctly and all relevant parties are aware of the next steps. One of the benefits of an e-Construction system is that this entire component will become very transparent, with everyone knowing the history and status of each document.

6. Change Orders

It is a given that change orders will occur on construction projects. Formerly a change order could cause significant delay while waiting for the documentation to be delivered, reviewed, and approved. An e-Construction collaborative site simplifies the submission of change orders and the subsequent approval of change orders.

PROJECT COMPLETION / FINAL ACCEPTANCE

Once a contractor believes they have fulfilled the requirements of the contract they will notify the state they have completed the project. The state will then confirm completion and develop, if necessary, a punch list of items that still need the attention of the contractor. Once the contractor has addressed all items on the punch list, the state will provide its final acceptance. An e-Construction collaborative site can manage this punch list and associated approvals so that all stakeholders are aware of open items and their status.

CLOSEOUT

Upon final acceptance of the project is closed out. The state will perform a final close out process, confirm that all approvals and signatures are in place, and then send the project on for final payment. The e-Construction project specific collaborative site can be shut down once all the final approved documents have been transferred to state permanently archived database.

POTENTIAL OBSTACLES AND SOLUTIONS

As was noted earlier, it is important to understand up front that there will be obstacles during the process of implementing e-Construction in your state. Some obstacles will be easier to address than others, but each of these obstacles does have a solution.

Fortunately, two states (Michigan and Florida) have already implemented e-Construction in their states. They have been able to catalog the obstacles they experienced and shed light on the solutions they found to address each obstacle in their states. Of course, you may find that you encounter obstacles in your own state that were not experienced in Michigan or Florida.

In this section we will look at a number of obstacles, including:

- Selling the idea to decision makers,
- Lack of available resources,
- Information technology limitations,
- Operational limitations,
- Legal questions and concerns, and
- Personnel concerns.

We will also look at some solutions to each of these obstacles.

OBSTACLE 1: SELLING THE IDEA TO DECISION MAKERS

One of the first obstacles you may encounter is the challenge of selling the idea of e-Construction to the decision makers and holders of the purse strings in your state. Some individuals in positions of leadership are reluctant to make significant changes to processes that have been in place for years and are working as intended. They may believe that introducing a wholesale change to the construction process could result in "rocking the boat" that will create unnecessary stress among employees and contractors. They may also have difficulty in investing in the up-front costs involved with implementing e-Construction, whether those costs be in building the technology infrastructure, purchasing the necessary licensing for software and electronic signature management, or even adding personnel to implement an e-Construction system.

Solution:

In order to address these potential obstacles it is best to go to the decision makers with as much information and backing as possible. If you can gain the support of all stakeholders in the initial phases of exploring e-Construction in your state, it will serve as a measure of security to the decision makers when they realize that the various stakeholders (both state and contractor) are in agreement with pursuing e-Construction. As an example, the State of Florida Department of Transportation was able to go as far as developing a Memorandum of Understanding between the state and construction industry leaders that outlined the mutual goal and desire to convert the outdated manual construction processes to the more efficient e-Construction process.

You should also be prepared to reply to the budgetary concerns with information about the potential savings your state would realize over a period of time that would allow the state to recoup its investment. When doing this, be sure to consider all potential cost-savings with resource hours, travel, fuel, postage, printing, scanning, etc.

Finally, you should be able to provide an estimate of time savings realized as a result of the implementation of technology that allows for time-consuming processes to be significantly streamlined. This could include estimates of time saved by cutting out travel involved with site inspections, time saved with moving documents through the chain of authority for signatures, etc.

OBSTACLE 2: LACK OF AVAILABLE RESOURCES TO BUILD / IMPLEMENT AN E-CONSTRUCTION SYSTEM

If you are just now considering implementing e-Construction in your state, it is most likely that your state will not have budgeted for this yet. Likewise, it is unlikely that your state will have personnel available to be fully dedicated to the implementation of e-Construction.

Solution:

As just noted, it is important to determine what your up-front costs will be. This will help you understand what your potential savings will be after implementation of e-Construction, but of course will also allow you to understand what you will require in the budget. Most of your costs will relate to building the IT infrastructure required to support the e-Construction system. This may include hardware, software, licenses, and portable devices. It is important that you coordinate with IT personnel to accurately document these requirements and their associated costs.

