DEVELOPMENT OF AN INNOVATIVE, ON-DEMAND E-CONSTRUCTION TRAINING PROGRAM TO INCREASE USAGE AND UNDERSTANDING OF AGENCY-WIDE SOFTWARE PROGRAMS

by

WILL SHIRLEY

(Under the Direction of Stephan Durham)

ABSTRACT

The Georgia Department of Transportation (GDOT) e-construction initiatives utilize key software programs: ProjectWise, Bluebeam, and CATS, that currently lack adequate on-demand training. This study aims to develop innovative and engaging e-construction training programs to increase usage and understanding of ProjectWise, Bluebeam, and CATS across the department. E-construction training practices at the national, state DOT, and commercial level were initially investigated. GDOT's current e-construction training practices were evaluated to understand existing training content and opportunities to improve Department training. A survey and subsequent meetings were conducted with GDOT Construction personnel to fully understand the software challenges and training goals. ProjectWise, Bluebeam, and CATS training programs were developed consisting of PDF guides, instructional video demos, and interactive modules organized asynchronously into beginner and intermediate/advanced topics. Through a multifaceted approach, the training programs offer on-demand, engaging online materials that increase productivity in the programs resulting in resource and time savings for the department.

INDEX WORDS: E-construction, Software, Training Program, ProjectWise, Bluebeam, Video Module, Interactive Training

DEVELOPMENT OF AN INNOVATIVE, ON-DEMAND E-CONSTRUCTION TRAINING PROGRAM TO INCREASE USAGE AND UNDERSTANDING OF AGENCY-WIDE SOFTWARE PROGRAMS

by

WILL SHIRLEY

B.S.C.E., University of Georgia, 2020

A Thesis submitted to the graduate faculty of the University of Georgia in partial fulfillment of

the requirements for the degree of

MASTER OF SCIENCE

ATHENS, GEORGIA

2021

DEVELOPMENT OF AN INNOVATIVE, ON-DEMAND E-CONSTRUCTION TRAINING PROGRAM TO INCREASE USAGE AND UNDERSTANDING OF AGENCY-WIDE SOFTWARE PROGRAMS

by

WILL SHIRLEY

Major Professor: Stephan A. Durham
Committee: Mi Geum Chorzepa
S. Sonny Kim

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
December 2021

ACKNOWLEDGEMENTS

The success of this research would not have been possible without the support of several individuals. First and foremost, I would like to thank Dr. Stephan Durham, my major professor, for introducing me to this project as an undergraduate student and his mentorship throughout the project lifecycle. Additionally, I would like to thank my committee members Dr. Mi Geum Chorzepa and Dr. S. Sonny Kim for their involvement and recommendations with the research. On behalf of the University of Georgia, I would like to thank the Georgia Department of Transportation (GDOT) for their financial support and involvement over the past year and a half. Specifically, I would like to thank John Hancock, P.E., GDOT State Construction Engineer; Beau Quarles, P.E., Assistant State Construction Engineer; and Brennan Ronney, Research Engineer, for their direct involvement with the project. Additionally, I would like to thank Frank Flanders, Assistant State Design Policy Engineer, Glenn Williams, Technology Implementation Manager, and Devon Wheatle, Office of IT, for their help with the training program development. Finally, I would like to thank GDOT IT personnel Teague Buchanan, Assistant Administrator, Tabatha Doby, Team Lead-Training, Ana Maria Marin, Instructional Designer/Trainer, and Dennis Fuller, Training and Development Specialist, for their support with posting the training material.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 | INTRODUCTION

E-construction has become a vital component of the construction industry over the last twenty years. The Federal Highway Administration defines e-construction as the collection, review, approval, and distribution of highway construction contract documents in a paperless environment. Departments of Transportation (DOTs) across the country have implemented countless e-construction programs and practices at various levels. The use of e-construction applications and processes by DOTs improves the efficiency and productivity of the construction management process. One of the most important features to implement along with new e-construction technologies is effective, relevant, and specific training to facilitate the transition to unfamiliar technologies and practices.

As the Georgia Department of Transportation (GDOT) shifts to a more paperless environment, the software programs ProjectWise, Bluebeam, and CATS are vital to the construction management process and require more relevant and effective training. A thorough literature review of e-construction training material and techniques at the national, state, and GDOT levels was conducted to comprehensively understand existing e-construction training. Following the literature review, a thorough investigation into GDOT uses and challenges of the three software programs was conducted. Through the extensive feedback of GDOT Construction personnel, a robust and innovative set of training modules covering ProjectWise, Bluebeam, and CATS material was developed to increase agency wide understanding of the three programs. Recommendations to this research are found in Chapter 7 of this thesis titled "Conclusions/Recommendations".

1.1 | Structure of Thesis Chapters

The structure of this thesis encompasses seven chapters that describe the process of developing new training modules for ProjectWise, Bluebeam, and CATS for use by GDOT personnel and consultants. Chapter 2 describes the results of a past research study that investigated an implementation plan for GDOT's e-construction program. Additionally, Chapter 2 provides a review of existing GDOT training material available to employees with a specific focus on ProjectWise, Bluebeam, and CATS material. Chapter 3 provides an extensive literature review covering national and state DOT e-construction training material and methods, along with a review of existing commercial training material available for ProjectWise and Bluebeam. Chapter 4 reviews the research objectives and significance. Chapter 5 investigates the research methodology which consisted of an in-depth survey, multiple meetings with various GDOT construction personnel, collaboration with the State Office of Construction and the Office of IT, and training module development, review, and publishing. Chapter 6 discusses the results of the survey and GDOT meetings, along with the development of the new training material. Finally, Chapter 7 summarizes the research and offers multiple recommendations for future studies. A list of references and appendix including a copy of the survey questionnaire are found in the last two sections of this thesis.

2.0 | BACKGROUND

2.1 | GDOT e-Construction Past Research Findings

Georgia DOT Research Project 17-13: Development of Implementation Plan for GDOT e-Construction Program was submitted in November 2018 and was tasked with identifying and understanding limitations of GDOT's construction administration process, establish framework for a more advanced e-Construction program, and develop a proposal for the FHWA AID Demonstration. Over the course of November 2017 to May 2018, the research team met with GDOT representatives from 15 offices including Construction, Roadway Design, Engineering Services, and IT Infrastructure to understand more completely each office's software usage, communication needs, and challenges. Various challenges were identified relating to GDOT training and ProjectWise features.

The Office of Construction indicated the disadvantage of implementing new software is the training required, and offices involved with preconstruction, consultants, and contractors do not have direct access to ProjectWise. The Office of Engineering saw a lack of knowledge regarding functionality of ProjectWise. Although training was provided for ProjectWise, it was provided a year or more before it was implemented. The Office of Environmental Service indicated that because some new software programs are not implemented on all projects, they do not have adequate time to learn the application. IT expressed the excessive number of folders within ProjectWise. Program Delivery indicated that program users are not always comfortable using a dashboard such as one available in ProjectWise. Similar to the Office of Engineering, the Right-of-Way Office indicated that ProjectWise training was provided 6 months before implementation.

The Roadway Office also discussed the importance of being able to resolve problems in the field as quickly as possible. Finally, it was noted that the Program Control Office leads the Plan Development Process, PDP, training course and the Local Technical Assistance Program (LTAP) for GDOT.

Following the information gathered from the various GDOT offices, two software usage diagrams were created to depict software use across GDOT's offices. The first diagram created was a web-based, interactive mapping tool depicting GDOT's software usage related to office, project phase, and task. The tool allows users to scroll over any item and view the connections between each category. Observing ProjectWise through the mapping tool, depicted in Figure 1, shows a connection to every office interviewed, all phases of construction, and most depicted tasks. The second figure developed was a mapping diagram depicting GDOT's software usage in relation to office and task, shown in Figure 2. It was determined that ProjectWise was being used by virtually every GDOT office during all phases of construction for document distribution, retrieval, storage, management, historical plans research, updating the PDP, sharing documents externally, and reporting. The internal software CATS was another very common software program used for routing contracts and documents that require the commissioner's signature.

Many offices discussed a need for e-Construction software training, especially for ProjectWise. ProjectWise training was determined to be a challenge in at least four GDOT offices: Engineering Services, Environmental Services, Program Delivery, and Right-of-Way. Another challenge for both the Office of Construction and IT Application Support was the inability to query in ProjectWise. Heavy reliance on IT was expressed for the Office of Materials and Testing (OMAT). Finally, keeping up with advances in technology was addressed as a concern for IT Application Support. The RP 17-13 indicated one of GDOT's primary goals as "developing a

robust training program for its employees and consultants for its newer software programs not currently being used to full advantage."

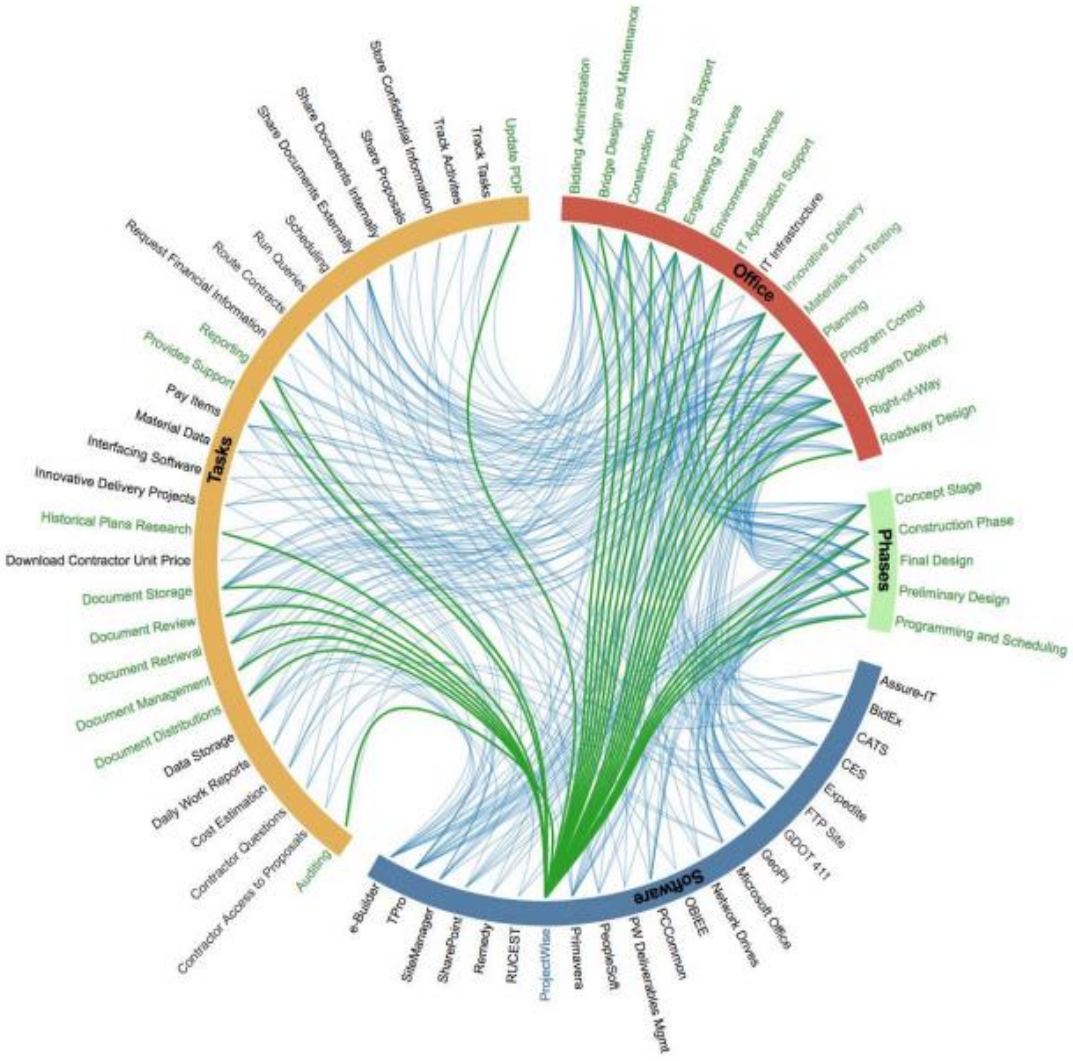

Figure 1: *GDOT Interactive Mapping Tool: ProjectWise (Shannon, 2018)*

Figure 2: *GDOT Mapping Diagram of Software Usage (Shannon, 2018)*

2.2 | GDOT e-Construction Current Training

GDOT provides a variety of training opportunities for pre-qualified engineers, public workers, and technicians that do business with the Department. Training is administered through the MYGDOT Employee Center, a Learning Management System (ELMS), the Local Technical Assistance Program (LTAP), and a Technician Certification Program. The training is managed by the GDOT Human Resources-Training and Development Team.

The MYGDOT page contains access to the ELMS system, HR and IT training, various resources and courses, and tutorials for a wide range of GDOT applications. HR Training classes are available for employees to enhance professional skills, while IT Training classes provide employees learning opportunities to enhance their skills on GDOT program applications, software, and systems. The tutorials section contains extensive resources for AASHTOWare Project, ArcGIS, CATS, DocuSign, ProjectWise, Primavera, and others.

The Certifications & Training page located on GDOT's website contains a wealth of training materials and course registration opportunities for the PDP, Construction Engineering Inspection Training (Engineering Skills Development), Flagger Certification, and Work Zone Safety & Mobility. In addition, the page contains extensive Stormwater (MS4) Training that offers scheduled training sessions via Microsoft Teams. Sessions require users to register through the LMS system. The LMS system allows users to easily track training enrollment, progress, and certificates. Other training including the GDOT Maintenance Service Contractor Training is presented in the form of presentations. Managers/supervisors review content of applicable portions of training with their employees and record their participation and understanding. Software training materials are found under Design Software and includes materials covering Bentley Navigator Software, Bridge, CaiCE, Drainage, InRoads, MicroStation, OpenRoads, ProjectWise, and Traffic. The largest quantity of materials is provided for Bridge, InRoads, and ProjectWise. The material is delivered through various guidelines, videos, flowcharts, and other documents. While there is existing ProjectWise and CATS training material available for construction personnel, there is currently no Bluebeam training section available on the GDOT website or internal MYGDOT page.

2.2.1 | ProjectWise Training Material

Pertaining to ProjectWise, the GDOT website shown in Figure 3 currently contains Workflows and Training in the form of PDF documents, flowcharts, and YouTube videos. Further, the material is found on the internal MYGDOT Training page under the Tutorials section. Most of the material consists of PDF documents, guides, and workflows. The content delivered through the PDF training documents are categorized into six sections:

1. Access to ProjectWise
2. Applications
3. General
4. Plotting
5. ProjectWise Deliverables Management
6. ProjectWise Essentials

The PDF guides in each section are listed in Figure 4 while the distribution of material by section is shown in Figure 5.

ProjectWise

Workflows | Training

Training	Section	Flowchart	Video
External User Access Instructions	Access to ProjectWise		
Using ProjectWise Web Access	Access to ProjectWise		
ProjectWise Mobile Application	Access to ProjectWise		
Using MicroStation in ProjectWise	Applications		
Working with Office Applications and ProjectWise	Applications		
Using InRoads in ProjectWise	Applications		
Digitally Signing ProjectWise Documents using Bluebeam Revu	Applications		
Early Installation Help Document	General		
User Training Manual	General		
Why ProjectWise?	General		
Making Documents Available Externally (Public Access Flag)	General		

