PennDOT Construction Documentation System

Version 3

The Road To *eConstruction* Business

NASCIO 2021 State IT Recognition Awards

State: Commonwealth of Pennsylvania

Agency: Department of Transportation

Category: Government to Business

Project Dates: February 2014 – January 2021

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EXECUTIVE SUMMARY

The Pennsylvania Department of Transportation (PennDOT) maintains and improves approximately 120,000 miles of state and local highways and 32,000 state and local bridges. It is a large undertaking shared between the department, local governments, and private contractors. With a construction project portfolio averaging over $2 billion per year, the tracking and maintaining of data and documentation across the project portfolio is a huge undertaking. Documentation must be maintained for the entire length of the construction phase of the project, which could last several years.

In January 2021, PennDOT's Construction community, working with the Office of Administration, successfully completed and delivered a multi-year project called the **Construction Documentation System version 3** (CDSv3). This project introduced a complete electronic process on top of an existing platform – the Engineering and Construction Management System (ECMS). ECMS covers a construction project from beginning to end, including design, bid, award, management, finalization, and inspection, providing PennDOT, its business partners and the public with up-to-date information on construction contracts and consultant agreements.

Prior to the implementation of CDSv3, data was captured in application known as CDS NeXtGen, which resided on individual personal computers (PCs) located in construction inspection field offices at each project site. Paper records for each project were stored in file cabinets at each site. Remote access to paper documentation and CDS NeXtGen did not exist. Approvals of invoices and work orders were performed in ECMS, but there was no direct linkage between the two systems. As a result, data transfer between ECMS and CDS NeXtGen was cumbersome, expensive and inefficient.

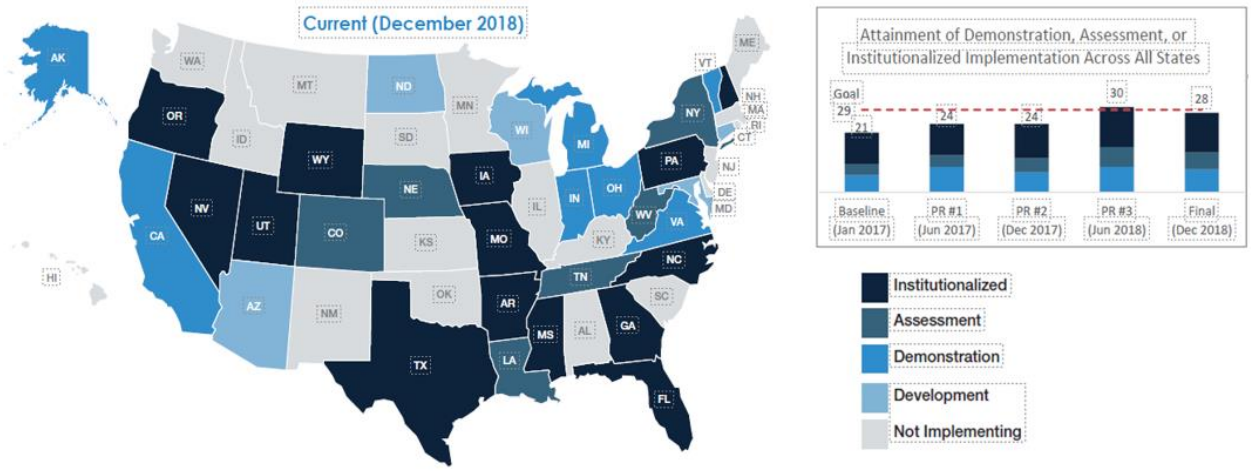
Since the first successful release of the CDSv3 project, PennDOT has reaped many benefits from the increased efficiency and improved quality of the construction documentation process. These benefits are in addition to meeting the goal of retiring of the CDS NeXtGen application.

