Current/Ongoing Work

AASHTO TC3 course: Fundamentals of Digital Construction Inspection (web-based training)
While compared to other industries, highway construction inspection has been slow to digitize, a movement towards implementing digital construction inspection has started. This course introduces participants to the concept of a digital construction site and what "digital construction inspection" means today for highway transportation. The course covers foundational knowledge of digital construction inspection technologies and practices, including, but not limited to: leveraging 3D digital data for visualization; collecting digital data using surveying technologies; capturing sophisticated images, models and maps using aerial and scanning technologies in the field; and converting traditionally more manual and paper-based functions, such as e-ticketing and daily inspection reporting, to digitally-based activities.

NCHRP Synthesis 20-05/Topic 51-01: Practices for Construction-Ready Digital Terrain Models
The objective of this synthesis is to document current processes and strategies to the effective use and transfer of DTMs from design into the construction phase of highway projects. The study will document DOT identified benefits and challenges to using DTMs in highway construction and inspection.

Information to be gathered includes, but is not limited to:

- Extent of DOT use of DTMs for construction and inspection
- Size and type of projects using DTMs for construction (e.g., new construction, rehabilitation, maintenance)
- Written DOT guidance for the use of DTMs in design and construction phases
- Are DTMs considered a legal document? If so, what is the extent of liability for accuracy and level of detail?
- How do DOTs ensure that the contractor's DTM is equivalent to the designer's DTM?
- Are DTMs provided to contractors for "information only" during the letting process?
- Responsibility for DTM model modifications during construction (e.g., DOT staff, consultants, contractors)
- DOT process for quality control and assurance
- Benefits and challenges to effective use of DTMs in construction

Related publication: Construction-Ready Digital Terrain Models KTC-20-06/SPR19-576-1F
https://doi.org/10.13023/ktc.rr.2020.06

NCHRP TFRS-02: Lifecycle BIM for Infrastructure: A Business Case for Project Delivery and Asset Management
The objective of this research is to evaluate the business case for BIM in the United States by quantifying how adopting enterprise-wide BIM systems can provide increased agency efficiencies and foster advanced, comprehensive lifecycle management of enterprise assets.

The data for this research shall be gathered using domestic and international examples, with the findings targeted for the U.S. market and DOT stakeholders.

FHWA BIM Roadmap

Transitioning to Digital As-Builts: Identifying Needs, Addressing Challenges, Demonstrating Benefits, and Assisting with Deployment

The objective of this task order is to:

1. Investigate the needs, gaps, and barriers for a DOT to make the transition from paper-based, marked-up paper plans or digital CAD drawings to, digital asbuilts.
2. Establish the link between the information in the digital as-built and needed asset management data (for example, between the digital as-built's Project Information Model (PIM) to the Asset Information Model (AIM)).
3. Develop approaches and methods for structural/organizational changes a DOT should take to facilitate the use of digital as-builts.
4. Support FHWA in planning and conducting Everyday Counts Round 6 (EDC6) activities related to Advanced Digital Construction topic, which includes digital asbuilt technology. (Optional)

Work in Publication (Drafts Available)

Model Development Standards in the Construction Industry and Beyond (2020)
The objective of this research is to determine how UDOT's approach to formalizing digital delivery aligns with the trajectory of national and international developments and to capture insights from how other industries manage and exchange digital information.

Construction Inspection for Digital Project Delivery (2019)
The study outcomes include guidance for effectively using digital data in the construction inspection process and informing workflows for digital data mobility from design to construction to project closeout. This study also developed effective practices for establishing and scaling sUAS programs and integrating sUAS in the construction inspection process.

Electronic Construction Model Definition (2020)
This Final Report provides an overview of 3D modeling for design through construction, discuss previous PennDOT efforts related to 3D modeling, provide a benchmark of other state DOTs, summarize best practices and recommendations for implementation, and create an implementation strategy. Additionally, the report will primarily focus on aggregating information in a way that will improve the understanding of 3D modeling practices and highlight the best actions to successfully implement 3D models.