Figure 3: *GDOT ProjectWise Training Layout*

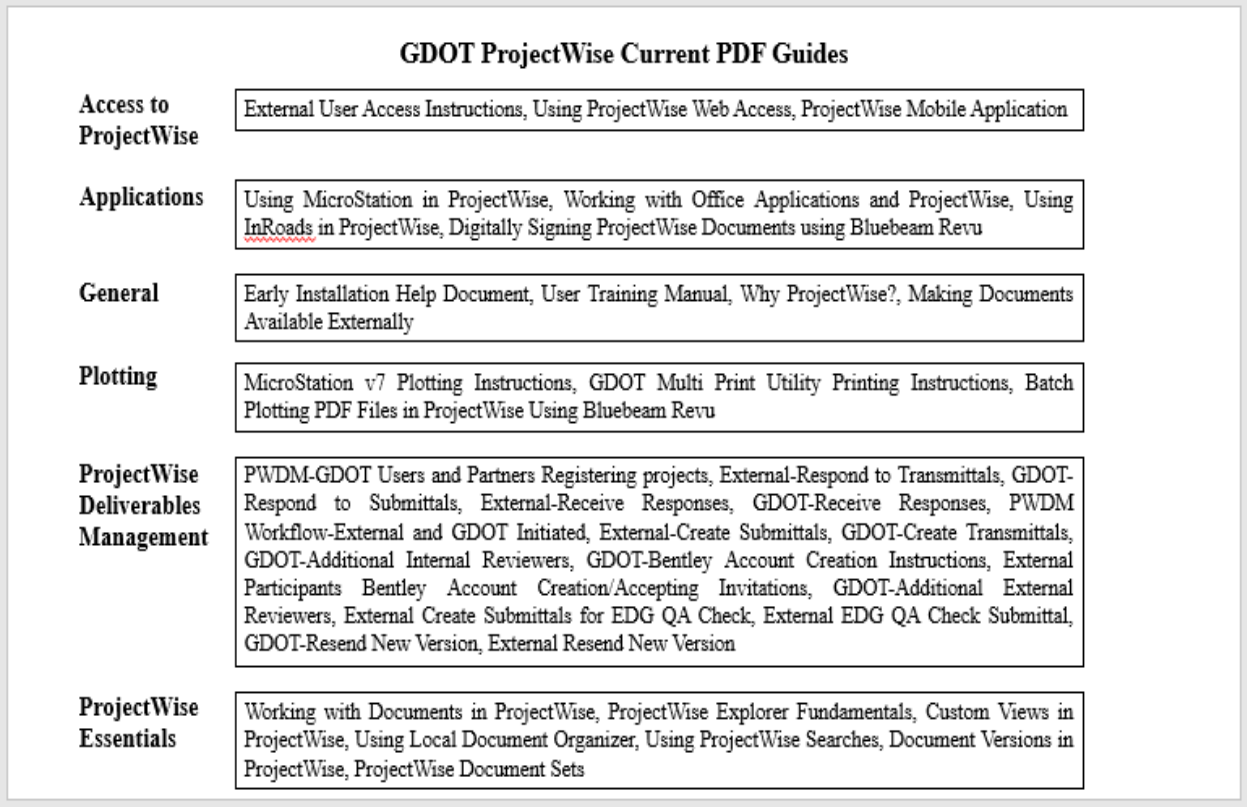

Figure 4: *GDOT ProjectWise Current PDF Training Guides*

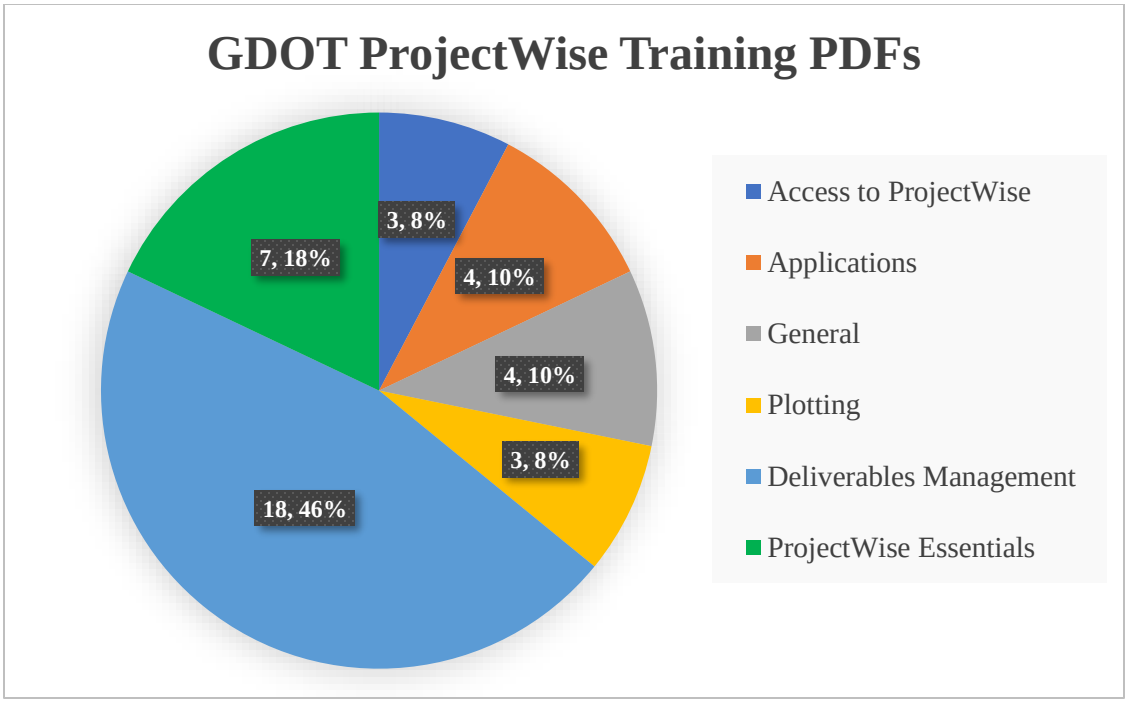

Figure 5: *GDOT Distribution of ProjectWise Training PDFs*

As depicted in Figure 5, a majority (64.00%) of the guides describe topics within ProjectWise Deliverables Management and ProjectWise Essentials. The documents provide detailed step-by-step instructions and guidelines for each topic with screenshots of the steps being carried out in ProjectWise. There are several PDF guides for ProjectWise Workflows that are not organized in sections or chapters but are listed in alphabetical order from Award Process to VE Studies Process. The existing PDF guides offered a possible organizational structure for the new ProjectWise training modules, along with suggested video topics.

The only ProjectWise training videos available by GDOT include ProjectWise Deliverables Management topics and consist of External-Respond to Transmittals, GDOT-Receive Responses, External-Create Submittals, and GDOT-Create Transmittals. The four training videos are available via GDOT's YouTube channel and are 4-6 minutes. The videos focus on correspondence between external partners and GDOT concerning package responses, transmittals,

and submittals. There are currently no ProjectWise training modules/videos for other sections including ProjectWise Essentials. Much of the training appears to focus on external user operations, rather than in-house ProjectWise functions.

2.2.2 | Bluebeam Training Material

Currently, there is minimal existing Bluebeam training pertaining to GDOT. The following documents related to Bluebeam training are available:

1. Process for Digitally Signing Documents in Bluebeam Revu
2. Batch Stamping in Bluebeam Revu
3. Batch Plotting Using Bluebeam Revu

The PDF documents depict step-by-step instructions with images of actions being completed in Bluebeam, similar to the ProjectWise guides. Unlike ProjectWise and CATS, Bluebeam does not contain a specified training section on the GDOT or MYGDOT website. While "Bluebeam was adopted to serve as a method for creating, editing, marking up, and sharing PDF design and construction documents" (Durham, 2020), there is currently no available training for using Bluebeam's markup tools. Although general training is offered by Bluebeam (see section 3.5 | Commercial Training Materials for Bluebeam and ProjectWise and Figure 14), the training is not GDOT specific and provides information on general features in Bluebeam through short video demonstrations. The Office of Construction would benefit from more workflow specific and concise training.

2.2.3 | CATS Training Material

Similar to Bluebeam, the publicly accessible GDOT website does not contain a section for CATS material or training. However, the internal page, MYGDOT, contains a CATS section with multiple training tutorials. A series of seven YouTube videos on the GDOT IT Training Group

channel covers electronic routing of agreements, generate contract ID, quit-deed manual approval process, quit-deed routing request, ROW petition routing request, supplemental agreement negotiation, and vendor electronic signature. In addition, the site contains the CATS User Guide which aims to provide an understanding of the new/revised functionality of the CATS application. The User Guide provides an extensive review of multiple function in CATS and contains step-by-step examples of actions in the program including creating a Contract ID and creating a new Supplemental Agreement Negotiation. Further, various classes are offered by IT through the ELMS system and demonstrate specific CATS processes. While CATS is only used by 4 of 15 GDOT offices, it is essential that department employees are knowledgeable of the system such that sensitive contract documents are appropriately documented within the program. The current CATS training material does not appear to be widely used by the Office of Construction.

3.0 | LITERATURE REVIEW

E-Construction is a paperless construction administration process aimed to improve the quality and efficiency of the construction process. Different forms of e-construction practices have been implemented across national, state, and local DOTs during the last decade, with many DOTs, if not already done so, planning to go completely paperless. One of the largest challenges with e-construction implementation is proper training of DOT staff and their constituents. Constituents include contractors and consultants that work closely with DOT staff. While some software companies such as Bentley and Bluebeam offer general online software training, it is not tailored specifically to GDOT needs. Transportation agencies across the country have investigated various training methods for e-construction software. The goal of the literature review was to understand current e-construction training practices for national and state transportation agencies, outline commercially available training materials (concerning ProjectWise and Bluebeam), and investigate optimum training materials/methods to exceed GDOT's training goals to implement an innovative and engaging training program to increase agency-wide usage and understanding of ProjectWise, Bluebeam, and CATS.

3.1 | Nation Wide e-Construction Implementation

E-Construction is being implemented at some level by virtually every DOT in the country. State leaders such as Michigan, Pennsylvania, Florida, and Georgia have led the way with e-Construction implementation and innovation. The implementation of e-Construction practices occurs over various phases including developing, demonstrating, assessing, and

institutionalizing/adopting. The Federal Highway Administration (FHWA) has been a large proponent in the advancement of e-Construction efforts.

The FHWA website, "e-Construction" (www.fhwa.dot.gov/construction/econstruction/), contains a wealth of information pertaining to e-Construction technologies. Resources include case studies, technical briefs, how to guides, technical reports and resources, and resources from the Everyday Counts (EDC) initiative. The case studies investigate various collaboration efforts with DOTs including Minnesota, Iowa, Indiana, and Ohio. The technical briefs and how to guides include peer exchanges and e-Construction guides that are discussed in section 3.3 National e-Construction Training. The FHWA created the EDC initiative to promote innovation and advancements in the transportation engineering industry. The 4th round of the EDC initiative contains a series of webinars which included "Creating a Roadmap to Implement e-Construction Practices and Strategies for Assessing and Procuring Technology" (Mitchell, et. al., 2018). Alaska DOT presented on the topic and discussed their roadmap to e-Construction implementation:

1. Identify DOT needs
2. Assess legacy systems
3. Identify challenges such as budget restrictions, reorganization, resistance to change, lack of personnel, etc.)
4. Create a plan and choose a system
5. Create a phased implementation
6. Identify technology and personnel resources
7. Understand cost effectiveness: one-time implementation costs and annual licensing fees
8. Identify gaps and find solutions

The webinar discussed the importance of identifying current technology resources, picking the right team, and coordinating with IT staff when implementing e-construction technologies.

3.1.1 | FHWA e-Construction Matrix

As part of the FHWA's EDC 4 program, innovation matrices were developed that display a summary of products being evaluated, piloted, and used by state DOTs organized both by product and state. The matrices are housed on the same "e-Construction" website previously mentioned (www.fhwa.dot.gov/construction/econstruction/). Information in the table was acquired from publicly available sources including internet searches, state DOT websites, and conference presentations and is not all inclusive (Weisner, 2020). Using information gathered from the product matrix, ProjectWise is currently being implemented by thirty state DOTs as their Document Management System, with GDOT and MDOT also using it as Project References and a Collaboration Portal. Other Document Management Systems being implemented include custom applications, DocExpress, Falcon DMS, OnBase, and SharePoint. Bluebeam is currently being implemented by eleven state DOTs as a Collaboration Portal and three states as Electronic As-Builts. Other Collaboration Portals being investigated and implemented include Autodesk BIM 360 Docs, Bentley OpenRoads Navigator, custom applications, e-Builder, and SharePoint. The matrices are valuable resources to view other state DOTs' current e-construction practices and are available on the FHWA website.

3.1.2 | DOT e-Construction Benefits

While the initial development of e-Construction requires extensive time and resources, the long-term benefits including improved document distribution and workflow, real-time document access, and reduction/elimination of paper are substantial (Weisner, 2017). Additional benefits include time savings, higher productivity, and increased document security.

The Florida Department of Transportation (FDOT) was one of the early implementers of e-construction after much planning, effort, and investment. The initial cost of implementing e-construction technologies for FDOT was $1.5 million. Annual operating costs were estimated to be $1 million. Despite these initial operating costs, as of 2015, FDOT's projected annual savings are expected to reach $22 million (*e-Construction How-To Guide,* 2015).

Michigan DOT estimates a savings of $12 million annually and savings of 6 million pieces of paper annually from their e-construction efforts (*The Age of e-Construction,* 2017). Change order processing time was also estimated to reduce by 27 days. MDOT has noted less time spent on paperwork and an increase in employee and constituent engagement, enthusiasm, and efficiency.

3.2 | Need for e-Construction Training

Although there are many advantages, e-Construction implementation is met with various challenges including a scarcity of relevant and effective training. To fully adopt e-Construction material, all personnel involved in the implementation must be adequately trained in the system operation, tools, and processes. With the proper training, e-Construction technologies are more successfully integrated. Proper training also helps with office pushback resulting from new and unfamiliar technologies.

There are various common pitfalls when developing online training materials. One of the more common are limitations beyond employee control. This could stem from a lack of communication between the training implementation team, inadequate training supervision, and impractical training expectations (Mansell, 2019). Another common pitfall is excessive or minimal training materials. The amount of training should be somewhere in the middle ground: not too

much to cause impatience or unnecessary burdens, and not too little to cause confusion and lack of engagement.

3.3 | National e-Construction Training

One of the How to Guides created by the FHWA titled "Training the 21st Century e-Construction Workforce" (2019) describes the 4 main components of a successful adult training program:

1. Self-Directed
2. Relevant
3. Task-Oriented
4. Clear Benefit

Training is recommended to follow a blended e-learning environment containing mentoring, documentation, and innovative technology. Mentoring options are implemented in various ways. For example, the FHWA discussed the Virginia DOT using retired construction staff as mentors for employee training. Online training should be structured asynchronously, so the user can complete at his/her own speed and need. A form of accountability in the training is critical to track progress and competency level. Accountability is in the form of assessments, certificates, or other similar tools and is often implemented through an LMS system or similar e-learning system. Kathryn Weisner, a Construction & Contract Administration Engineer who is heavily involved in FHWA e-Construction efforts, helped develop the guide and stressed the importance of task oriented, on demand, and easily accessible/navigated training resources.

The AASHTO Transportation Coordination Council (TC3) provides online training modules covering topics including construction, maintenance, and materials. Redundancy is avoided by sharing training nationally across various DOTs. The TC3 offers an e-Construction Introduction course for 2 Professional Development Hours (PDHs) that outlines what e-

construction is, how it impacts the construction process, key considerations related to e-construction implementation, steps to implementation, and examples of successful state DOT e-construction implementation.

The International Highway Engineering Exchange Program (IHEEP) hosts a conference once a year devoted to sharing ideas across DOTs currently implementing construction technology. The 2018 conference contained various e-Construction related technical sessions including "e-Construction Confessions from the Field" and "Michigan DOT Partnering with Industry for a Digital Tomorrow." "E-Construction Confessions from the Field" was presented by the Virginia DOT (VDOT) who discussed benefits of e-Construction, challenges, a project example, and e-Construction solutions. VDOT recommended to not "assume experience levels or comfort with software solutions" and to "foster a collaborative team approach to facilitate making each user a trainer" (Ridgell, 2018). Further, VDOT recommended the importance of starting with the end user and working up from there. MDOT's presentation was concerned with digital delivery in construction and Level of Development (LOD) that helps improve digital data processes and data consistency. MDOT highlighted the importance of setting up an early training program and engaging all stakeholders (Cassar, 2018).

3.3.1 | FHWA Efforts and Resources

The FHWA's Local Technical Assistance Program (LTAP) provides web-based training videos, documents, and other materials to each state DOT. The GDOT LTAP program, led by the Program Control Office, provides training for DOT staff through scheduled classes. All workshops are available to GDOT employees, local and state agencies, contractors, and consultants. Users sign up for classes through the GDOT Learning Management System (LMS).

Along with the innovation matrices, the FHWA EDC 4 program conducted a series of peer exchanges from mid-2018 to early 2019. The focus of the peer exchanges was DOT e-construction technology and innovation. The FHWA worked with sate DOTs to develop a scope and agenda for the peer exchanges and provided speakers for the event. The venue location and attendee list were the responsibility of the state DOT host. Upon review of the peer exchanges, multiple takeaways concerning e-construction training were concluded:

1. On demand training is the most effective for online e-Construction learning
2. The importance of implementing a dedicated e-Construction engineer/team/tech-savvy employees to lead e-Construction efforts was heavily discussed
3. Educate IT staff on field personnel needs and work with field personnel to understand training needs

3.4 | State DOT Efforts

Multiple states have led the way in e-construction efforts and innovation including Pennsylvania, Florida, and Michigan. The Michigan DOT began using e-Construction technologies in 2012 and has led the way with FHWA peer exchanges, having hosted one in 2016 with the California DOT. The Pennsylvania DOT developed and released 8 mobile construction apps through their mobile developing team. The Pennsylvania State Transportation Innovation Council (STIC) supports and facilitates the implementation of the FHWA EDC initiatives. Finally, the Florida DOT was one of the early implementers of e-construction technology and currently is operating through a paperless environment. Florida DOT has also developed an extensive CADD (Computer Aided Design) support YouTube channel, where training videos for a wide variety of e-construction technologies are available.

With e-Construction technology being implemented at some level in nearly every state DOT, a wide variety of training materials has been investigated and applied. As part of the literature review, online public training resources were investigated for each state DOT. Training materials across departments included PDF documents, training videos/modules, YouTube channels, classes/webinars, PowerPoint presentations, LMS/elearning system, extensive support teams, and national resources. A summary of the training methods is depicted in Figure 6 and Table 1. Note that MDT is the Montana Department of Transportation and ADOT & PF stands for the Alaska Department of Transportation and Public Facilities. Figure 6 illustrates the general breakdown of training types used by state DOTs. The percentage data labels indicate the percentage of states using the specific training method. Table 1 shows the distribution by individual state DOT.