Michigan and Florida found that they were unable to add additional personnel that were dedicated to implementing e-Construction in their states. The job fell to employees that already had a full workload. It is possible that this will be the case in your state as well. For this reason, it is very important that you find employees that are passionate about improving the construction processes, are not intimidated by changes (particularly those involving technology), are able to put in the additional hours of effort for up to a year or more, and are willing to serve as “champions” for the e-Construction effort. Again, it is important to take into consideration the various stakeholders in the construction process and have them involved to the greatest degree possible.

OBSTACLE 3: INFORMATION TECHNOLOGY LIMITATIONS

Some of the most far-reaching obstacles you may encounter are those associated with information technology limitations. Since e-Construction relies so heavily on technology, it is important that your state's IT personnel consider all of the potential obstacles to fully implementing an e-Construction system. Some of the obstacles associated with IT limitations may include:

1. Lack of necessary technology,
2. Lack of connectivity in remote locations,
3. Data storage concerns,
4. Adobe software and iOS incompatibility,
5. IT security concerns, and
6. Field hardware support.

1. Lack of Necessary Technology

A primary concern is that there may not be the necessary technology in place to handle the e-Construction process. For a state that operates with a very manual construction management process there may by very little, if any, of the necessary technology in place. While some necessary hardware may be in place, it is doubtful that your state will have software in place to manage the e-Construction process. It is also unlikely that all of the necessary personnel will have mobile/portable devices that would be required.

Solution:

In order to overcome this obstacle, the state IT personnel must be engaged to determine how existing technology can be leveraged for use with e-Construction and what additional hardware, software, and devices will need to be considered and budgeted for.

2. Lack of Connectivity in Remote Locations

Many times a construction project may be the first phase of development in an area, or the project may be in a very remote location. In these cases, it is quite possible that connectivity to personnel onsite will be very limited. If there is cellular data or Wi-Fi in remote locations, it may be extremely slow. This could be particularly problematic when attempting to perform tasks that require higher connection speeds, such as downloading large drawings or conducting a video chat.

Solution:

There may not be a simple solution to this obstacle. Whenever possible, the network should be improved to allow for adequate communication. Again, the state IT personnel will need to provide their input for solutions to this obstacle.

3. Data Storage Concerns

When transitioning from a paper-based system to a digital paperless system the issue of data storage will become obvious very quickly. Any individual project can have potentially hundreds of digital versions of documents. Some documents, such as drawings, can be very large files. This is particularly true if 3D renderings are used. Your state may not have the necessary IT hardware resources to provide storage for the sizable amount of data and documentation that will be associated with each construction project.

Solution:

The state IT personnel will need to assess the potential data storage needs and plan accordingly. If your state chooses to use a vendor-hosted solution, storage space may be less of an issue; however, hosting fees will need to be accounted for when budgeting.

4. Potential Mobile Device Deficiencies

In order to meet the objective of having a paperless e-Construction system in place, it will be necessary to obtain mobile devices to be used by personnel in the field. Each mobile device option considered may have some shortcomings and may not be exactly what your state is looking for. Some devices may have compatibility issues with other technologies your state is using. Some devices may not have GPS or data connectivity that meets your needs. Some devices may suffer from issues such as low battery life, which can have an impact on users in the field.

Solution:

Develop a list of your requirements for the mobile devices that will be used. Work closely with your state IT personnel to make sure that technical and security concerns are properly accounted for. You may find that none of your options meet all of your needs, so you will have to choose one that best meets your needs.

5. IT Security Concerns

A common concern for all organizations, including state governments, is how to protect the sensitive data they maintain. Even though it may seem innocuous, and even though much of the information related to construction projects may eventually be a matter public record, it is critical that access to e-Construction systems and the data they house is protected. IT security obstacles can be present whether the data is housed on state systems or on a hosted vendor-supplied system. The security of mobile devices and the data on those devices can also pose obstacles to successful implementation of e-Construction.

Solution:

It is likely that your state IT personnel already have policies and procedures in place concerning IT security, access control, and mobile device security. They will need to assess the proposed IT hardware, software, and devices to determine whether or not existing polices and procedures will adequately protect the e-Construction IT infrastructure. Your state should expect that both state employees and vendors would have access to the state's e-Construction systems.

6. Field Hardware Support

One of the benefits of e-Construction is that personnel will have mobile devices for use in the field. One of the drawbacks of e-Construction is that personnel will have mobile devices for use in the field. Though the benefits of mobile devices will far outweigh their drawbacks, your state must still account for the fact that users in the field will, at one point or another, have issues that must be resolved. These issues may be hardware or software related, or they may be training issues.