Key achievement highlights include:

- Technologies
  - Electronically capturing construction data
  - Electronic submission of all construction documentation
  - Increased use of mobile devices
  - Increased automation of document review and approval
  - Use of electronic signatures by all parties throughout the process
  - Secure document and workflow management, accessible from any device
- Moved towards a paperless and sustainable system
- Provided a single source of truth where documents are stored exactly once, and all parties use the same version
- Reduced time and cost of printing, mailing, storage, travel
  - Saved an average of 2 hours per day per inspector
  - Inspectors collected 2.75 times more information
  - Saved an estimated $14,000 per project per year
    - An average of 700 projects per year results in $9.8 million in savings per year
- Achieved standardization across projects

- Facilitated faster turnaround for estimate and work order approvals using a web-based system to eliminate travel by IICs to job offices to process Project Site Activity (PSA) reports, saving approximately $572,000 per year.
- Reduced math errors and improved data integrity through automated calculations and inspectors entering data themselves from anywhere, rather than delegating data entry to staff at the project office.
- Project field Inspectors have access to ECMS and CDSv3
- Get reimbursed faster due to fewer mistakes
- Enabled project tracking through PennDOT Project Collaboration Center
- Contract close-out has been reduced from 12-18 months to 6-9 months. Open projects lower a business partner's bidding capacity; faster closing allows them to bid on more projects, thereby providing them with greater opportunity to generate revenue.

By incorporating these key accomplishments, CDSv3 has been transformational for PennDOT's construction business as well as its contractor and business partner communities. CDSv3 also played a major role in helping PennDOT transform its construction business into one of the national leaders in eConstruction.



IDEA

Many challenges existed in managing road and bridge construction documentation. One computer at each field office housed the CDS NeXtGen software, which worked with a Microsoft Access database. As CDS NeXtGen continued to age, updates to the operating systems and Office software of these computers had to be suspended for the application to continue to work. This in turn made it more difficult for business partners and PennDOT to acquire hardware that could run the software. Each project had a CDS NeXtGen Operator to input the inspector's handwritten inspection diaries and every PennDOT's Engineering District had a CDS NeXtGen Coordinator who traveled to each project field office to install the CDS NeXtGen software.

The Inspector-in-charge (IIC) had to generate each estimate and work order for a project from the same PC at the job site. The IIC may have multiple projects under construction at one time, causing the IIC to travel back and forth to approve estimates and work orders.

The source documents - handwritten field inspection diaries and calculations - had to be kept in project files as reference. Also, there were no attachment capabilities in CDS NeXtGen. Manual records including source

of supplies, material certifications, items quantity books, concrete field inspection books and material testing information were maintained and stored in the project field office files. To address these issues and continue to modernize the business processes, the CDSv3 project had the following primary goals and objectives:

1. Fully replace the CDS NeXtGen functionalities with an enterprise web-enabled platform
2. Significantly improve the use of Construction Forms
    a. Convert priority construction forms to electronic format
    b. Make forms easily accessible over the Internet
    c. Allow for detailed analysis of data collected by priority construction forms
3. Improve efficiency of the Construction Documentation System
    a. Reduce manual data entry errors
    b. Make construction documentation accessible over the Internet
    c. Streamline audits process