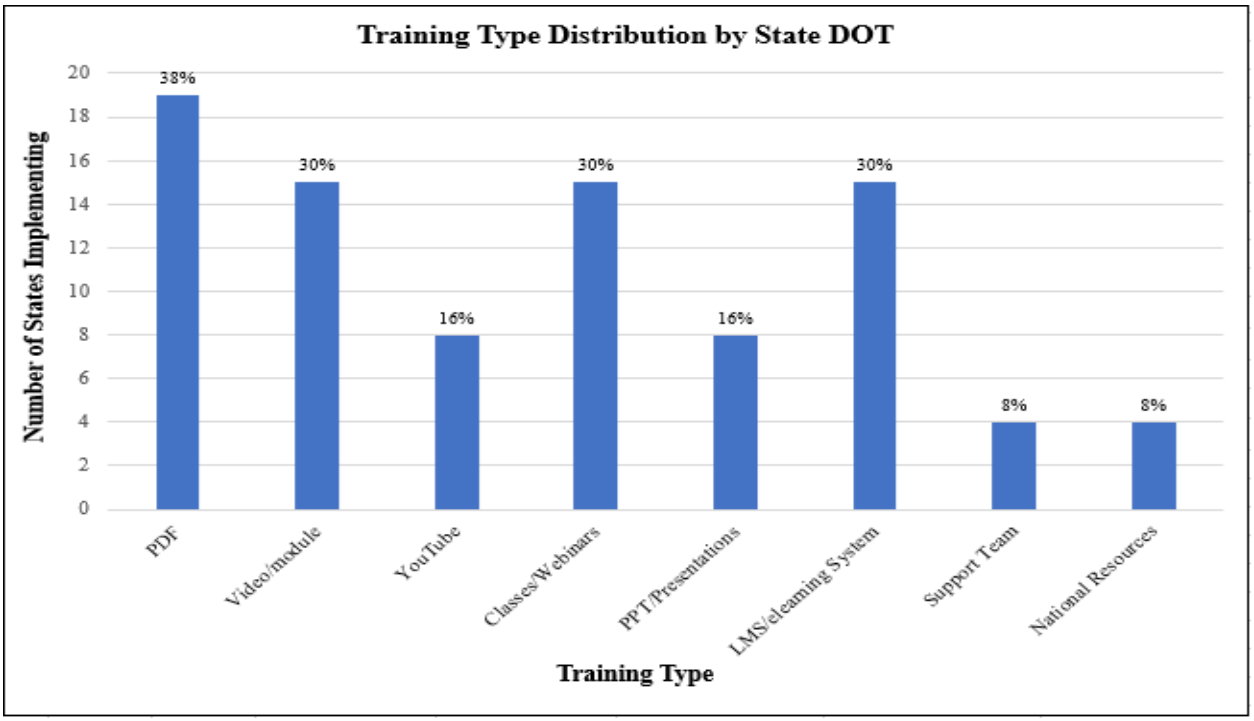

Figure 6: *Training Type Distribution by State DOT*

Table 1: *Publicly Available Training Method by State DOT*

	Training Method							
	PDF	Video (website)/Modules	Youtube	Classes/Webinars	PPT/Presentations	LMS/elearning system	Support Team	National Resources
State Use	ADOT & PF	ADOT & PF	*FDOT	ALDOT	ADOT & PF	*CDOT	*FDOT	ALDOT
	ArDOT	Caltrans	GDOT	ADOT & PF	DelDOT	*FDOT	*MDOT (MI)	ADOT & PF
	*CDOT	*CDOT	IowaDOT	ADOT	MaineDOT	GDOT	*MoDOT	RIDOT
	ConnDOT	ConnDOT	KDOT	GDOT	*MoDOT	IDOT	*PennDOT	TDOT
	*FDOT	*FDOT	NDOT	*FDOT	MDOT (MS)	IowaDOT		
	GDOT	GDOT	NDDOT	LaDOTD	MDT	*MoDOT		
	LaDOTD	INDOT	ODOT	NDOT	NCDOT	NCDOT		
	*MDOT (MI)	*MoDOT	TxDOT	NCDOT	*UDOT	ODOT		
	*MoDOT	MDT		ODOT		ODOT		
	MDT	NDDOT		ODOT		*PennDOT		
	NHDOT	ODOT		*PennDOT		TxDOT		
	ODOT (OR)	TxDOT		SDDOT		*UDOT		
	TDOT	*UDOT		TDOT		VDOT		
	TxDOT	Vtrans		TxDOT		WSDOT		
	*UDOT	WVDOT		VDOT		WisDOT		
	VTrans							
	WSDOT							
	WVDOT							
	WisDOT							

The support team section identifies state DOTs containing detailed and extensive contacts for e-Construction assistance. Some states did not contain substantial in-house resources, but rather primarily used national resources, as indicated in the National Resources section. Although not all inclusive, the goal of Figure 6 and Table 1 was to provide a broad overview of existing DOT training practices and recognize general trends and commonalities between state DOTs across the country. Individual state DOT efforts in Alaska, Iowa, Oregon, Texas, and Washington stood out with unique and innovative training materials.

The Alaska DOT contains a large variety of materials including various environmental procedures training modules, FHWA webinars, PDF documents, PowerPoint presentations, and in person class training. The training modules review Alaska DOT environmental procedures and contain 10 well-organized module videos, each one taking roughly 25 minutes to complete. To receive credit for the training, the user must take a short multiple-choice quiz at the end of each module.

The Iowa DOT contains web-based training and a technical training and Certification Program (TTCP). The web-based training requires users to register for courses that are completed at the pace set by the individual user. Doc Express is used by Iowa DOT for digital signatures and as a document management system. A list of ten YouTube Doc Express training videos is posted on the Iowa DOT YouTube channel, with each video being under nine and a half minutes, aside from the overview. Along with the training videos, there is also a twenty-eight-page Doc Express user's guide.

Along with many DOTs, Oregon uses ProjectWise as their Document Management System. They launched ProjectWise in October 2016 as part of the Statewide Transportation Improvement Program. The Oregon DOT website contains information on requesting access and resetting account password for ProjectWise use, along with user resources containing fifteen PDF quick guides and manuals. Online training videos and webinars are implemented for MicroStation use. Online training is also conducted via their training website: iLearnOregon.

The Texas DOT primary training resources are through its Connect system. The TxDOT Connect system contains a large variety of training videos, reference material PDFs, interactive modules, and virtual coaching sessions that are also accessible to external partners. Online short course presentations are available including a 2014 presentation "Project Management Short Course" that discusses TxDOT ProjectWise implementation. The TxDOT Inspector Development Program (IDP) contains classroom training, online courses, and YouTube training videos that are well-organized into eighteen modules beginning with general requirements and ending with specific technical details.

The Washington State DOT contains continuously evolving Design Project Development Training classes for employees. Part of this training is a Project Management e-learning section

consisting of Negotiation Essentials, Risk Management, and Cost Management using Primavera Scheduler YouTube videos ranging from six minutes to twenty-nine minutes. Online training modules are available for local agencies covering a variety of Construction Activity topics. Washington originally implemented ProjectWise in 2005 within the state mega-projects and currently uses the platform in more minor projects and offices. Ten ProjectWise Training Documents including Creating Engineering Files, Creating Custom Views, and Advanced ProjectWise File Commands are publicly available on the DOT website along with four ProjectWise Tech Note documents. For ProjectWise support, most projects have a local ProjectWise administrator that helps facilitate issues. Colorado, Florida, Michigan, Missouri, Pennsylvania, and Utah contained exceptional public e-Construction training resources and are expanded on in the following section.

3.4.1 | E-Construction Training State Leaders

The Colorado Department of Transportation (CDOT) contains a set of publicly available ProjectWise training videos and documents on their website. The asynchronous ProjectWise videos incorporate various topics of the program including viewing and opening documents, checking in and checking out documents, and editing title block attributes. Training materials specifically tailored to CDOT employees are accessed via the ProjectWise intranet website. The Business Center also contains PDF guides and training videos for other programs including MicroStation and InRoads. A list of publicly available CDOT ProjectWise videos is shown in Figure 7.

Figure 7: *Publicly Available ProjectWise Training Materials: CDOT*

The Florida Department of Transportation (FDOT) was one of the early implementers of e-Construction after realizing its considerable benefits. The FDOT website contains an extensive CADD Training page that employs various training courses for programs including MicroStation, Civil 3D, OpenRoads, and other resources. The training courses include detailed PDF guides and well-organized module training videos, as seen in Figure 9. The video modules are organized by chapters on FDOT's YouTube channel. Each set of modules is accompanied by a PDF manual. While the support site is extremely organized, the videos are generally longer than twenty minutes, with some exceeding an hour long. When developing GDOT video modules, it will be beneficial to keep videos to a shorter length and more specific topic focused. An FDOT CADD support team is also available to answer any employee questions, comments, or concerns.

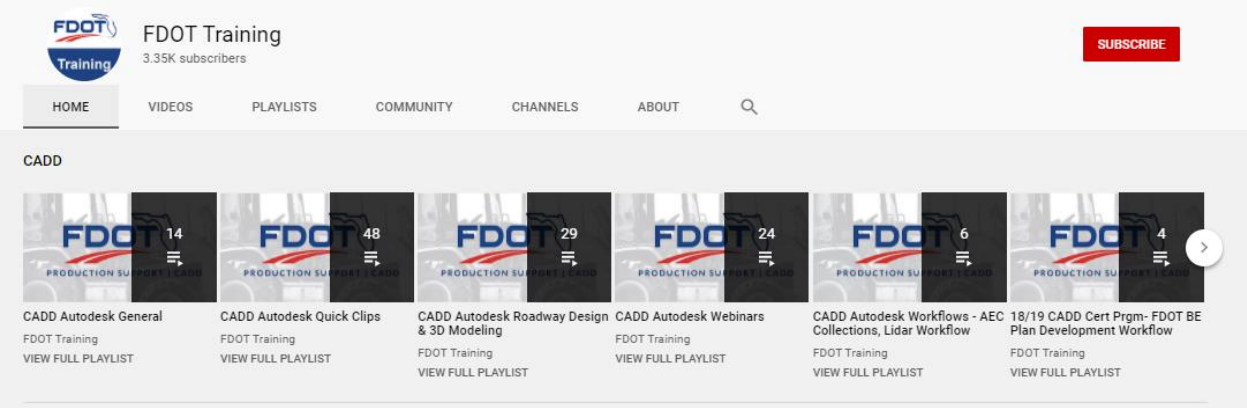

Figure 8: *FDOT Training YouTube Channel*

Documentation	
File	Updated Date
Training Guide	09/26/2018
Dataset	09/26/2018

Videos	
Title	Updated Date
Module 1 of 15: Chapter 1 - Introduction and Design Files	04/26/2019
Module 2 of 15: Chapter 2 - Design Environment	04/26/2019
Module 3 of 15: Chapter 3 - Viewing and Zooming	04/26/2019
Module 4 of 15: Chapter 4 - Models	04/26/2019
Module 5 of 15: Chapter 5 - Levels	04/26/2019
Module 6 of 15: Chapter 6 - Basics Drawing Tools	04/26/2019
Module 7 of 15: Chapter 7 - Drawing with Precision	04/26/2019
Module 8 of 15: Chapter 8 - Changing Elements	04/26/2019
Module 9 of 15: Chapter 9 Selecting & Grouping	04/26/2019
Module 10 of 15: Chapter 10 - Drawing Annotation	04/26/2019
Module 11 of 15: Chapter 11 - Cells & Points	04/26/2019
Module 12 of 15: Chapter 12 - Patterning & Hatching	04/26/2019
Module 13 of 15: Chapter 13 - Dimensions	04/26/2019
Module 14 of 15: Chapter 14 - Information & Measuring Tools	04/26/2019
Module 15 of 15: Chapter 15 - Reference Files	04/26/2019

Figure 9: *FDOT Training Module Organization*

Along with FDOT, the Michigan Department of Transportation (MDOT) was one of the early adopters of e-construction technology. MDOT utilizes both ProjectWise and Bluebeam in their construction and engineering workflows. The Support Services page is laid out in categories that include CADD Basics, Bridge Modeling, and GIS Surveying. A specific ProjectWise Support page contains extensive contacts for help and PDF documents organized by Construction, Development, External Installation, and Local Agency, shown in Figure 10. Michigan participated in two peer exchanges in the FHWA EDC 4 program where project collaborations for software like ProjectWise were discussed. MDOT also stresses the importance of employee involvement in e-Construction ideas, implementation, and innovations.

Figure 10: *MDOT ProjectWise Support Page*

The Missouri Department of Transportation (MoDOT) contains a well presented CADD Support page, shown in Figure 11, for ProjectWise, GEOPAK, Microstation, and ArcGIS training. The Support site uses a variety of training materials such as videos, PDF files, PowerPoint presentations, and web pages. The ProjectWise training material contains a ProjectWise manual, Contract Plans Information, Miscellaneous Information, and Signing and Sealing. The three

categories contain primarily PDF manuals and two webpages for “File Naming Convention for Contract Plan Drawings” and “File Naming Convention for Addendums or Revision Sheets.”

Figure 11: *Missouri DOT CADD Services Support Page Layout*

The Pennsylvania Department of Transportation (PennDOT) has been a leader in e-construction development. The Pennsylvania State Transportation Innovation Council (STIC) is a large proponent of the FHWA EDC initiative and facilitates the implementation of new technologies at PennDOT. The STIC conducted a study to investigate the level of preparedness for e-Construction implementation where a majority of respondents identified online training and statewide guidance and standards as the most desired support tools (*PennDOT Advances E-Construction Plans*, 2020). PennDOT contains an Online Services page where most resources require a business partner or employee login. A technical training calendar for business partners and employees is also used and shown in Figure 12 for the month of November 2020. The training calendar contains instructor led courses on an extensive variety of topics including Construction

Management, Highway Design, Information technology, and Project Management. Employees have “training coordinators” that help employees track training progress and goals.

Figure 12: *Snapshot of PennDOT Training Calendar*

The Utah Department of Transportation (UDOT) website contains a wealth of video resources pertaining to Digital Delivery, Workspace Modification, Display Rules, and Miscellaneous topics, as shown in Figure 13. The videos are organized into "Parts" where the first part contains basics and terminologies followed by more in-depth discussions. The UDOT website also contains Project Management Training that provides tools, resources, and training for UDOT project teams. A portion of the training was created on Issuu Inc., an electronic publishing platform that enables creators of publications to digitally share materials. UDOT currently has webpages under construction with digital delivery information on roadway, structures, and drainage and utility design.

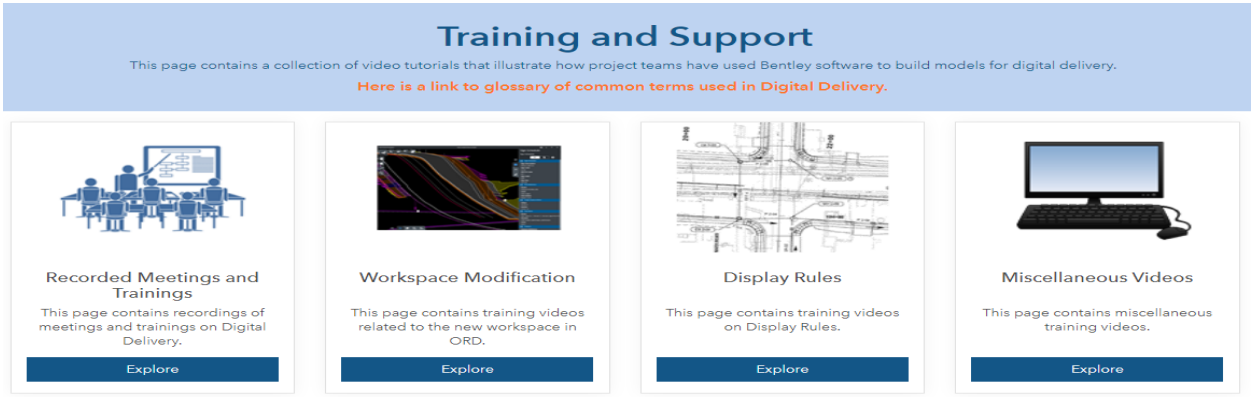

Figure 13: *Utah DOT Training and Support Videos*

3.4.2 | Noteworthy Training Practices

The most important training practice discussed by various DOTs was dedicating an e-Construction support team that assists employees with the implementation and development of e-Construction technologies and training materials. Alabama DOT created an e-construction engineer position within its construction bureau to accelerate the advancement of digital solutions and oversee all e-Construction initiatives. The Ohio Facilities Construction Commission (OFCC) dedicated 5-7 full

time equivalents that provide end-user support and training for Primavera Unifier. Colorado DOT created a group called “The Core 5” consisting of four volunteers and one full time employee specifically hired to lead e-construction efforts. Michigan DOT, a leader in e-Construction development, created a mobile computing development team that develops applications to enhance user experience. Virginia DOT established a small team to oversee e-Construction initiatives. Regardless of training material type, a dedicated e-Construction support team helps facilitate the implementation of e-Construction technologies.

The most common publicly available training material for state DOTs are PDF manuals or guides. Other training techniques included module or chapter videos created on various platforms, PowerPoint presentations, classes or webinars, and a combination of two or more methods. While general training was offered, many state DOTs’ resources pertained to their specific workflows/systems. The following optimum online training practices were examined when developing GDOT training materials for ProjectWise, Bluebeam, and CATS:

- Short (<10 mins) and relevant videos with a specific topic focus
- Adobe Captivate, SCORM 1.2 compliant
- Topics well-organized into chapters/parts and easily accessible and navigated (on-demand)
- Accompanying manual/PDF that outlines video discussions
- Implementation and support of an e-Construction support team/staff with highest knowledge of software and e-Construction practices to facilitate training/implementation. This involved close collaboration with the GDOT project advisory group and the Office of IT.
- Some form of accountability with the training i.e. certifications/assessments
- Training progress easily tracked

- The need to hear from field staff when generating material and understand user specific needs

With an understanding of national and state DOT training methods, the following section of the literature review aimed to investigate commercial training material offered by Bentley and Bluebeam.

3.5 | Commercial Training Materials for Bluebeam and ProjectWise

The second task of the literature review was to investigate commercially available training materials. Because CATS was developed in-house by GDOT, the review focused on Bluebeam and Bentley ProjectWise materials.