Solution:

The state IT personnel will need to determine how devices in the field will be supported. If the state IT personnel provide support, this will potentially add to their workload and possibly require additional personnel. If a vendor provides support, this additional expense must be accounted for.

OBSTACLE 4: OPERATIONAL LIMITATIONS

The reality for most states is that many of their construction polices, procedures, and processes have been in place for decades. These policies, procedures, and processes may have been developed at a time when the current technology that supports e-Construction was not even in the realm of consideration. The transition from a manual paper-based system to e-Construction will most likely mean that many existing policies, procedures, and processes will be obsolete, and some could even be in conflict with the policies, procedures, and processes that necessarily need to be in place for e-Construction.

Solution:

In order to address operational concerns that may arise due to the implementation of e-Construction, a cross-functional team representing the various stakeholders will need to be involved in updating policies, procedures, and processes to allow for e-Construction to function as intended. This cross-functional team may need to include members from the IT, CAD, finance, and legal groups.

OBSTACLE 5: LEGAL QUESTIONS AND CONCERNS

One of the most challenging obstacles you may encounter has to deal with various legal questions and concerns that could come up during the process of implementing e-Construction. It is important that your state legal representatives are involved in addressing these questions and concerns. In some cases, it may even become necessary for state laws to be amended to address some of these concerns. Some of the legal obstacles you may encounter include:

1. Acceptance of electronic and digital signatures,
2. A lack of "hard copies," and
3. Document retention (hard copy vs. digital).

Acceptance of Electronic and Digital Signature

A completely paperless e-Construction system will require the use of electronic and/or digital signatures. You may find that legally it is not feasible to use electronic or digital signatures in your state. Some states fully recognize the use of electronic and/or digital signatures as form consent, however, some states have not addressed the use of electronic and/or digital signatures.

The terms "electronic" and "digital" are sometimes used interchangeably, however, they are not synonymous.

An **electronic signature** is a version of an actual signature that is electronically embedded in a document. This can be done by cutting and pasting a scanned image of a signature, or by manually using a finger or stylus to sign directly onto a screen for the signature to be captured. However, an electronic signature does not necessarily have to be an electronic version of an actual signature. An electronic signature can take many different forms. Some examples include typing initials, checking a consent box, or recording a voice or video approval. *The state of Michigan has adopted the use of electronic signatures.*

A **digital signature** is a more robust and secure way to sign electronic documents. A digital signature provides protections regarding the signing of the document:

- **Signer Authentication:** The digital signature provides an encrypted and secure connection between the signature on the document and the person who provided the signature.
- **Data Integrity:** The digital signature creates a "fingerprint" of the document that is signed. If the document were to change after being digitally signed, the signature would be invalidated.

The state of Florida has adopted the use of digital signatures.

Solution:

Your state legal personnel will need to help you understand if state statutes allow for the use of electronic and/or digital signatures. An important consideration is whether or not your state has signed on to the Uniform Electronic Transactions Act (UETA). The UETA has been signed by 47 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. Its intent is to help standardize state laws concerning the retention of paper records and the validity of electronic and digital signatures. If your state has signed on to the UETA, it is likely to approve electronic and digital signatures in an e-Construction system.

If your state does not allow for electronic and/or digital signatures, steps will need to be taken to amend existing statutes or create new statutes addressing the use of these types of signatures.

You should also consider the input of your state IT personnel as there are data security and integrity differences between electronic signatures and digital signatures.

It should be noted that digital signatures might require a license fee. This expense must be accounted for.

1. Acceptance of Electronic PE Stamp

The obstacles related to the use of electronic PE stamps are similar to those associated with electronic and digital signatures.

Solution:

Your state legal personnel will need to help you understand if state statutes allow for the use of electronic PE stamps. If your state does not allow for electronic PE stamps, steps will need to be taken to amend existing statutes or create new statutes addressing the use of electronic PE stamps. In addition, you will need to determine if your state's Professional Engineering Board recognizes the use of electronic PE stamps.

2. Lack of "Hard Copies"

Policies, procedures, and even state statutes in your state may require that construction-related documentation exist in printed form. If this is the case, a fully paperless e-Construction system is not feasible.

Solution:

A review of policies and procedures, and possibly state statutes, should be performed to determine if your state allows for documentation to exist in electronic formats. If your policies, procedures, and state statutes do not allow for construction-related documentation to exist in electronic form, steps will need to be taken to amend existing policies, procedures, and state statutes to allow for the use of electronic documentation.