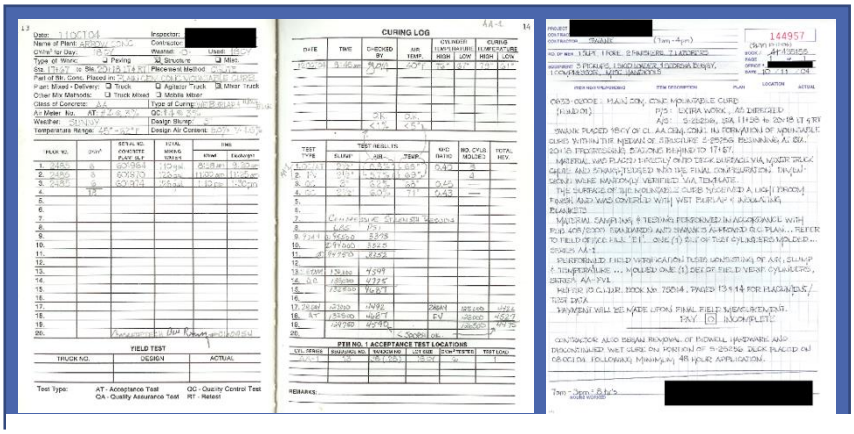


Figure 1 - Samples of handwritten construction documents

IMPLEMENTATION

This project strictly followed the Software Development Life Cycle (SDLC) methodology during system releases, which ensured consistency in the development and implementation process. In addition to working within the organization, the project team collaborated its efforts with the Federal Highway Administration (FHWA) for solutions and procedures.

The project was carried out using the Iterative Project Management methodology, with many major and minor releases into production. During such time, the project team worked closely to come up with an approach that followed best practices. CDSv3 transformed many paper-based processes, associated with many delays and inefficiencies, into fully electronic processes.

To meet the project's goals and objectives, the following major functionalities were developed and implemented along the project timeline.

1. **Source of Supply** – Contractors must submit a list of potential suppliers for all materials incorporated into a project. This ensures that all materials are being provided by approved suppliers and their use can be tracked across various projects. Using CDSv3, contractors can now enter their information directly in ECMS, which allows for more efficient review and approvals.

2. **Certifications** – Similar to the Source of Supply, the Certification functionality allows contractors to submit Manufacturer / Supplier information to certify that approved materials are being used for a project. The Certification functionality designates lot numbers, quantities, and various other detailed pieces of information. This enhancement has enabled the department to create a database of materials and their placement around the state. Not only has the approval process for getting Certifications greatly improved, but the database compilations will increase the speed to track inferior materials and respond to Right to Know Law requests.
3. **Consultant Mileage and Hours** – The original process involved the consultant completing paperwork, acquiring a signature, and uploading into ECMS to receive payment. The new process allows the consultant to enter their data into a mobile application and submit it directly to the ECMS system, where all reviews and approvals for payment use the system workflow process. Like many of the changes, this has created great savings in efficiency.
4. **Project Site Activities (PSA)** – PSA reports are the primary method of tracking progress on a project. It allows staff to record activities by contractors and utilities and monitor inspector hours, weather conditions, and environmental mitigations. It also allows for PDF and image file attachments to visually document the activities. This was another function previously housed in a satellite system that could only be completed from a specific computer. Incorporating this functionality into ECMS not only allows completion of the reports from any location, but also allowed the creation of a mobile PSA application that can be completed in parallel with the activities and then uploaded to ECMS. This saves a considerable amount of time in completing reports.
5. **Paybook** – While ECMS users do not normally interact with the Paybook functionality, it is nonetheless critical for several other functions. Paybook serves as a ledger for items, quantities, and fund codes. This combination of factors determines which items have enough quantity to place on estimates, and which ones will need additional quantity ordered in. It is the cornerstone of transferring the Estimate and Work Order functions to ECMS and required extensive coding and testing.
6. **Estimates** – Estimates is the way ECMS generates payments to contractors for quantities of items from approved PSAs. Estimates were always approved through ECMS workflow but had to be created in a satellite system and uploaded. This necessitated visiting a specific field location for every estimate. This became costly in time and funds as many inspectors had multiple projects. CDSv3 replaced the entire process within ECMS. Now estimates can be done for any project from any location. With every project generating an estimate every two weeks, this enhanced functionality created a massive improvement in efficiency and cost reduction.
7. **Work Orders** – Work orders are the mechanism by which quantities and funds are encumbered for a project through normal negotiation techniques. Work Orders were always approved through ECMS workflow but had to be created and in a satellite system and uploaded to ECMS. This required IICs to visit the satellite location for every work order. This became costly in time and funds as many inspectors had multiple projects. CDSv3 replaced the entire process within ECMS. Now work orders can be done for any project from any location. As every project has multiple work orders, this created a significant improvement in efficiency and cost through travel reduction.
8. **Force Account** – Force Account is the process by which item quantities and funds are secured for a project when other negotiation methods fail. Manpower, equipment, and materials are tracked and priced directly for an overall cost. This was previously accomplished via paper forms or fillable PDFs and often contained errors for larger projects. Contractors can now upload information into ECMS, and the inspection staff can track everything on their mobile devices. This reduces errors due to system validations and improves approval times. Also introduced was a contractor insurance verification submission in ECMS that further reduces costs as this process was rarely monitored in the past.