3.5.1 | Bluebeam Training

The Bluebeam website offers self-guided training courses (sign up required), instructor-led training courses for a team, scheduled webinars, and a series of free training videos covering the topics seen in Figure 14. The training videos outline key Bluebeam features, are generally 2-5 minutes, and apply to Revu 20, Revu 2019, and Revu 2018. Each video depicts a clear picture of a Bluebeam screen with varying voiceovers describing step by step actions and processes of the video topic. The training videos follow a slow to moderate pace and are easily understood. Bluebeam training videos that relate to existing GDOT Bluebeam training PDFs include Digital Signatures/Certifications, markup tools, and Flattening tools. The free training videos offered by Bluebeam provide a valuable reference for basic Bluebeam features and capabilities.

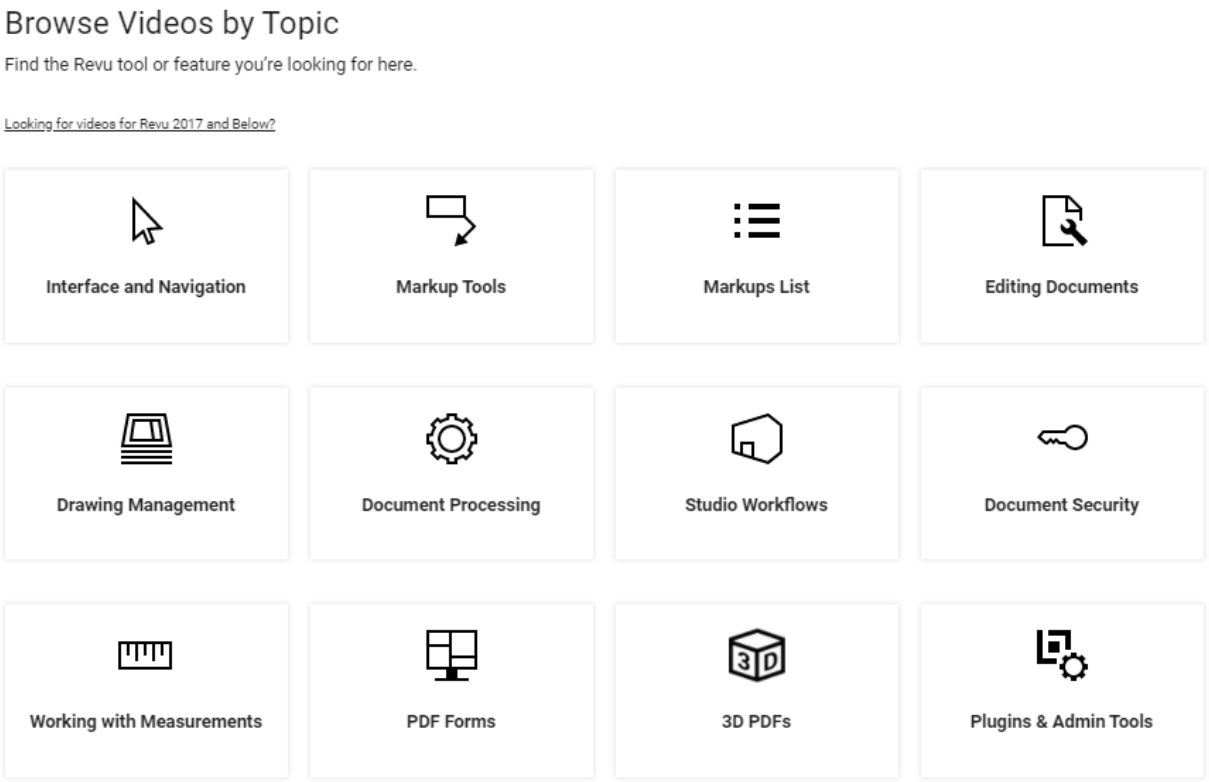

Figure 14: *Bluebeam Free Online Training Videos*

While the free training videos offer simple demonstrations for many Bluebeam features, more involved self-guided training courses are available through the Bluebeam University. The Bluebeam University is a self-paced Revu training program available in various formats. The coursework contains step-by-step videos, interactive exercises, quick quizzes, and a certificate of completion after the course has been mastered. While all the coursework contained in Bluebeam University is completed through a web-based interface, there are numerous downloadable exercises that are completed using Bluebeam. To receive a completion certificate, the user needs to click through each lesson in the course and pass the final test at the end. Once the test is passed, a certificate is awarded. The "BBU Power Pack" is a comprehensive package that covers tools and features in Revu 2018, Revu 2019, and Revu 20. An alternative pack available covers just Revu

basics and is available for yearly access. Additional courses include Drawing Management, Field Issues, Measurements Takeoffs and Estimation, and Building Project Dashboards. These courses are incorporated in the BBU Power Pack. Once payment is processed ($249 for a year of access), the user logs in to blubeamuniversity.com and begins the coursework.

Instructor-led training is also available for essential Revu features and workflows by utilizing the knowledge of Bluebeam trainers. The Revu Fundamentals Bundle identifies key features and workflows including Revu and Studio Essentials, Quality Takeoff, and Drawing Management taught over two days. An online option and an in-person option are available. Individual courses are also available and include Revu Essentials (online or in person), Studio Essentials (online only), and Revu for iPad (in person only).

Finally, Bluebeam Certified Instructor Training is offered to accelerate company-wide software implementation by providing ready-to-deliver Bluebeam Certified Training (BCT) courses. The training is specifically for Bluebeam Certified Instructors (BCIs). Individuals that should attend include corporate trainers leading Bluebeam training within their organizations, trainers responsible for training project teams, subcontractors, or employees, and trainers providing Revu training to members of the industry or similar associations. The curriculum is given over 3 days. Day 1 is Bluebeam Trainer Basics, Day 2 is Training Bluebeam Revu (Part 1), and Day 3 is Training Bluebeam Revu (Part 2).

3.5.2 | Bentley ProjectWise Training

The Bentley Institute provides a wide variety of learning and training programs for all types of schedules and budgets. Training options available include virtual classrooms, local classrooms, on-demand courses, Bentley Institute User Group Program, webinars, Bentley Institute Press Books, and Bentley Communities. PDHs are awarded by the Bentley Institute for each completed

course. Team learning reports and individual transcripts are reported to help track training progress and calculate return on investment.

With a Bentley login, users are able to access Bentley Institute's LEARNserver that provides on-demand training courses presented in "learning paths" for a wide variety of software types. The ProjectWise training is organized by edition (Connect or V8i) and level of training (fundamental, intermediate, and advanced). The training consists of eighteen fundamental learning paths, eleven intermediate learning paths, and six advanced learning paths, all shown in Figure 15.

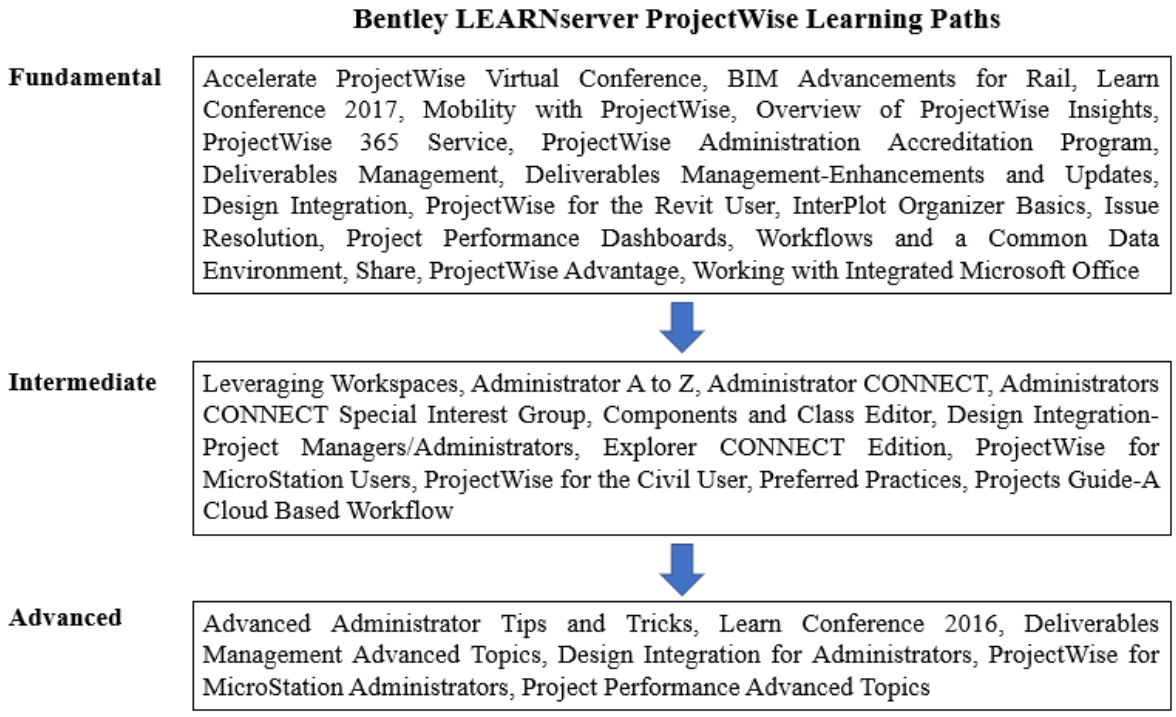

Figure 15: *Bentley ProjectWise On Demand Training Courses*

Each learning path contains lecture videos of varying lengths that cover specific topics of the path, some more extensive than others. For example, the "ProjectWise Deliverables Management" fundamental learning path is shown in Figure 16.

	Title	Language	Generation	Release Detail	Type	Duration	Status	Launch
▼	1 An Overview and Getting Started	English	CONNECT Edition					
	What is ProjectWise Deliverables Management?				Lecture	1m		Launch
	How Do I Get Started with ProjectWise Deliverables Management?				Lecture	1m		Launch
▼	2 How Do I Use It?	English	CONNECT Edition					
	Working Through ProjectWise Explorer				Lecture	2m		Launch
	Working Through the Cloud				Lecture	2m		Launch
	Creating & Sending a Transmittal				Lecture	2m		Launch
	Adding Team Members				Lecture	1m		Launch
	Adding External Participants				Lecture	1m		Launch
	Working with RFIs				Lecture	1m		Launch
	Receiving & Responding to a Submittal				Lecture	2m		Launch
	Viewing Package Responses				Lecture	1m		Launch
	Rejecting Deliverables				Lecture	3m		Launch
	Creating & Responding to General Correspondence				Lecture	3m		Launch
	2D and 3D Design Review				Lecture	49m		Launch
▼	3 How Do I Set It Up?	English	CONNECT Edition					
	Registering a CONNECTED Project				Lecture	1m		Launch
	Enabling Deliverables Management for Your Project				Lecture	27s		Launch
	How to Set Up Deliverables Management Settings				Lecture	12m		Launch
	Configuring Your Project in ProjectWise				Lecture	1m		Launch
▼	4 Where Can I Apply a Document Distribution Matrix?	English	CONNECT Edition					
	Document Distribution Functionality				Lecture	4m		Launch
	Ensuring a Valid Matrix				Lecture	3m		Launch
	Populating the Template				Lecture	6m		Launch
	Applying a Matrix				Lecture	6m		Launch
	Upload and Validation				Lecture	3m		Launch
	See a Package with a Matrix Applied				Lecture	4m		Launch
▼	5 How do I get Insight into my Project Deliverables?	English	CONNECT Edition					
	Deliverables Management Dashboard				Lecture	1h 1m		Launch
	ProjectWise Project Insights Update1 Release Overview				Lecture	21m		Launch

Figure 16: *Bentley ProjectWise Learning Path: Deliverables Management*

Each lecture video contains a walkthrough of the topic focus with a clear and easy to follow video voiceover, similar to the Bluebeam videos. The lecture videos are accompanied by a course details section where “skills taught” are listed out in bullet point form along with any course prerequisites needed for the video. The bullet point list offers a quick overview of the topics outlined in the video. Other learning paths such as the fundamental “ProjectWise Virtual Bentley Institute Learn Conference” contain recorded PowerPoint presentations that cover more broad

topics such as an introduction to “ProjectWise Connection Services” and “Supporting the Transition to a Hosted ProjectWise Environment.” While many of these courses have an underwhelming number of views indicating the resources may not be well-known by DOTs or other user groups, they offer a valuable resource for users of various experience levels.

Bentley Communities offer an opportunity to connect with industry peers and Bentley software experts to assist with various software questions. The ProjectWise community offers tips, product support, best practices, advice, and an easy way to query for a variety of ProjectWise topics. The community is split into smaller sub-communities: Content Management, Content Publishing, Project Review, and ProjectWise Deliverables Management, to provide more specific help. On some occasions, DOT agencies will partner with Bentley and/or Bluebeam to create training programs while others will contract with external partners to produce training that is workflow specific. The latter is generally more effective for DOT employees (Maier, 2020). After investigating Bluebeam and Bentley materials, additional optimum training methods were added to the list previously discussed:

- Bluebeam quick quizzes and/or certificates of completion for courses
- Bluebeam video topics
- Bentley level of training (fundamental, intermediate, advanced)
- Bentley learning path organizational structure
- Bentley videos accompanied with bullet point list of topics and video prerequisites

3.6 | Literature Review Summary

This literature review investigated national e-construction efforts and training resources with a focus on the FHWA, individual state DOT methods concerning e-construction and e-construction training, and commercially available training resources pertaining to ProjectWise and Bluebeam.

The FHWA contains a wealth of resources, such as the Everyday Counts (EDC) initiative, for state DOTs when tackling the challenge of implementing e-construction technologies. Additional national organizations including AASHTO and the Transportation Curriculum Coordination Council (TC3) offer state DOTs e-construction training guidelines and resources. When developing new training, it is important for the material to be self-directed, relevant, task-oriented, and contain a clear benefit. State DOTs across the country have implemented a wide variety of e-construction technologies and training practices. Various states including Florida, Colorado, Pennsylvania, Utah, Missouri, and Michigan have paved the way for e-construction advancement and contain a wealth of e-construction software related training resources. The most noteworthy training practices included short and relevant video modules with a specific topic focus, well-organized training topics that are easily accessible/navigated, accompanying manual/PDF with video training, and training that is workflow specific to DOT needs. Finally, Bluebeam and Bentley provide users with a wide variety of training material that offers a general overview of software functions and tools but does not pertain specifically to DOT workflows and functions. However, Bentley and Bluebeam both contain effective training methods that include short, specific video modules, tiered learning for multiple experience levels, and learning path organization methods. Following the literature review, the goals for the new training program were specifically outlined to better understand the impact of the new training on the Office of Construction.

4.0 | PROBLEM STATEMENT

4.1 | Research Objectives

This research aimed to develop a robust training program to assist GDOT staff in learning and fully implementing agency wide software programs. The training programs were modeled after a successful GDOT project (RP 17-18) to develop online learning modules for pavement design AASHTOWare PavementME software. Specifically, the research objective was to create online training modules for ProjectWise, Bluebeam, and CATS. Along with being SCORM 1.2 compliant, the module development used Adobe Captivate to create the eLearning video training material. The modules are expected to enhance the usage and understanding of the three programs within the GDOT Construction office.

The research provided a summary of e-construction training methods at the national and state DOT levels, commercially available training programs for ProjectWise and Bluebeam, and an overview of GDOT's existing training methods and capabilities. To more completely understand GDOT's needs, a survey was conducted to provide different GDOT Construction perspectives of the three programs. Secondly, meetings with various GDOT Construction personnel were held to understand the use, implementation, and challenges with ProjectWise, Bluebeam, and CATS that were addressed when creating the training modules. Following the survey and meeting period, a working list of training material was developed from the survey and meeting feedback. Once the final list of training topics was confirmed, the training material for Bluebeam and ProjectWise was created which included a blend of video demonstrations, interactive software simulations, and PDF go-by documents. The objective of the new material

was to create more engaging, interactive, and relevant material that GDOT Construction employees and consultants could reference regardless of experience level.

4.2 | Research Significance

With the benefits of increased efficiency, cost savings, and time savings, one of the largest challenges in successfully implementing an e-construction program is the training required for new software. While there is a large amount of national and commercial training material available for e-construction software, it is not tailored specifically to GDOT needs. There were several e-Construction challenges identified in RP 17-13 pertaining to ProjectWise, Bluebeam, and CATS. Lack of training, inadequate knowledge, and inability to use the software to its full capacity were three of the main challenges GDOT employees face. The training programs created fill GDOT's training void and increase employee knowledge and understanding of the programs to maximize their capabilities. The programs provide on-demand training for GDOT employees of varying experience levels to access and reference at their own pace. Additionally, the training programs provide several types of material for the user to interact with including PDF reference guides, video demonstrations, and interactive software simulations that allow users to actively engage with the material. Increased understanding of the programs will result in higher efficiency and resource, time, and cost savings for the department.