3. Document Retention (Hard Copy vs. Digital)

As with some of the previous obstacles, some policies, procedures, or possibly even state statutes regarding document retention require that hard copies of official documents be retained. Retaining hard copies of documentation may not impact the majority of the e-Construction process; however, it will impact the overall goal of having a fully paperless, highly accessible, and transparent system in place.

Solution:

A review of policies and procedures, and possibly state statutes, should be performed to determine if your state allows for electronic document retention as opposed to requiring hard copies. If your policies, procedures, and state statutes do not allow for construction-related documentation to exist in electronic form, steps will need to be taken to amend existing policies, procedures, and state statutes to allow for the use of electronic documentation.

OBSTACLE 6: PERSONNEL CONCERNS

Perhaps one of the least considered obstacles faced when implementing e-Construction is the challenge that can be posed by personnel. This obstacle should be expected since e-Construction has the potential to impact the day-to-day processes of every employee involved in the construction process. There are several potential obstacles when it comes to personnel, including:

1. A reluctance to accept change,
2. A potentially lengthy learning curve and other training issues for some personnel, and
3. Challenges in including all stakeholders in the process.

1. Reluctance to Accept Change

For many states, an e-Construction system will replace one that has been in place for some time, perhaps decades. Many times even the simplest of changes in the work place and in employees' routines can be met with reluctance, or even resistance. e-Construction has the potential to bring about very significant changes.

Some employees will simply have a reluctance to make changes. Others, especially those that are not particularly accustomed to relying on technology as part of their daily routine, may actually resist making changes. You should expect that this will be the case with some employees in your state. Some personnel will likely argue that the current system works perfectly well and does not need to be fixed or improved.

Solution:

This obstacle is one that does not have an easy solution to implement. Some proactive steps can be taken to address the concerns employees may have, including:

- Develop materials to distribute to employees to help them understand the benefits of using an e-Construction process and why the state is choosing to transition away from its manual processes.
- Get the buy-in of leadership, stakeholders, and key personnel so that they can serve as "champions" for the e-Construction system.

2. Learning Curve and Training Issues

All personnel that are affected by the implementation of an e-Construction system will have a learning curve associated with coming to understand how e-Construction impacts them and their jobs. However, some personnel may be significantly impacted by the changes in policies, procedures, and processes that accommodate for e-Construction.

- This may be due to the amount of changes they personally experience in their day-to-day routines.
- This may be due to their lack of understanding of the technology that is used.

Or, this may be due to their reluctance to make changes.

Solution:

You should expect that all employees will require training to one degree or another. Some employees may require a significant amount of training and support as they transition to the newer e-Construction processes. It would be particularly helpful to have all policies, procedures, and processes well documented before fully rolling out your e-Construction program. It would also be helpful to pilot your e-Construction with a handful of projects using employees that are particularly well suited to the e-Construction process. Their experiences and feedback can be valuable when developing training for the rest of the employees. You should also plan on allowing ample time for initial training and ongoing support of employees as they become accustomed to the e-Construction system.

If you have state training personnel available, engage them to develop employee training on the e-Construction system, processes, procedures, and polices. If you use a vendor-supplied solution (such as a collaborative site) you should consider having the vendor provide documentation and training for state users.

3. Including All Stakeholders

The involvement of all stakeholders is critical to the successful implementation of an e-Construction system. Unfortunately, for various reasons some stakeholders may not be able to participate as fully as is necessary. As discussed before, the development and implementation of an e-Construction system is likely going to be work done in addition to the regular work duties of everyone involved. There is also the possibility that some of those in stakeholder positions may be resistant to the changes that e-Construction will bring. Finally, the possibility exists that you will have to work with stakeholders that may have competing interests, which can create unnecessary conflict, stress, and distractions.

Solution:

It is highly recommended that you find representatives from each stakeholder area that have the qualities needed to successfully implement the e-Construction system. Particularly, you should seek out individuals that are genuinely excited about being involved in the project and would serve as “champions” and advocates for e-Construction. These types of employees may be willing to put in the additional hours and effort that will be necessary. You should also be prepared to take on the role of diplomat when working with stakeholders that may have competing interests. The overall goals and functional requirements of the e-Construction system should be clearly known to all stakeholders as soon as possible in the process so that everyone is working towards the same objective from the beginning.