Demonstration of Bridge Project Delivery Using BIM (2020)
This research addresses two specific challenges to digital delivery: technical requirements and specifications to manage the new, digital processes and media, and standardizing the content and format of the digital exchanges. There are three discrete products of this research included in this report:

- A case study of a bridge project delivered digitally using BIM-based media for the contract documents.
- Information for contracting professionals who need to incorporate BIM into contracts and specifications.
- A utility that implements the Industry Foundation Class (IFC) Bridge Design to Construction Information Exchange (U.S.) exchange specification to convert AASHTOWare Bridge Design data into 3D bridge models.

Determination of Improved Pavement Ride Quality when Utilizing 3D Modeling and Automated Machine Guidance (2017)

Integrating 3D Digital Models and other Building Information Management Data into Asset Management (2019)

Identifying Data Frameworks and Governance for Establishing Identifying Data Frameworks and Governance for Establishing Future BIM for Infrastructure Standards (2018)

New Synthesis Statements

NCHRP Synthesis 20-05/Topic 52-01: State of Practice on Infrastructure Inspections for the Digital Age

The objective of this synthesis is to document the various technologies used by DOTs to inspect infrastructure projects.

Information to be gathered includes (but is not limited to):

- •The technologies used for infrastructure inspection
- •The different methods used to assess the viability, efficiencies, and return on investment(ROI) of such inspection technologies

NCHRP Synthesis 20-05/Topic 52-04: Use of Unmanned Aircraft Systems for Departments of Transportation

The objective of this synthesis is to document the use of Unmanned Aircraft Systems (UAS) by state DOTs during construction.

Information to be gathered includes (but is not limited to):

- Current use of UAS by state DOTs
- How DOTs procure UAS application services (e.g., DOT staff or outsourcing)
- Identification of potential obstacles of UAS applications by state DOTs (e.g., legal implications, technical expertise, and training)

NCHRP Synthesis 20-05/Topic 52-14: 3D Digital Models as Highway Construction Contract Documents
The objective of this synthesis is to document current DOT practice for delivering 3D digital models to highway contractors and the use of these models as part of the legal construction contract document.

Information to be gathered includes (but is not limited to):

- Extent of use of 3D models for informational purposes and as contract documents;
- Identification of the controlling digital contract documents (sometimes called “model of record”);
- Access control for the “model of record” digital contract documents;
- Managing authorized changes to the contractual 3D models including who pays for the changes;
- Methods for document retention and data security;
- Scope of using 3D models as contract documents (e.g., aspects of the highway project that are depicted in the models, the level of metadata and detail in the models);
- Procedures for quality control and quality assurance of the digital contractual and supplemental data;

- Risk mitigation strategies (e.g., partnering and previewing the 3D models in advance of the letting, contract liability issues);
- Outlays made by DOTs to use 3D models in contracting;
- Sample consultant design and inspection scopes of work;
- Sample construction special provisions; and
- Effect on construction bid prices as a result of using contractual digital contract documents.

NCHRP Synthesis 20-05/Topic 51-17: Practices for Closing Out Highway Projects from Substantial Completion to Final Payment
Information to be gathered will include but not be limited to:

- Reported durations of time to close out a project from opening day to final contractor payment and final closeout.
- Required documentation for close out (e.g. certifications of work, materials, test results and other documents)
- Financial implications of not closing out a project
- Policies, processes, tools and metrics agencies use to control the duration required to close out projects (e.g. milestones, agency goals, monitoring and tracking mechanisms)
- Major factors influencing the delay of the close out of a project, including internal processes and external stakeholder influences
- Successful practices as reported by DOTs

Recent Publications

Electronic Ticketing of Materials for Construction Management (2020)
The objective of this synthesis is to identify state DOTs that have experience using e-ticketing technology and provide an overview of the implementation of these technologies to identify success factors and challenges. This synthesis collected the information regarding material-specific tracking technologies being used by state transportation agencies (STAs), pilot efforts using e-ticketing and lessons learned to date, barriers to implementing e-ticketing for those agencies not using this technology, and tools and applications available to implement e-ticketing.

Leveraging Augmented Reality (AR) for Highway Construction for Highway Construction (2020)
The study documents current augmented reality (AR) technologies and applications focused on the state of the practice in highway design, construction, and inspection. The study included a literature review (with a desk scan to document AR use in construction) and interviews with researchers and vendors. Two workshops that involved technology and application developers, State departments of transportation, contractors, consultants, and other practitioners were also held. The final task of the FHWA study involved the development of five use-case examples of potential highway construction activities that could be enhanced using AR. These use-cases were based on workshop outcomes that were then refined using research results from chapter 4, which focused on AR state of the practice. Each use-case was outlined in a narrative format with a description of the AR technology and workflow that would be used.