5.0 | RESEARCH METHODOLOGY

A complete e-construction training program involves on-demand, innovative, and well-organized training material that is specific to DOT workflows and practices. Following the extensive background and literature review, the research methodology was clearly defined through five main components:

1. A survey questionnaire distributed to construction personnel
2. Subsequent GDOT meetings with construction personnel
3. Training topic development
4. Module Development, Review, and Confirmation
5. Collaboration with IT

A preliminary review involved meeting with the Office of Construction project advisory group on January 7th, 2021. The project advisory group includes GDOT State Construction Engineer John Hancock, Assistant State Construction Engineer Beau Quarles, and Research Engineer Brennan Roney. The goal of the meeting was to discuss ProjectWise, Bluebeam, and CATS uses and training challenges, along with determining the need for subsequent meetings with GDOT offices and districts. Secondly, a survey was developed to obtain feedback from a wide variety of GDOT Construction offices and districts concerning the program's existing processes and challenges, along with various challenges associated with the GDOT Construction Manual. The primary focus of the research study was the development of training material for ProjectWise, Bluebeam, and CATS, while a separate but parallel study focused on updating the GDOT Construction Manual. Following a highly successful response rate to the survey, subsequent

meetings with GDOT construction personnel were conducted to elaborate on the survey results and understand more completely the ultimate goal for the new training. Finally, a meeting was held with the GDOT IT department to understand training branding and guidelines. Following the meeting, communication continued with IT to format and post the training material to locations specified by the project advisory group. After the meetings and survey analysis, a working list of training material for ProjectWise, Bluebeam, and CATS was developed. The complete list of findings from the research methodology is found in Section 6.0.

5.1 | Preliminary Review

In order to understand fully the goal and purpose of implementing new training for ProjectWise, Bluebeam, and CATS, a meeting was held with the project advisory group, on January 7th, 2021. Although background information acquired from RP 17-13 discussed the use and challenges of the three programs across GDOT, existing uses, process, and challenges associated with the three programs needed to be further investigated. The remainder of the section provides an overview of the meeting minutes.

Despite a few select old projects, ProjectWise and Bluebeam are currently used for all GDOT projects, with ProjectWise being pushed as a requirement. Bluebeam and ProjectWise use directly coincides across offices. A project advisory group member mentioned an in-house survey conducted about a year ago with the GDOT districts and found an approximate 80.00% usage rate for ProjectWise. Additionally, the project advisory group discussed how offices are becoming more comfortable with ProjectWise as they use them more and adjust accordingly. Even with an increase in use of the programs, minimal regular training occurs in the office. Instead, training is primarily performed as needed and by a project manager. All ProjectWise training is managed through the Design Policy and Support Office, who conducted initial training for ProjectWise, and

unless the office receives a request, no training is conducted. As far as Bluebeam and ProjectWise is concerned, there is no current formal training. Concerning CATS, the project advisory group discussed how the State Construction team conducts training for the in-house software every quarter or half year and when a need rises.

The goal of the new training modules is to provide more formalized, detailed, and on-demand training for the three programs in question. The new training will aim to contain more details that are specific to the activities/actions that individuals complete on a regular basis. Another goal of the new training is to add more interactive elements. A majority of the current training (ProjectWise) is simple PDFs with step-by-step instructions. By producing new training that is more interactive, users will more completely digest the content which will result in more efficient use of the software. The focus of the new training should contain content supporting construction and district engineers, but the project advisory group indicated obtaining perspectives from other offices would prove beneficial. Furthermore, the current ProjectWise training material was discussed. The current material required review and evaluation for updates. The following questions concerning the ProjectWise material were discussed in the meeting:

1. What topic only needs a PDF outline/description/step-by-step instruction?
2. What topic calls for a video tutorial?
3. What topic needs both a PDF outline and video tutorial?

While some software topics/features are simple and do not require a video tutorial, other more extensive features may require both. Finally, the project advisory group mentioned a certificate/assessment is not important for the new training modules. Alternatively, it is more important for the new training to be on-demand and readily available for construction staff across the state depending on individual needs and learning preferences.

5.2 | Survey Overview

A survey was conducted to obtain a variety of GDOT personnel perspectives on the processes and challenges with ProjectWise, Bluebeam, CATS, and the construction manual. The survey was directed to Office of Construction personnel and their supporting staff. The goal of the survey was to provide GDOT personnel a chance to voice their concerns with the three programs and construction manual without having to conduct a formal meeting. With additional feedback, the training material was developed that more completely addressed GDOT challenges.

5.2.1 | Survey Development and Distribution

A copy of the survey questionnaire is presented in the **Appendix**. The web-based application Qualtrics was used to develop the survey and document and analyze responses. The survey was divided between 5 blocks of questions, with a total of 17 questions. The blocks of questions were categorized as follows:

1. General Information. Aside from the contact information, this section included 3 questions covering general use of the 3 software programs and the confidence level of the respondent with using the programs.
2. Training Information. This block also included 3 questions to gauge what type of training occurs in the respondent's office, how often training occurs, and which of the three software programs the respondent feels is in most need of new training.
3. ProjectWise, Bluebeam, and CATS Challenges. The third block provided the most important feedback of the questionnaire and consisted of 5 questions. The goal of these questions was to understand more completely the challenges facing GDOT concerning the three programs, along with what they are looking for in the new training material.

4. Construction Manual Use. The remainder of the survey focused on the GDOT Construction Manual. This block consisted of only one question, intended to weed out respondents who do not use the manual. If 'never' was selected as the answer, the survey would end.
5. Construction Manual Challenges. The final block in the survey consisted of 5 questions which focused on missing elements in the construction manual and how it can be improved, the main focus of the separate study mentioned earlier.

The survey link was provided to the project advisory group on January 25th, 2021 who proceeded to distribute the survey to GDOT district construction managers. In order to obtain additional survey responses, the construction managers sent the survey to their respective staff.

5.3 | GDOT Meetings

A meeting was held with the Office of Construction to discuss the survey results along with next steps on February 26, 2021. Following the presentation of the survey results and main takeaways, the project advisory group was asked to compile a list of GDOT construction personnel, focusing on District 1, they felt would be beneficial to meet with and discuss software and construction manual challenges more extensively. Additionally, it was requested the survey results presentation be shared with District engineers and managers so that they could reach out with any additional feedback and/or questions. The project advisory group provided a list of five individuals: three managers from District 1 and 2 managers from District 2 to speak with. Table 2 provides a complete list of the GDOT meetings. Section 6.0 provides the key takeaways from the meetings.

Table 2: *GDOT Meetings*

GDOT Meetings	
Office/District	**Date**
State Construction	2/26/2021
D1 Construction	3/18/2021
D2 Construction	3/25/2021
D1 and D2 CMs and Inspectors	4/14-15/2021
State Construction	5/5/2021
IT	5/13/2021

5.3.1 | District 1 Construction Meeting

A meeting was held with District 1 personnel on March 18, 2021 to discuss in more detail ProjectWise, Bluebeam, and CATS challenges along with specific goals for the new training modules. Before discussing new training material, the critical software challenges ascertained from the survey were presented and discussed with District 1 personnel in order to gain their unique perspective on the challenges. Specifically, concerning ProjectWise, the file naming system and file navigation were discussed in detail. Concerning Bluebeam, the primary challenge discussed was becoming accustomed to the Bluebeam interface, along with learning the most efficient tools to edit/markup documents. Finally, the primary challenge discussed concerning CATS was the software not allowing users to go back/send back documents or processes once they are started.

The second half of the meeting focused on the goals of the new training and construction manual updates. With the general objective in mind to develop more interactive, organized, and formal training with a blend of both general and construction specific information, the goal of meeting with District 1 personnel was to understand more specifically their expectations with the new training and how to effectively build the material around their needs. Additionally, a sample video demo was presented to the District 1 personnel to understand their feedback and suggestions with the format of the demo.

5.3.2 | District 2 Construction Meeting

Following the District 1 meeting, a meeting was held with District 2 personnel on March 25, 2021, to discuss in more detail ProjectWise, Bluebeam, and CATS challenges along with specific goals for the new training program. The meeting followed a similar format to the meeting with District 1 personnel. Critical challenges for District 2 personnel concerning the three programs were first discussed including the ProjectWise naming system and Deliverables Management, the experience level gap with Bluebeam users, and accessing project information in CATS.

The second portion of the meeting focused on new training and construction manual update goals. Similar to the District 1 meeting, the goal of meeting with District 2 personnel was to understand more specifically their expectations with the new training and how to effectively build the material around their needs. Additionally, a sample interactive module (building off the video demo presented to District 1) was shared with the District 2 personnel to understand their feedback and suggestions with the format of the module.

5.3.3 | Construction Managers and Inspectors Meeting

Following the meetings with district and area managers, additional meetings were held to gain the perspective of project managers and inspectors concerning software challenges and potential new training topics, along with Construction Manual updates. Two meetings were conducted with two consultants and three project managers on April 14, 2021, and April 15, 2021. Similar to District 1 and 2 manager meetings, specific challenges with the three programs were discussed first. Following the discussion of software challenges, the specific topic areas and goals for new training was further discussed.

5.4 | Module Development Strategy

Before discussing the survey and meeting results, the module development, review, and confirmation process is clearly outlined in this section. The process of the training program development began with a video outline where the learning outcomes and goals were clearly defined. Next, the video script was outlined and recorded. The video script was then used to record the video demo in Adobe Captivate, with special attention given to the recording time and pace. Following the completion of the video demo, the audio was uploaded into Adobe Captivate where it was edited through a noise reduction process. Additionally, animations were added to the video demo through Adobe Captivate features in the form of text, shape, and object callouts that aimed to enhance the user's engagement with the material. The process for the video demo development is shown in Figure 17.

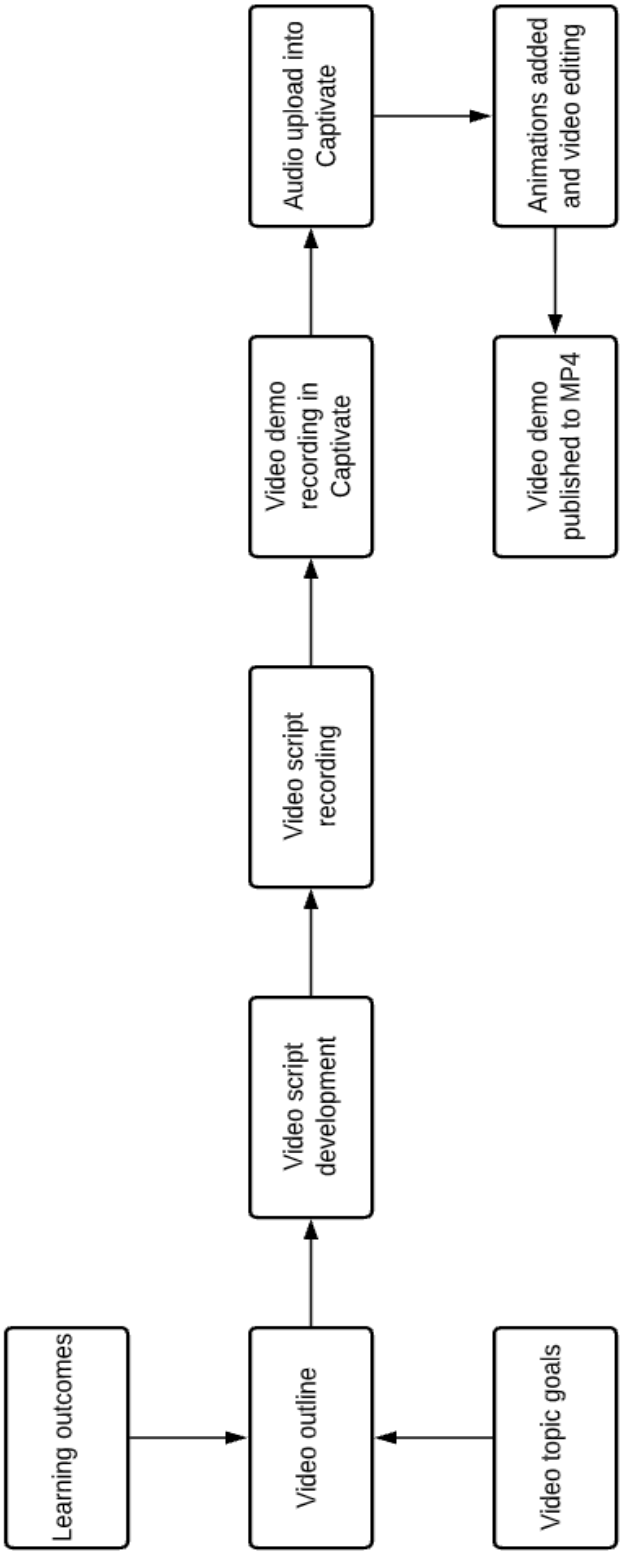

Figure 17: *Video Demo Creation Process*

If a PDF go-by document was required for the topic, it was developed following the completion of the video demo. The PDF go-by documents follow along with the video demos and contain descriptions and screenshots directly from the demo. Screenshots from the video demo were added to show the locations of tools, action box items, and additional software features discussed in the video demos. Various callouts, numbered step-by-step instructions, and additional information were added to the screenshots to complete the PDF documents. After being developed and edited in Microsoft Word, the guides were saved as PDF documents. The process for the PDF training guide development is shown in Figure 18.

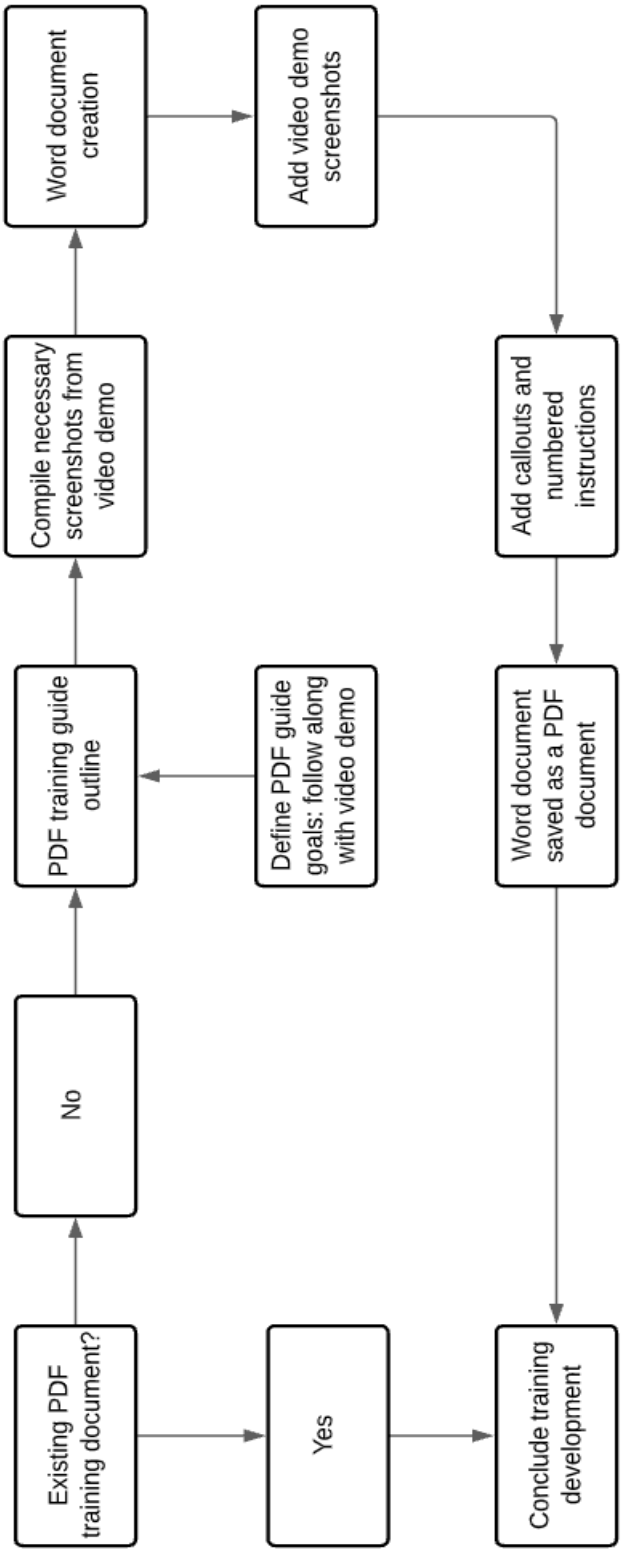

Figure 18: *PDF Training Document Creation Process*

Finally, if an interactive module was required for the topic, a software simulation was recorded in Adobe Captivate. The software simulation follows similar, slightly simplified, software actions outlined in the video demo. Similar to the video demo, the software simulation was edited in Adobe Captivate where audio was added along with various on-screen prompts that direct the user through the training. The process for the interactive module development is shown in Figure 19.