THE BENEFITS OF E-CONSTRUCTION

As you can see, there are a number of potential obstacles that could create challenges as you work towards implementing e-Construction in your state. However, the experiences of states that have implemented e-Construction (such as Michigan and Florida) have proven that the benefits far outweigh the obstacles and challenges that may exist. The benefits experienced by the state, vendors and contractors, and the general public can be significant. It is important that all stakeholders in the e-Construction process along with all decision makers understand the benefits your state will experience when e-Construction is implemented.

BENEFIT 1: SAVING TIME

Consider just two areas in which construction projects experience delays or wait time.

- **Signatures:** Frequently construction-related documents need to be signed by multiple individuals, including perhaps the contractor and state employees. How much time does it take for the document to be routed from one person to the next? If a partially electronic system is used, documents still have to be signed, scanned, then faxed or emailed. How much time does this take? How much more time is spent waiting if a delivery service or courier delivers hard copies of the same documents or drawings? How much more time may be spent waiting if the person providing the signature or stamp is away on vacation or official business?
- **Inspections:** Whenever site inspections are carried out, state inspectors must physically travel to the construction site. How much time does the inspector spend travelling to the site, performing the inspection, completing documentation regarding the inspection, then travelling back to the office?

Now, consider how much time could be saved in these same scenarios if an e-Construction system was fully implemented.

- **Signatures:** When a document must be signed, or drawings must be stamped, the responsible party simply inserts their electronic/digital signature or stamp on the document or drawing that exists in the system and saves the file. The e-Construction system automatically notifies the next person in the chain that the document or drawing requires their attention. There is no lag time waiting on documents to be scanned and email or faxed. There is no downtime as hard copies of the documents or drawings are being delivered to the next person in the chain.

- **Inspections:** When a routine inspection is to be performed, the state inspector simply initiates a video chat with the contractor in the field. The inspector can see exactly what the contractor sees at the construction site, can ask questions, and can provide instructions to the contractor. When the inspection is completed, the state inspector simply inserts his or her electronic/digital signature into the appropriate form in the system. There is no time spent in a vehicle driving to and from a construction site. There is only a fraction of the time spent in the process of completing the appropriate documentation.

By virtue of the fact that every document and drawing can exist in electronic format, all signatures and stamps can be inserted electronically, and most inspections can be carried out via video chat, virtually all downtime associated with travel, delivery, printing, scanning, faxing, and waiting on hand written signatures will be eliminated when an e-Construction system is fully implemented.

BENEFIT 2: HIGHER PRODUCTIVITY

Any time a complicated or time-consuming process can be replaced or supplemented with technology, the productivity of personnel will improve. You should expect that an e-Construction system might replace entire components of your existing construction process and improve the efficiency of the oversight and construction management by personnel. It will also reduce the workload of other components, even if direct personnel involvement is still required. Some tasks that formerly may have taken hours could instead take minutes. As a result, personnel with both the state and contractors/vendors will have more hours in the day to devote to other work-related tasks.

BENEFIT 3: REDUCING BUDGET

It is said that time is money. This is certainly true when it comes to contractors. When time is saved in the construction process, money will be saved. However, there will be many other areas of savings. Consider the amount of documentation and drawings your state and its contractors may currently print out. Consider the amount of time and expenses associated with document scanning. Consider the expenses associated with travel to construction sites, including fuel, meals and incidentals, and vehicle maintenance. Consider the costs associated with delivery of documents and drawings. When an e-Construction system is fully implemented in your state, most of these expenses can be removed or significantly reduced. In fact, the states of Florida and Michigan both estimate that they will save $40,000 per year, per contract after e-Construction is fully implemented.

BENEFIT 4: ACCESSIBILITY, TRANSPARENCY, AND SECURITY

An area of benefit that may not get much consideration is the inherent accessibility, transparency, and security that an e-Construction system provides. When your state has a collaborative site established for all stakeholders, access to information is made exponentially easier. All stakeholders will be provided with a complete view of each construction project as the e-Construction system will serve as a single source of accurate, reliable, and real-time information. This will create a process that is very transparent, which will lead to greater accountability by all stakeholders. An e-Construction system will be more secure and reliable than a manual process, particularly when it comes to the protection and retention of documentation.