Indiana and Ohio DOT Collaborative Solutions for Digital Construction Inspection (2020)
The Indiana Department of Transportation (INDOT) and Ohio Department of Transportation (ODOT) are prioritizing digital delivery practices and have made significant progress with enriching digital workflows for design and construction. Most recently, the two agencies collaborated on developing a construction

inspection application that incorporates easy-to-use inspection checklists and an interactive inspection experience using design intent model elements. This collaboration included working directly with a common software vendor to advance their respective interests in improving digital construction inspection practices.

Guide For e-Construction & Partnering: Training the 21st Century e-Construction Workforce (2019)

Innovative As-Built Data Collection Delivers Enterprise Value (2019)

Michigan DOT Digital Delivery Work Group (2019)

3D Highway Design Model Cost Benefit Analysis (2019)
The primary objectives of this research project were to research and evaluate construction costs to determine the return on investment (ROI), investigate and document contractor's current practices of using RID 3D models, explore ways to streamline plan production by delivering contractual model elements, and conduct an analysis of potential and actual risk reductions associated with issuing 3D models.

INDOT e-Construction Initiative Update (2018)

Guide for Using 3D Engineered Models for Construction Engineering and Inspection (2017)
This guide highlights key considerations for deploying three-dimensional (3D) engineered models for construction inspection. These include generating workflows for activities before, during, and after construction through partnering agreements; updating or creating new specifications and workflows for inspection work; and providing the necessary training and tools for construction staff to be successful.

Utilizing 3D Digital Design Data in Highway Construction - Case Studies (2017)
This research explores opportunities to refine processes for generating the 3D digital design data used in construction, identifies priorities for addressing data schema gaps, offers strategies for determining and controlling 3D data quality, and identifies project characteristics that lend themselves toward creating 3D digital design data for use in construction.

Development of 3D and 4D Bridge Models and Plans (2017)
Researchers conducted a thorough review of the state of the practice and engaged with industry partners to help create a plan that will help MDOT implement 3D models for bridges. The plan includes recommendations for producing, managing and documenting the production of bridge models, and a framework to organize the information in the models, define the level of development and visual quality of model elements, manage geospatial distance distortions, and clarify desired outputs from the models. The project also tested a 3D bridge modeling software on real projects and provided training materials to advance the market-ready 3D modeling applications for bridge designers.

Automation in Highway Construction Part II: Design Guidance and Guide Specification Manual (2016)
Part II (this volume) presents an overview of enabling technologies and policies for automation in highway construction as well as implementation strategies. This volume also includes design procedures and practical guidelines to properly generate three-dimensional models for uses in construction and other phases of highway project delivery.

INDOT 3D Workflow Study and Implementation Plan (2016)

Development and Use of As-Built Plans by State Departments of Transportation (2020)

Addressing Challenges and Return on Investment (ROI) for Paperless Project Delivery (e-Construction) (2017)

Effective Use of Geospatial Tools in Highway Construction (2017)

Emerging Technologies for Construction Delivery (2019)

Data Management and Governance Practices (2017)

Leveraging Technology for Transportation Agency Workforce Development and Training (2017)

Training and Certification of Highway Maintenance Workers (2015)

Practice Documents

Model Development Standards Manual (UDOT, 2020)

The UDOT Model Development Standards Manual (MDSM) was developed to provide project development staff (UDOT and consultants) with minimum modeling requirements specific to UDOT projects. The MDSM provides specific requirements related to the content and the accuracy of the design elements to be created when authoring models for roadway and bridge projects. In addition, the MDSM outlines the project management considerations when developing individual project requirements. Engineers are expected to follow the minimum requirements herein; and consult other UDOT standards and specifications when developing digital information for highway and bridge construction. This manual was originally released in September 2020.

Model Based Design and Construction (MBDC) Guidelines for Digital Delivery (Utah DOT, 2019)

Utah Department of Transportation, 2017. **Survey and Geomatics Standards**, Salt Lake City, UT: Utah Department of Transportation.