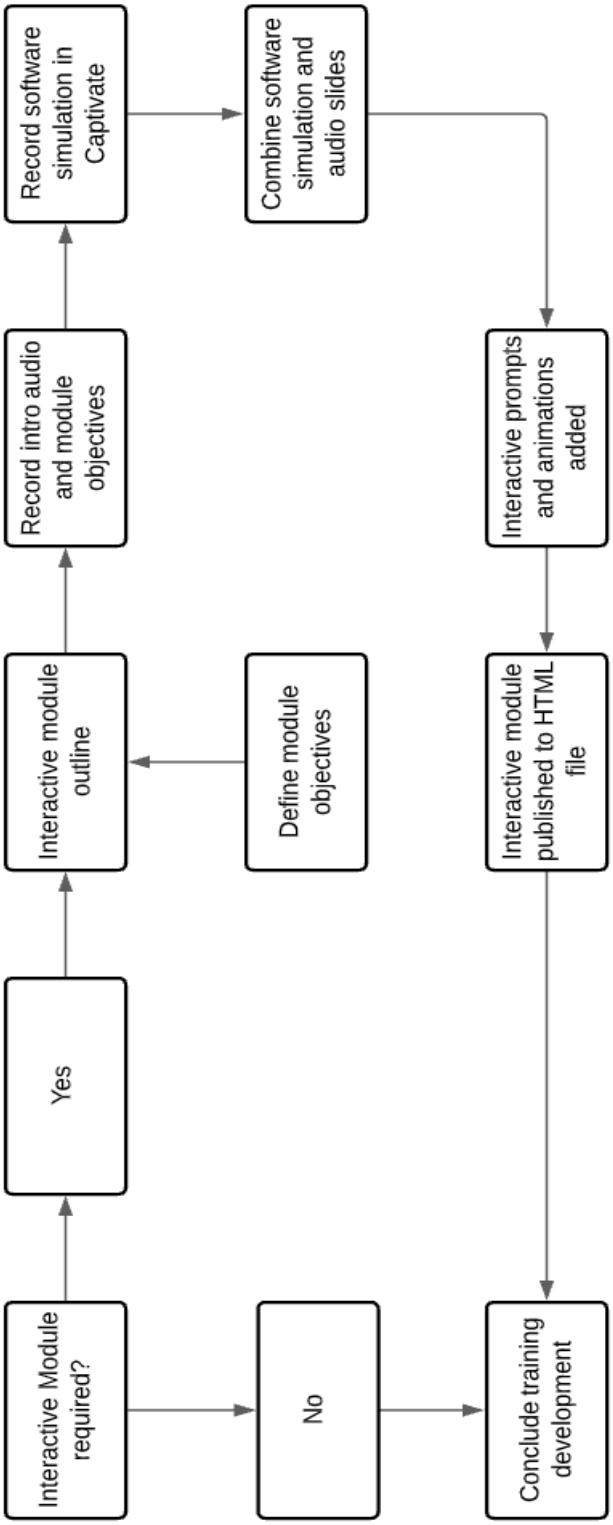

Figure 19: *Interactive Module Creation Process*

Following the completion of the module development, the material was sent to the project advisory group for review. Upon receiving feedback, the material was updated accordingly and sent to the Office of IT for an additional review and format check. Collaboration with IT personnel was critical in the confirmation and posting of the training material.

5.5 | Learning Outcome Assessment

As part of the e-learning training program development, learning outcome assessment options and recommendations were investigated. The goal of this investigation was to clearly understand how the training programs enhances user understanding or achievement in their profession, along with how to assess this achievement/improvement. As part of the investigation, multiple articles published in the Journal of Education (JEE) by the American Society for Engineering Education (ASEE) were reviewed to understand how to measure the success of the ProjectWise, Bluebeam, and CATS e-learning training programs. The features outlined in this investigation were incorporated into the training programs throughout the development process.

The training program development followed a Competency Based Learning (CBL) approach. CBL is defined as a "pedagogical approach that focuses on the mastery of measurable student outcomes" (Henri, 2017) which allows students or learners to progress through material at their own pace, making it ideal for an online environment. The training programs follow this approach through beginner and advanced topics that allow users to master basic topics before moving on to more advanced software features. While the training is designed to be asynchronous, various advanced topics require existing knowledge of the software outlined in the beginner topics. In addition to setting the learner's own pace, the CBL strategy aims to accommodate differences in learning style and encourages learners to take an active role in their continuing education (Henri, 2017). By providing multiple training materials through PDF documents, video demos, and

interactive software simulations, users are able to choose the material best suited for their training needs.

A study presented at the 2021 ASEE Annual Conference titled "Creating ACTIVE Learning in an Online Environment" investigated a method for evaluating video platforms for development of active videos for Generation-Z (Basinger, 2021). Although the target audience is different, this study contained clear parallels with the proposed ProjectWise, Bluebeam, and CATS training programs. While online video learning is extremely popular both in the academic and professional engineering industry, stand-alone videos may not be enough to establish meaningful learning (Basinger, 2021). Because ProjectWise, Bluebeam, and CATS are key components in GDOT's construction management process, it is vital construction staff actively learn the software through interacting with the training content. Active learning is developed by supplementing passive videos with activities that require users to learn the information based on completing a task (Basinger, 2021). The interactive modules provide this active learning task by requiring users to carry out various software actions presented in the video demos in a simulated software environment. Additionally, construction staff indicated the usefulness of PDF go by documents not only for training, but for references as well. The PDF guides developed offer additional supplemental material to ensure meaningful learning.

Online training is often accompanied by assessments, tests, and/or certificates that track user progression through the material. Although the software training programs do not contain standard assessments or quizzes, the programs still allow users to actively work through training topics through the interactive modules. Generally, training assessments are split between two categories: knowledge tests and task/skill-based tests or performance assessments (Dalto, 2015). The interactive modules act as self-guided performance assessments to be completed once the user

has reviewed the video demo and/or the PDF reference guide for the specific topic. Following the review of the PDF guide, video demo, and completion of the interactive module for a specific software topic, it is recommended the user performs the action directly in the software and return to the material for reference.

The measure of e-learning success is based on several factors. A study conducted in 2006 by Holsapple and Lee-Post introduced the E-Learning Success Model that defined the overall success of an e-learning initiative through an information systems perspective. The model defined three stages of e-learning systems development: system design, system delivery, and system outcome (Holsapple and Lee-Post, 2006), and is depicted in Figure 20.

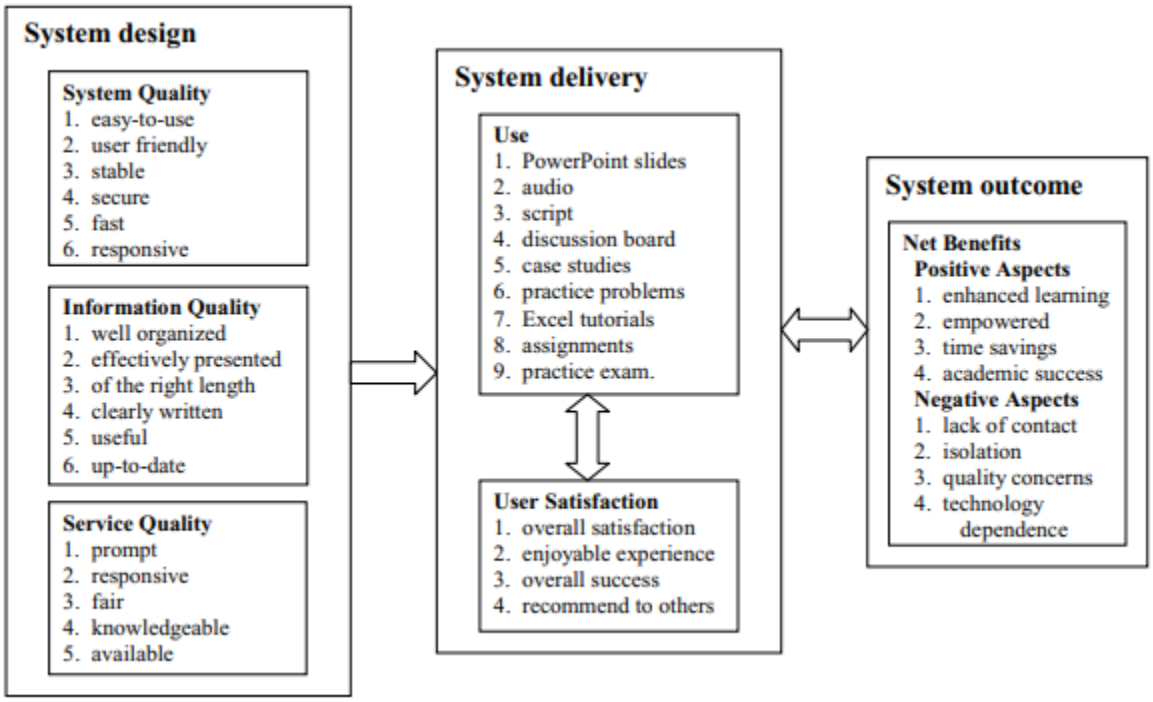

Figure 20: *E-Learning Success Model (Holsapple and Lee-Post, 2006)*

While the model was investigated and evaluated in an undergraduate student setting, the three stages of e-learning success contain clear parallels to the ProjectWise, Bluebeam, and CATS training programs. Success of the design stage is evaluated through system quality, information quality, and service quality (Holsapple and Lee-Post, 2006). Similar success metrics seen in Figure 20 were evaluated for the Bluebeam and ProjectWise training programs with focus on the following:

System Quality: user friendly, easily accessible, on-demand, engaging

Information Quality: well-organized, asynchronous, short/specific relevant topic focused, useful for construction operations, up to date

Service Quality: responsive and knowledgeable, dependent on IT personnel and software-savvy construction personnel

The system delivery consists of the following success metrics:

Use: PDF documents, video demos, interactive software simulation modules

User Satisfaction: Construction staff satisfaction with the programs, ability to learn from the material and apply the knowledge to day-to-day Construction operations

Finally, the system outcome is evaluated based on positive and negative aspects of the training programs. Positive aspects include enhanced learning and use of the software programs, and time and resource savings for the department. Negative aspects include lack of accessibility or use of the training. Concerning the above success metrics at the system design, delivery, and outcome levels, collaboration with the project advisory group was critical during training program delivery, review, and publishing to ensure the success of the e-learning software training programs.

6.0 | RESEARCH FINDINGS

6.1 | Preliminary Review Findings

The preliminary review consisted of a meeting conducted with the project advisory group on January 7th, 2021 as outlined in Section 5.1. The meeting provided initial high-level goals for the new training programs including building off existing training material to develop more engaging, interactive training, and developing construction specific training topics. These goals were further expanded on through the survey and subsequent meetings which are discussed in the following two sections.

6.2 | Survey Analysis

Survey responses were collected over a week and two-day period from January 26, 2021, to February 4, 2021. A total of 209 responses were collected primarily from district construction personnel along with approximately 5 KCI Technology (GDOT consultant) respondents and 3 KEA (Kennedy Engineering and Associates Group) respondents. The survey analysis was divided into the first three blocks of questions: general information, training information, and ProjectWise, Bluebeam, and CATS challenges. The questions were analyzed both quantitatively and qualitatively, depending on the specific question. The survey analysis concerning the construction manual is discussed in a separate but parallel study, as previously mentioned. Following the closure of the survey, the full survey report was extracted to a PDF document and excel spreadsheet to analyze the data.

6.2.1 General Information

The first section of the analysis pertained to how the respondents of the survey use ProjectWise, Bluebeam, and CATS, along with their confidence level with the three programs. Results of software use are presented in Figures 21, and broken down by software type in Figures 22, 23, and 24.

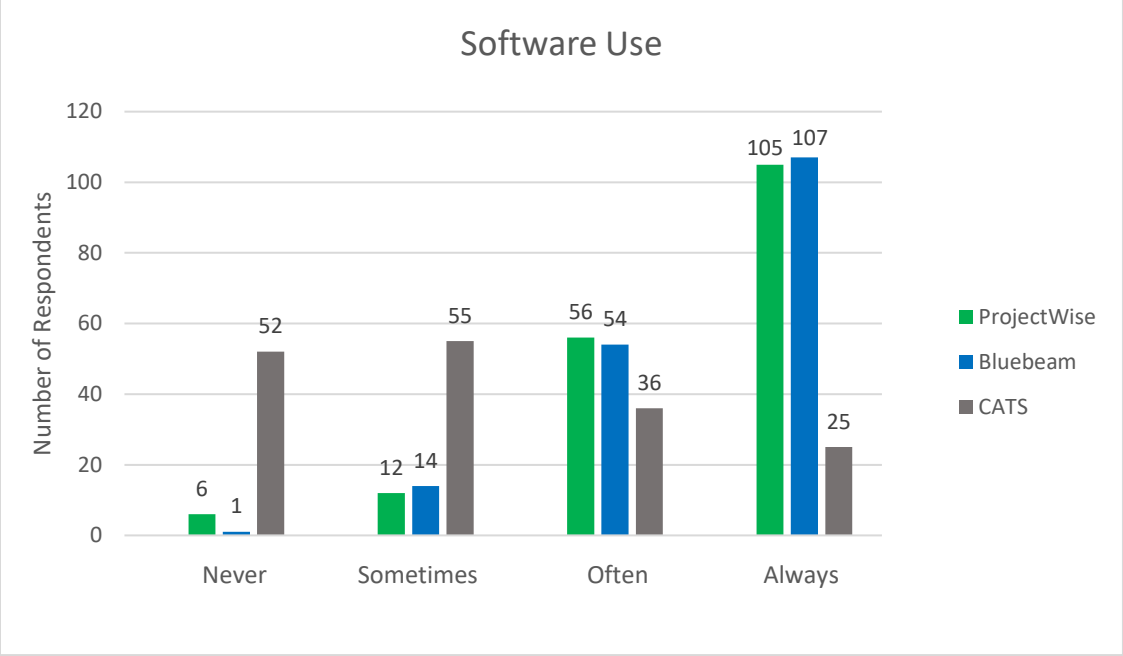

Figure 21*: ProjectWise, Bluebeam, and CATS Software Use*

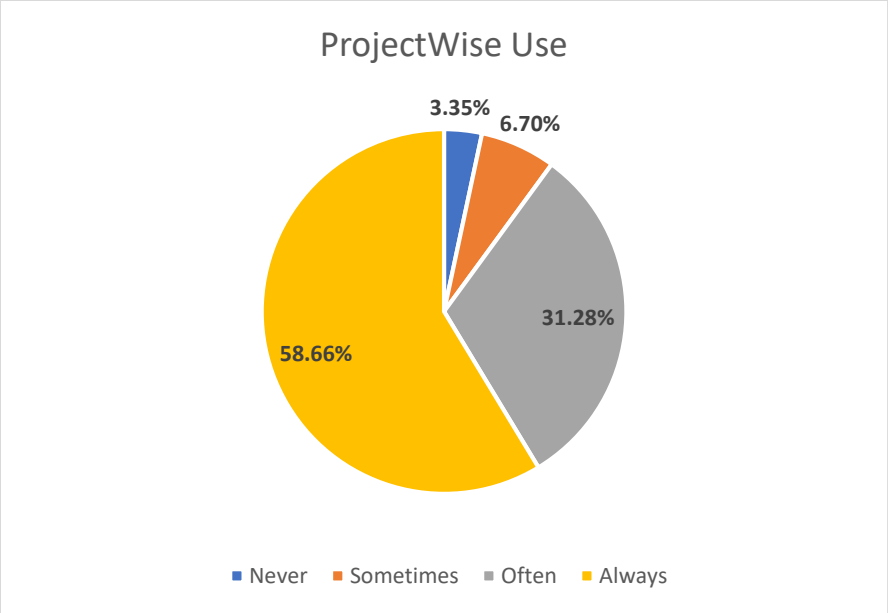

Figure 22: *ProjectWise Use*

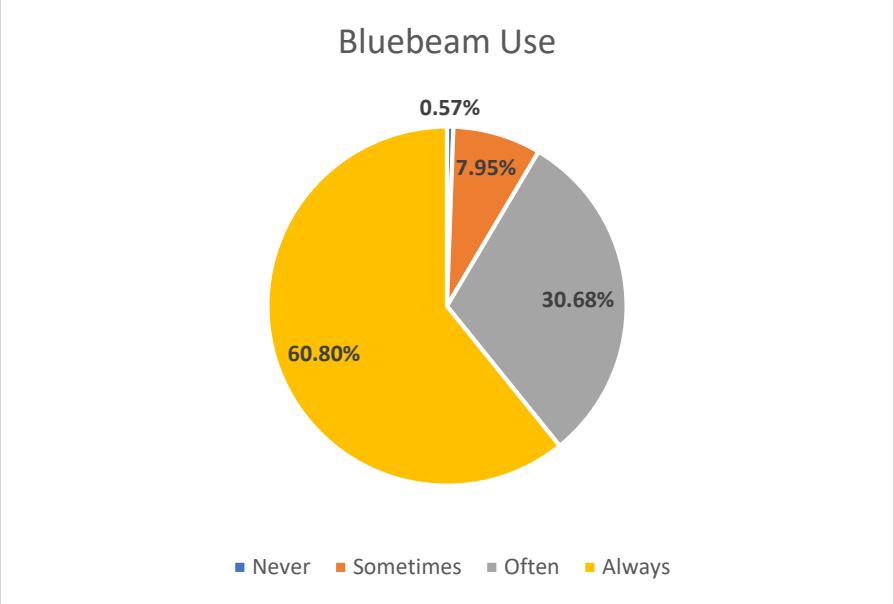

Figure 23: *Bluebeam Use*

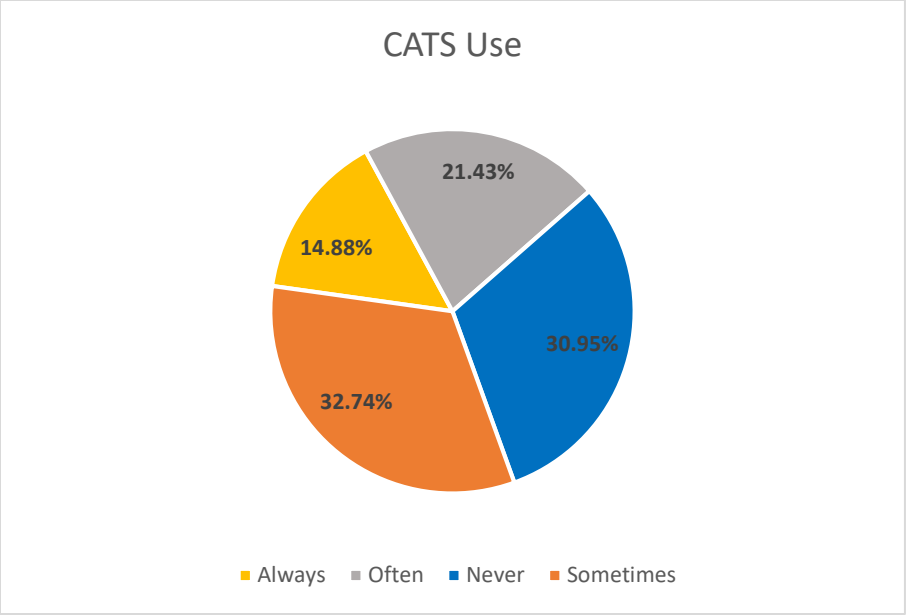

Figure 24: *CATS Use*

ProjectWise and Bluebeam use closely coincides, with 90.00% of respondents indicating they often or always use ProjectWise and 91.00% indicating they often or always use Bluebeam. CATS is not used nearly as frequently, with only 36.00% of respondents indicating they often or always use the program, and nearly a third, 31.00%, indicating they never use the program. Along with frequency of use, respondents were asked to provide a brief description of how their office currently uses the three programs.