9. **Asphalt and Diesel** – This functionality allows for cost adjustments to certain items when the price of fuel or asphalt differs too greatly from the bid amount. The process was manual prior to CDSv3 but has enjoyed a high level of automation due to the CDSV3 project. The system now tracks quantities and creates adjustments automatically with very little input from the project staff. This makes the process more efficient and keeps down oversight costs.
10. **Reports Facility**– The Reports Facility was incorporated to allow users to view various compilations of project information. Many reports are used for the auditing process, while others are used by the project managers to track progress. These reports have grown in number since the implementation of CDSc3 to cover almost all facets of construction. The reports can also be exported.
11. **Audits** –The audit functionality allows district office staff to review PSAs and ensure that all the information is correct. By cross referencing other information in ECMS and use of the Reports Facility, the system workflow allows for more efficient completion of the audits. At a minimum, one audit must be completed for project closeout.

The entire project lasted seven years and included eight major releases.

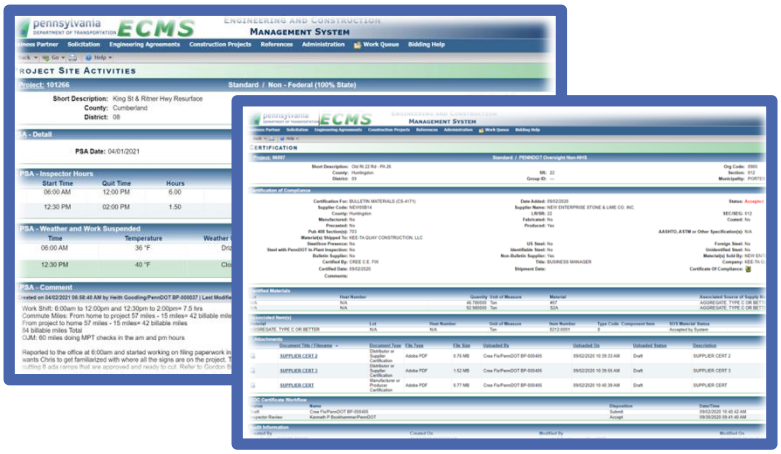


Figure 1 – Some screenshots of CDSv3 features within ECMS

In addition to the primary enterprise web-based application, CDSv3 also deployed many of its features on a mobile platform utilizing Apple iOS devices (iPads). Leveraging modern technologies, the department positioned its workforce to be independent from the traditional workstation setting, as well as allowing business data to be accessible on the construction site. All data are managed within the ECMS solution, which now also includes CDSv3.

IMPACT

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> *"From FHWA's perspective, e-Construction (specifically ECMS) has revolutionized the way we interact with PennDOT. We can now instantly see real-time project information, gather data, conduct reviews and approve actions like never before. This ability has saved us an incredible amount of time and paperwork to review and approve projects. PennDOT transforms itself through implementing innovation." - Tony Mento – Director of Technical Services, FHWA PA Division*

The benefits provided by the CDSv3 project allow PennDOT staff to manage and monitor an expansive portfolio of road and bridge construction projects more effectively, reducing time to enter information, process orders and payments, track progress and materials, and have easier access to records and documents associated with each project.

Taken together, these improvements are helping to reduce overall project costs so the department can get the most "mileage" from every transportation taxpayer dollar.