BENEFIT 5: QUICKER PAYMENT TO CONTRACTORS

Payment to contractors can be a particular point of frustration. In order to make payments, all relevant documentation has to be handled precisely and carefully. The state and the contractor must both be sure to "dot the i's and cross the t's." An e-Construction system will manage this process so that all documentation required prior to payment is correctly handled, approved, and moved along the chain in a quick and transparent manner.

BENEFIT 6: ADHERING TO BEST PRACTICES

Any time an organization has an opportunity to make an impactful improvement, it should. When your state implements an e-Construction system you can be certain that you are dramatically improving virtually every aspect of the construction process. You will be introducing efficiencies, cost reductions, and increased transparency and accountability. This is all due to the fact that you are replacing an antiquated, manual, paper-based system with a one that is built on a technology framework that is reliable, efficient, and accessible by all stakeholders.

FLORIDA DOT CASE STUDY

The path each state will follow to implement e-Construction will be unique. However, most states will have some common experiences as they attempt to replace their existing processes and procedures with a paperless e-Construction system. The state of Florida Department of Transportation (FDOT) has made tremendous progress in implementing e-Construction and is presently operating a paperless environment, using digital signatures, and incorporating technology solutions to allow for the ease of communication between personnel in the office and those in the field.

Florida didn't get e-Construction implemented without a tremendous amount of planning and effort. This section discusses how Florida went about implementing e-Construction. It may be that some of the experiences Florida encountered each step of the way will be of benefit to you as you make plans to implement e-Construction in your state.

STEP 1: GETTING BUY IN

Fortunately for the FDOT, its Secretary had a proactive vision to bring the organization's antiquated processes into the 21st Century. This proactive attitude from the leadership made the important step of getting buy-in from key stakeholders within the various FDOT districts much easier. FDOT also found that many of the contractors and consultants they worked with were already using advanced technology solutions such as mobile devices, electronic as-builts/review of plans, and 3D models. This helped make getting buy-in from industry stakeholders easier as FDOT's move to e-Construction would improve data sharing and collaboration between the state and contractors. FDOT formalized the mutual desire of FDOT and state construction industry leaders to work towards implementing e-Construction by drafting a Memorandum of Understanding signed by FDOT, the Florida Transportation Builders Association, and the Florida Institute of Consulting Engineers.

STEP 2: SETTING UP A COLLABORATIVE SITE

In order to begin going paperless, FDOT needed a collaborative site that state and contractor personnel could use to access construction documentation. FDOT determined that, due to firewalls, it would be necessary to host the collaborative site with a third-party outside the FDOT firewall. FDOT contracted with a consultant to help build a collaborative site that would facilitate sharing and document exchange for construction projects. FDOT required that the solution had to be off the shelf and completely configurable. The collaborative site is used to host project directories that hold the various documents and forms associated with each project. The collaborative site software pre-populates forms with project information, has built-in workflows for routing forms, and supports the use of digital/electronic signatures.

FDOT chose to use the ProjectSolve software to manage the collaborative site. FDOT budgets $125 per month per active contract, or about $800,000 a year.

STEP 3: INCORPORATING MOBILE DEVICES

In order to facilitate a paperless construction process in the field, the use of mobile devices was a necessity. FDOT outlined a number of requirements of the mobile device it would use, including being able to interface with the collaborative site, access e-Books (such as specifications, standards, and manuals), carry out video meetings from the field, access as-built plans, and provide calendar and email capabilities.

FDOT evaluated numerous mobile devices but settled on the Apple iPad, in particular because it was the most suited for mobile connectivity needs (with built in GPS and 4G data). FDOT budgeted $630,000 for the first year, which included 300 devices and accessories, training, custom software, and data plans. Going forward FDOT budgets $180,000 annually for data plans.

STEP 4: USING DIGITAL SIGNATURES

A key element of a paperless e-Construction system is the ability to electronically / digitally sign documentation. FDOT had to work with the Florida Department of Financial Services to gain approval to use digital signatures on monthly estimates. FDOT also had to confirm that statutes allowed for the use of digital signatures. Finally, FDOT worked with the Florida Board of Professional Engineers to gain approval for engineers to attach a digital signature to electronic plans without the need to sign and seal each individual sheet.

FDOT researched a number of companies that provide digital signatures and chose IdenTrust due to their ability to authenticate the digital signature certificate holder's identity. FDOT budgets $19,500 per year for 390 certificates. ($100 per certificate every two years.)