ProjectWise is used primarily as a file storage system and a way to organize and centralize all project information. Project documents are placed in, updated, and extracted through ProjectWise. The software is used as a form of communication and file sharing where information can be uploaded and reviewed by different offices, documents are sent and received, files are relayed from the field to the office for review and approval, and correspondence with GDOT contractors. Bluebeam is used primarily as a PDF editor for signing, marking up, redlining, highlighting, and manipulating documents (such as inserting, deleting, combining, or extracting

pages). A large majority of project documents are created, opened, and edited in Bluebeam. Plans are reviewed, measured, scaled, and printed from Bluebeam. Other uses of Bluebeam include time sheets, letters and correspondence, and converting word and excel documents to a PDF. Finally, CATS is used for creating and processing contract documents, negotiations, and amendments. The in-house software is a means to implement supplemental agreements (SAs), change orders, time extensions, allotment requests, and force accounts. CATS' primary use is dealing with the Office of Construction's SAs.

In order to develop relevant training material, the existing confidence of GDOT construction personnel when using ProjectWise, Bluebeam, and CATS must be well understood. The confidence level of respondents with the three programs was recorded on a scale of 0-100. The mean confidence level, median confidence level, standard deviation, and count (number of responses) are presented in Table 3, along with each respective program's percentage histogram presented in Figures 25, 26, and 27.

Table 3: *Software Confidence*

	Mean	Median	Standard Deviation	Count
ProjectWise	69.21	75.0	23.48	171
Bluebeam	67.48	74.5	22.34	176
CATS	47.45	50.0	31.42	133

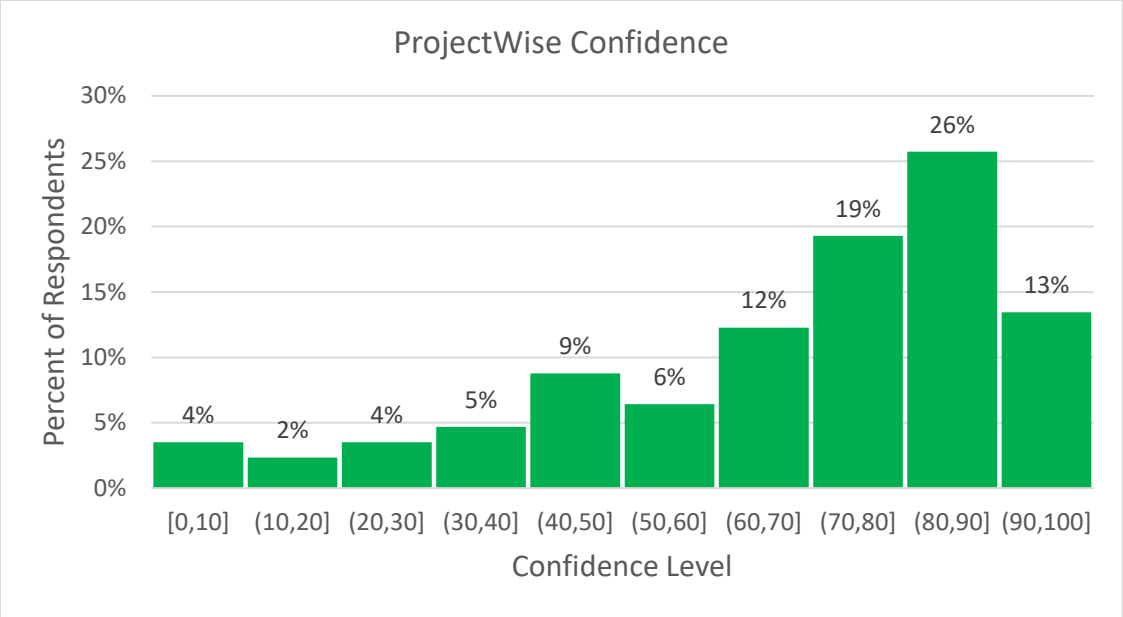

Figure 25: *ProjectWise Confidence*

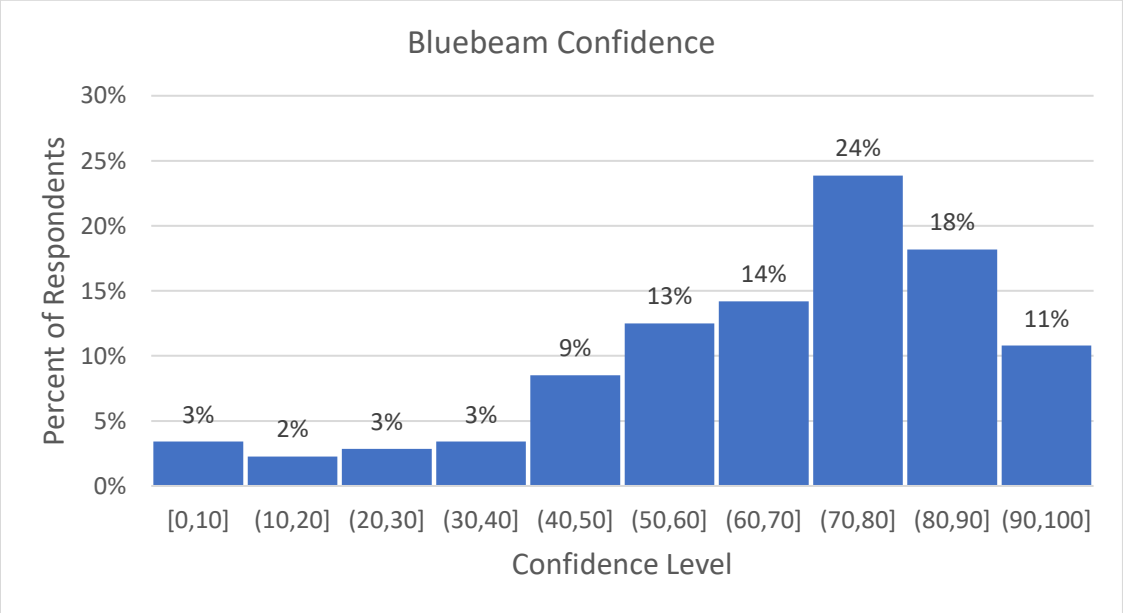

Figure 26: *Bluebeam Confidence*

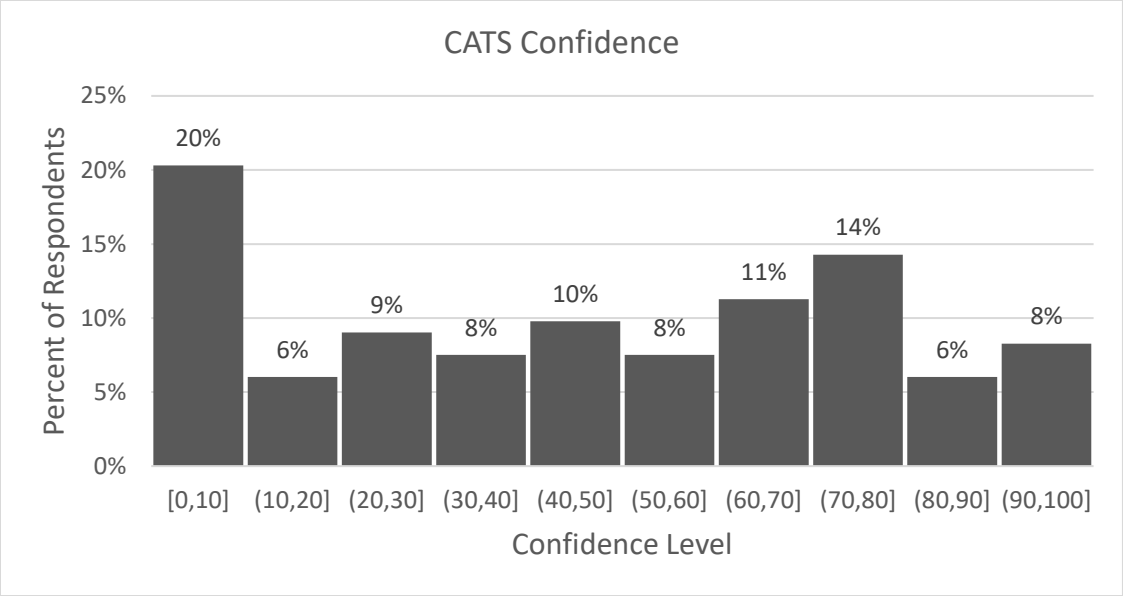

Figure 27: *CATS Confidence*

ProjectWise and Bluebeam displayed similar results with confidence level, with a mean confidence level of 69.21 and 67.48, respectively. Similarly, both data sets are skewed left, indicating a higher percentage of respondents who are generally more confident with the software than are not. 58.00% and 53.00% of respondents indicated having a confidence level of at least 70.00 with ProjectWise and Bluebeam, respectively. The CATS confidence level was much more dispersed, indicated by a higher standard deviation. The key takeaway from the CATS data is that 53.00% of respondents indicated a confidence level of 50.00 or below. While a portion of this lack of confidence is due to lack of use of the software, new training is a necessity to increase the confidence level of users with the program.

6.2.2 Training Information

The subsequent block of questions investigated existing GDOT training material and the level of priority for new training. In order to completely understand GDOT's existing training practices,

respondents were asked how often training occurs and how it is implemented. The results of training frequency and training type is displayed in Figures 28 and 29.

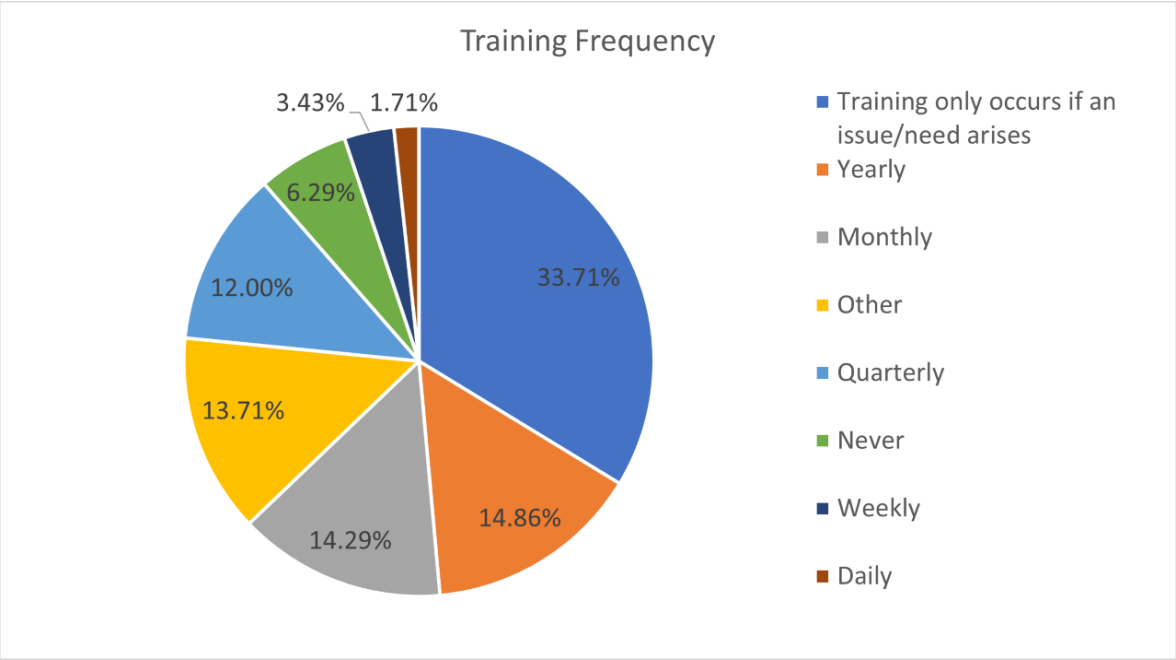

Figure 28: *Existing Training Frequency*

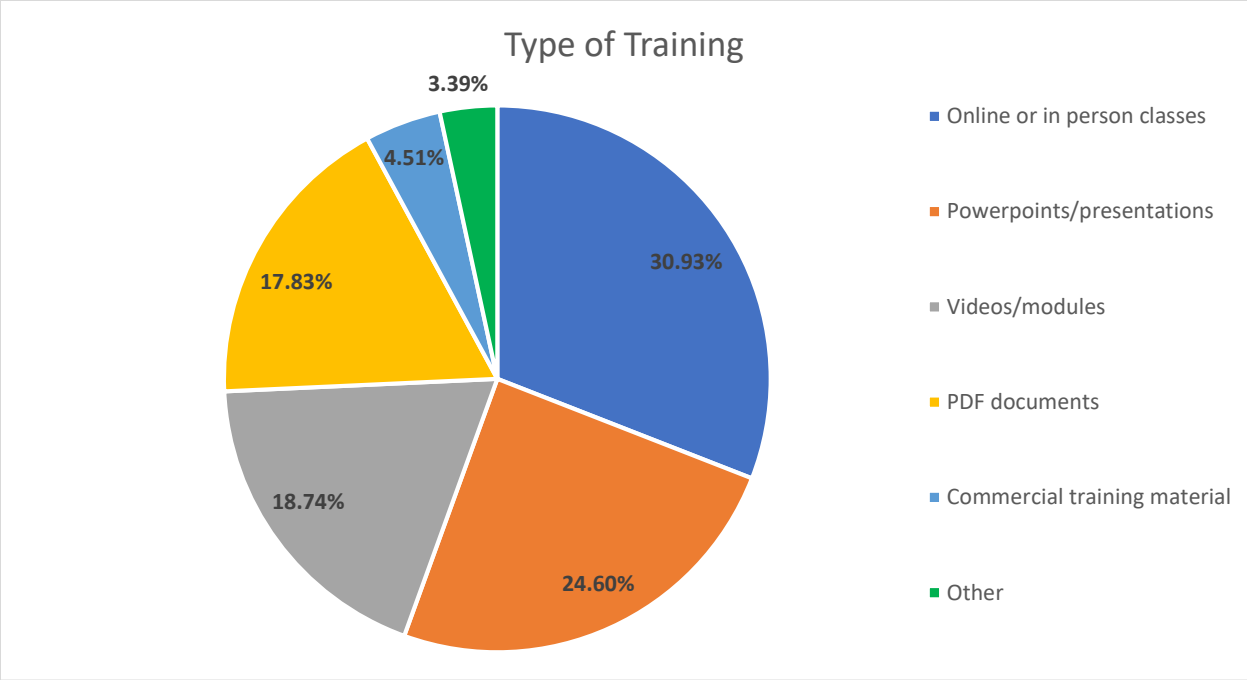

Figure 29: *Type of Existing Training*

Observing Figure 28, roughly a third of respondents indicated that training occurs only if a software challenge arises in the district, suggesting that a majority of district construction offices do not currently implement any formal, reoccurring training. In other words, training only occurs if construction personnel indicate the need for software training. Additional responses indicating yearly, quarterly, and monthly training also suggests no formal training occurs across construction offices. With training that does occur, online or in person classes followed by PowerPoints/presentations were the most popular methods for implementation, indicating that these methods are most familiar to construction personnel.

Before moving into software and training challenges, respondents were asked to give their perspective on the priority for new training. The results are shown in Figure 30. As expected, the highest priority for new training was ProjectWise, receiving 56.00% of the number one votes. The

priority was followed by Bluebeam and CATS, which obtained nearly 80.00% of the least priority votes.