STEP 5: AUTOMATING FORMS

Once the ability to use digital signatures was in place, FDOT began to automate forms in the collaborative site. Digital signature blocks were added to forms so digital signatures could be quickly and easily added. All forms were made uniform, using the same basic template so that all forms for a particular project were pre-populated with project-specific data.

STEP 6: USING ELECTRONIC AS-BUILTS

One of the final steps FDOT took in the implementation of e-Construction was to make as-builts. Since FDOT had a goal of going paperless, and since there wasn't a solid determination to implement 3D design, it was decided to use PDF software to address as-builts.

FDOT settled on Blue Beam software, which allowed them to easily embed pictures, annotate, and create markups. FDOT budgets $48,000 annually for licenses for Blue Beam software. (401 licenses statewide at $120 per license)

SAVINGS REALIZED

While the state of Florida invested a significant amount of money up front, the expected budgetary savings more than offset the investment. Florida invested $1.5 million implementing e-Construction, and expects to spend up to $1 million annually operating the e-Construction system. However, projected savings annually are expected to approach $22 million.

Savings in your state could vary widely, depending on how much technology you need to implement, which technology solutions and vendors you select, how many licenses you need to purchase, and how many construction projects are in progress.

GETTING STARTED

At this point you may appreciate the many benefits that can be derived from introducing an e-Construction system in your state. You may also understand the obstacles that you could encounter as you implement e-Construction. If you are ready to start the process of implementing e-Construction in your state there are a few steps you should take.

STEP 1: START GOING PAPERLESS

As soon as possible you should determine where your state might be able to convert to a paperless process. It may be that your state already has the technology in place to electronically store documents. Your state may also have existing automated solutions in place, such as a program to gather contractor progress. You should work with your state IT personnel to see if your existing technology can be leveraged as a step towards implementing e-Construction.

STEP 2: GET BUY-IN

It is very important that you get as many of the stakeholders as possible committed to implementing e-Construction. This will make the job of building and launching an e-Construction system much easier. You should make every effort to get input from all stakeholders. In particular you need to make sure your state IT personnel is involved from the beginning. The entire e-Construction system will hinge on the technology platform. Your state IT personnel will understand what technology your state currently uses and how it can be leveraged in an e-Construction system as well as what additional technology will be needed.

You should also get buy in from the private sector. In particular, it would you very helpful to get the construction industry involvement as soon as possible. As mentioned before, the State of Florida Department of Transportation developed a Memorandum of Understanding (see Exhibit below) between the state and construction industry leaders that outlined the mutual goal and desire to convert the outdated manual construction processes to the more efficient e-Construction process.

STEP 3: BUILD A COLLABORATIVE SITE

As quickly as possible you should establish a collaborative e-Construction site where all stakeholders can participate. This site would serve as a means to view all relevant information for each project, upload documentation, and eventually handle electronic/digital signatures and stamps. This collaborative site may be something that your state develops in-house, or it may be that you choose to use a third-party tool. Your state IT personnel will be able to help make this determination.

STEP 4: FIND "CHAMPIONS"

In addition to getting buy-in from the various stakeholders, you should also identify those that will serve as "champions" of the e-Construction system. These employees across your state will be of help in several ways.

Generate Enthusiasm

You will find that these employees are naturally excited about your state transitioning to an e-Construction system. They will embrace the change and improvements that e-Construction will bring. They will serve as ambassadors to less enthusiastic employees.

Pilot Projects

Your state champions can be friendly participants in pilot projects that your state will perform as it implements and tests the e-Construction system. They will provide valuable and honest feedback that will help improve the system.

Support and Training

The state champions will provide valuable ongoing services after the e-Construction system is implemented. They will be able to provide support and training to state personnel and contractors. The will also be able to serve as a liaison between the state and contractors.

CONCLUSION

As you know, the service provided by your state to oversee and manage the construction of your state's transportation infrastructure is critically important. The amount of resources (both time and expense) invested in these projects is tremendous. In just the last few years we have seen technology become more powerful, flexible, and practical while becoming less expensive. This has created opportunities for states to implement an e-Construction system that can dramatically and positively impact the way construction projects are managed.

While there are certain to be obstacles that you must work through, including questions about information technology, legal concerns, and personnel issues, these can be overcome with hard work, a team of dedicated e-Construction champions, and buy in from decision makers and stakeholders.

Once you have fully implemented e-Construction in your state, the benefits will become apparent immediately when you realize the savings in time, reduction in budget, increase in productivity, and improvements in accessibility and transparency of the construction process.