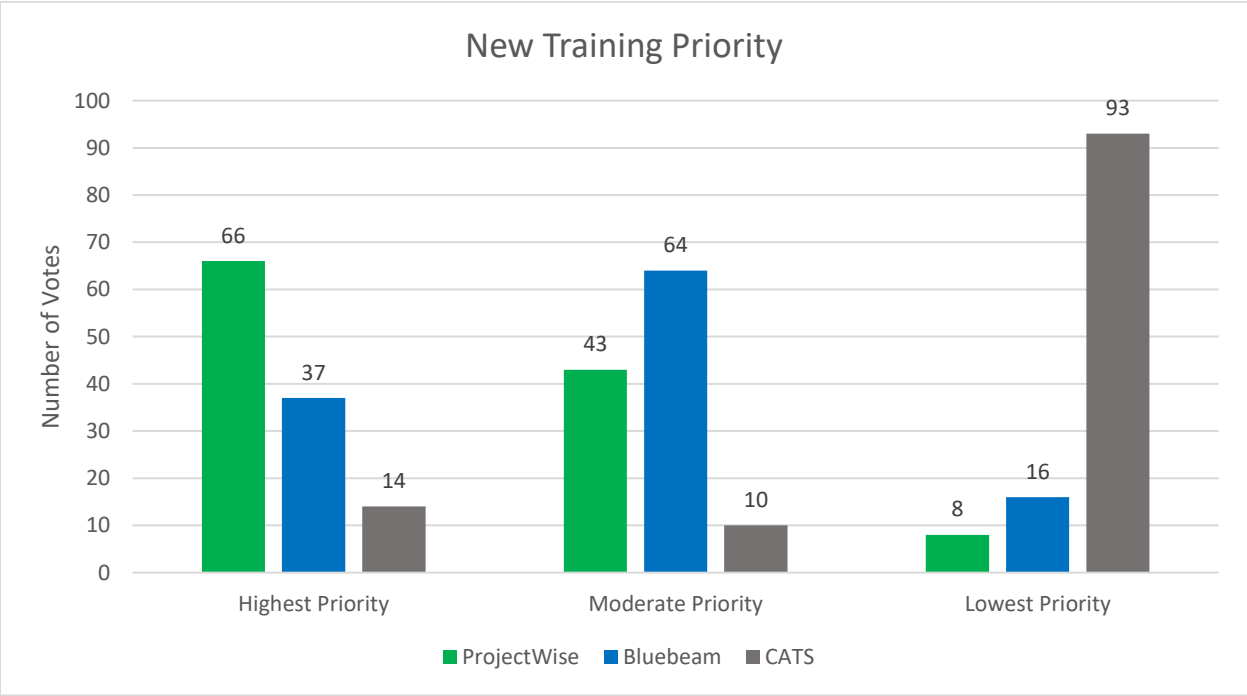

Figure 30: *New Training Priority*

6.2.3 ProjectWise, Bluebeam, and CATS Challenges

The final block of questions before the Construction manual section concerned software challenges. Respondents to the survey were asked to describe specific challenges with the three programs. Table 4 expresses the main challenges discussed by the respondents and the associated frequency of the specific challenge mentioned.

Table 4: *Key Challenges Associated with ProjectWise, Bluebeam, and CATS*

ProjectWise	Frequency	Bluebeam	Frequency	CATS	Frequency
Slow server/connectivity	18	General features, tools, and functions when editing	26	Lack of use, knowledge, and familiarity	6
Navigation, searching, and finding documents/projects	8	Training	7	Finding and filling out SA's	5
Labeling/naming documents	8	Info lost or corrupted when combining files or attaching to email	2	Training	4
Deliverables Management	7	Printing	2	Navigation, search, and find projects	3
Uploading files, lock, read only	7	Change/make a spreadsheet	1	Not user friendly, errors discovered down approval chain	3
Training	6	Apply digital signatures correctly	1	Not notified of updat	2
Deleting folders	5	Lock files, add permisions, edit after locked	1	Reference to contract ID's instead of PI's	2
Correspondence between GDOT and contractor	4	Measuring tool	1	Revising change orders	1

A common challenge indicated for all 3 programs included training. More specifically, respondents indicated the challenge with the programs was a lack of training, not adequate initial training for new hires, and ineffective training. Concerning ProjectWise, the top issue discussed was a slow server and slow connectivity. Because this is an external issue, focus remained on the other challenges listed including labeling/naming documents, deliverables management, and uploading and manipulating files. The primary challenge discussed by respondents for Bluebeam was understanding general tools, features, and functions of Bluebeam when editing documents. Many respondents indicated a lack of efficiency when redlining or marking up plans and felt that Bluebeam was not being used to its full capacity. Finally, with CATS, the primary challenge

indicated was a general lack of knowledge and familiarity with the program. The second most common challenge involved finding and filling out SAs. The common challenges listed provided multiple focus areas when developing the new training modules.

With the software challenges discussed, the next two questions inquired about the existing GDOT training material, focusing on ProjectWise. The GDOT website currently contains ProjectWise training material, as discussed in Section 2.4. In order to investigate the possibility of updating the current material, respondents were asked about their perception of the effectiveness of the current material. Nearly 70.00% of respondents indicated that the existing material is very effective, effective, or somewhat effective, as indicated in Figure 31.

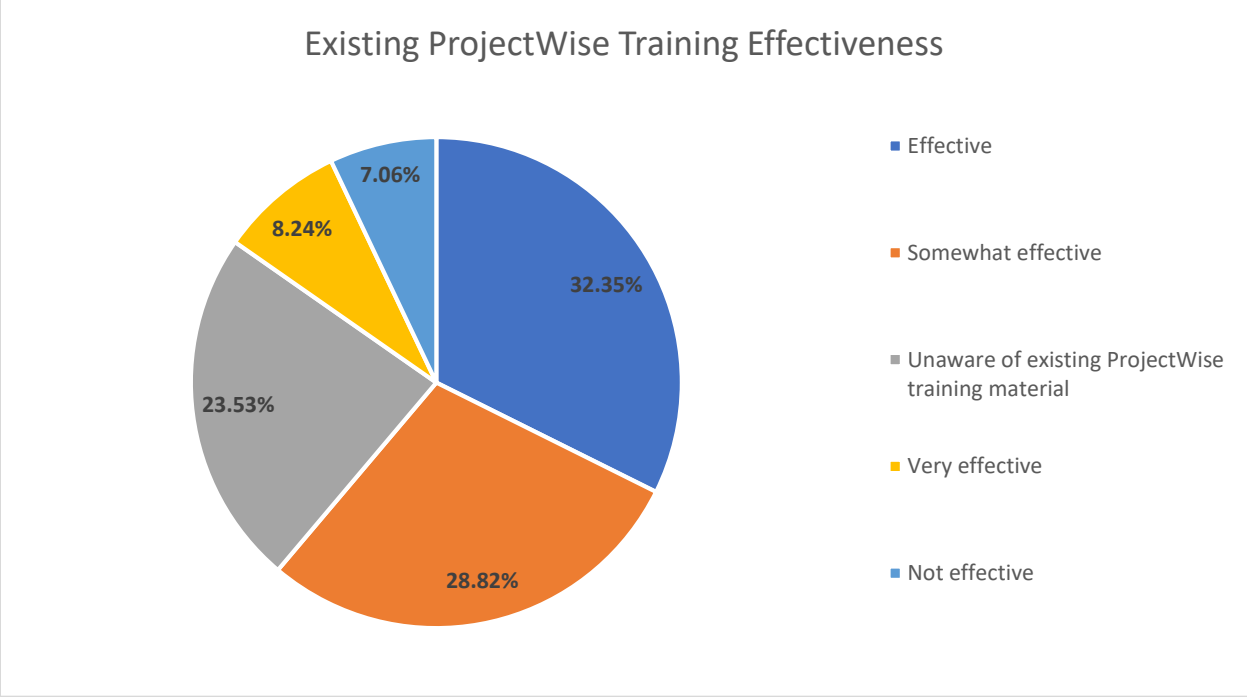

Figure 31: *Existing ProjectWise Training Effectiveness*

However, nearly a quarter, 23.53%, of respondents indicated they were unaware of existing ProjectWise training material. With the high percentage of positive responses to the existing

material, the goal of the new training was to update and enhance the material, while also making it more accessible.

Along with the effectiveness of the existing material, respondents were asked to describe what was missing from the material. The common responses are presented in Table 5. Many respondents indicated the missing factor from the ProjectWise material was more relevant demonstrations and examples related to construction. Additionally, a common response was more in-depth/engaging training along with updated training.

Table 5: *Missing Factors from Existing ProjectWise Training Material*

Missing Factors	Frequency
Step-by-step training material with specific examples, real world applications related to construction, simplicity	11
In-depth hands-on training, updates to training from changes to PW	10
Setting up, naming, and labeling documents	3
Difficult to navigate all PDF's, combine with index for easy reference?	3
Advertise training	3
Tools and multiple ways to achieve certain functions	1
Uploading files, locking, read only, etc.	1
Deliverables management	1

The final two questions of the survey inquired about desired features for general and interactive training. 93.00% of respondents indicated the want for more interactive training. Interactive features of Adobe Captivate were investigated in order to make the new training more engaging. Along with training specific to GDOT work and processes, 74.00% of respondents indicated general training is also needed for ProjectWise and Bluebeam. General training will offer

more of a broad overview of features and tools of the programs that will be especially beneficial for new hires.

6.2.4 Survey Main Takeaways

Following the survey analysis, multiple key takeaways were concluded. ProjectWise was the top priority for the new training, closely followed by Bluebeam, while the lowest priority for new training was CATS. ProjectWise and Bluebeam are used very often across construction offices and their use frequently coincides. The primary goal with the new training was to create more interactive, organized, and formal training that contained a blend of general and specific topics related to construction. The main focus with ProjectWise was navigation, document labeling and document manipulation (uploading and extracting files), and deliverables management, along with building off the existing ProjectWise training documents. The main focus with Bluebeam included general document manipulation features (inserting, deleting, combining, and extracting pages from a document) and tools to edit and markup PDF documents. Finally, the main focus with CATS was to increase general knowledge and familiarity with the program along with working with SAs.

6.3 | GDOT Meeting Takeaways

Following the survey period, meetings were conducted with GDOT District 1 and 2 construction personnel to more completely understand training needs concerning ProjectWise, Bluebeam, and CATS. Along with the survey results, the meetings provided key takeaways that resulted in a ProjectWise, Bluebeam, and CATS training program specifically tailored to the Office of Construction needs. Because Construction personnel had little knowledge or were unaware of existing ProjectWise and CATS training material, the goal of the new training program was to focus on promoting the material and ensure its accessibility to Construction staff.

6.3.1 | District 1 Construction Meeting Takeaways

District 1 personnel indicated multiple software challenges and suggestions to develop the most effective training material. Concerning ProjectWise, the file naming system and file navigation were described as serious challenges. The constant upgrades with the software cause issues along with the system speed. Only being able to open/check out one file at a time proved to be a challenge for employees, especially for a large set of plans. Finally, general ProjectWise basics such as navigating the interface was discussed as a challenge for new employees.

Concerning Bluebeam, the primary challenge discussed consisted of becoming accustomed to the Bluebeam interface, along with learning the most efficient tools to edit/markup documents. The use of Bluebeam in the field was discussed extensively. One of the key updates to the Construction Manual described for Bluebeam was proper as-built management, which is closely related to red-lining plans. Construction personnel desire to have the quickest and most efficient way to update/markup plans. The goal of field personnel is to redline plans in real time on a mobile device. It was discussed that while contractors use iPads or Getacs (not very user-friendly) to review plans, the majority of employees will redline hard copies of plans, have to scan them in, upload them, etc. With this process being very time consuming, the goal is to transition into more of an electronic streamlined process. One of the main focus areas for the new Bluebeam training should deal with correctly and efficiently redlining plans, especially for those in the field.

Finally, the primary challenge concerning CATS was the software not allowing users to go back/send back documents or processes once they are started. Once an error is found, the user must start over. Although this challenge was not in the scope of the project, it brought up a crucial issue in the operations of the software.

The second objective of the meeting focused on the goals of the new training and construction manual updates. Along with the main goal of the training to provide more interactive, organized, and formal training with a blend of both general and construction specific information, District 1 personnel discussed the idea of having multiple levels of training (i.e., beginner, intermediate, and advanced). The different levels of training allow users to pick and choose the material they want to view, whether this is basic training for new hires/users, or more advanced topics for the most effective use of the software. Specifically, with ProjectWise, the new training aimed to produce more engaging material and create more applicable material for construction personnel. Much of the current material is step-by-step PDF documents outlining a certain task or action in ProjectWise and does not appear to be well-known or widely used across construction personnel. District 1 personnel indicated the importance of repetition for training, especially for new hires. While training for software may have occurred in the past, it was a one-time class/course that may no longer be relevant. Short, specific, and engaging module videos allow training to be on-demand and viewed as frequently as the user requires.

Concerning Bluebeam, multiple features were discussed as important topics for new training including converting PDF documents to word documents, use of the flatten tool to prevent editing of documents, add text comments and leader lines, highlighting, markup clouds, etc., how to extract/combine/delete certain pages from a document, and effectively redlining plans and the tools involved. The idea was discussed to structure the Bluebeam training in levels or tiers covering software basics followed by more advanced topics. Following the preview of the "rough" draft training video covering digital signature implementation in Bluebeam, the interactive features of the new training was discussed. District 1 personnel indicated the video was a simple and good

place to start. More interactive features were investigated following the meeting in order to further enhance the video's engaging properties.

6.3.2 | District 2 Construction Meeting Takeaways

District 2 personnel discussed similar challenges with the software programs and added their unique perspective to the development of the new training material. Similar to District 1, two of the main challenges discussed with ProjectWise was locating documents and not having a naming system/guideline. Each area within District 2 may name files differently than other areas. Along with area differences, there are key differences across GDOT departments when it comes to naming files. An additional challenge discussed was implementing Deliverables Management, a feature in ProjectWise that is currently not being used. Because it is optional for contractors, many prefer to send documents through email. With Deliverables Management offering an easy way to track and file documents, its implementation would greatly increase productivity in the office. Deliverables Management is an area that the contractors need more training on than GDOT personnel.

One of the primary challenges discussed with Bluebeam was the large gap in experience level between many users in the office. While some users do not understand the basics of Bluebeam, others have been able to fully implement the basics and would benefit from more training on advanced features of the program. In order to assist district employees with Bluebeam, a redline guide was created for employees to follow. The guide offers step-by-step instructions with screenshots from Bluebeam on how to correctly markup plans. Also similar with District 1, field use of Bluebeam was discussed as a challenge primarily because the tablets currently in the field are rarely used and do not work effectively. A hard copy of the plans is normally redlined in

the field, brought back to the office, and transferred electronically into Bluebeam. Finally, with CATS, the only challenge mentioned was retrieving and searching for project information.

The second portion of the meeting focused on new training and construction manual update goals. Along with providing more interactive, organized, and formal training, District 2 personnel also discussed the idea of having multiple levels of training covering basics and more advanced topics, especially for Bluebeam. Similar to District 1 personnel, District 2 personnel indicated the general lack of knowledge of the existing ProjectWise training. While the training may have been initially mentioned, it does not appear to be used as relevant training material, the reason being that many people would do better with a video or in person/peer training. Concerning Bluebeam, it is important to contain basic and advanced training. District 2 personnel discussed how basic training will be useful for new users and ones not familiar with the program, while advanced training will dive more into the weeds of functions and tools in Bluebeam. Training topics discussed included redlining, converting PDF documents to word documents, editing and locking documents/markups. Robert Rowland, District 2 Area 5 manager, provided a redline guide he and his team developed to assist District 2 employees redline plans. The guide contains step-by-step instructions on how to redline and explores different features of Bluebeam. The guide offered relevant topic ideas for the new Bluebeam training.

Prior to the meeting, an interactive video was developed to accompany the digital signature video demo shown in the District 1 construction meeting. The two were combined to form one complete video containing a demo in the first half, and interactive software simulation in the second half. The software simulation allows users to physically click and input information as they would in the actual program. Following the preview of the video, the interactive features of the new training was discussed. District 2 personnel indicated that it may be more beneficial to

separate the two videos to create two distinct files: a passive video demo and a more engaging interactive video. Following the meetings with District and Area managers, additional meetings were conducted with construction managers and inspectors to gain their perspective on new training and Construction Manual updates.

6.3.3 | Construction Managers and Inspectors Meeting Takeaways

After gaining the perspective of District and Area managers, meetings were conducted to gain the input of project managers and inspectors concerning the software challenges and goals for the new training, along with Construction Manual updates. It was discussed that CMs and inspectors face similar challenges to district and area managers with the three programs including the labeling/naming system and working with Deliverables in ProjectWise, lack of understanding of new and existing tools in Bluebeam, and a challenge working with contract documents in CATS. Specifically, with ProjectWise, while there is a District 1 go-by for file naming, there is no training on the naming system. Training that describes this go-by document and goes through it would be very beneficial. The difficulty in not having a standard naming system was also discussed as a challenge and different areas within a district might even have different naming systems, thus the reason why District 1 created the go-by. While a statewide standard would be ideal, it may be hard to implement with districts and areas across the state that currently use conflicting methods. Concerning Bluebeam, it was discussed that new training is needed because of the recent update to the software that is new to many employees. While Bluebeam training did occur over Microsoft Teams in the past, it would be more helpful to have new training material to reference. CATS is also in need of new training, with a focus on navigating the program.

Following the discussion of software challenges, the specific topic areas for new training was further discussed. The most important topics discussed for new ProjectWise training was

document labeling and Deliverables Management. Both the CM's and inspectors were unaware of the existing ProjectWise training and indicated that something more engaging and interactive to go along with the PDF go-by's would be beneficial. Additional training regarding ProjectWise Deliverables Management and what is expected when using Deliverables Management was also discussed as an important topic for new training.

6.4 | Training Topic Development

Following the survey analysis and construction meetings, a working outline for the new training was developed. The outline focuses on software challenges and uses discussed in the survey and in the subsequent meetings with a variety of construction personnel. Table 6 shows the proposed training outline. The outline is structured around a tiered approach with beginner and intermediate-advanced topics which will provide relevant training for users of various experience levels. A total of 20 modules were proposed: 6 ProjectWise topics, 9 Bluebeam topics, and 5 CATS topics.

Table 6: *Proposed New Training Outline*

Software	Level	Module	Justification
ProjectWise	Beginner	Interface and Navigation	Provide a basic understanding and introduction to the software
		Navigating, Searching, and Finding Documents	One of the key challenges discussed, learn how to efficiently search
		Uploading and Extracting Files	Understand how to work with files in the system
		Document Setup, Labeling, and Organization	Naming and setup is confusing, no stnadard to follow
	Intermediate-Advanced	Using Deliverables Management Effectively	Another key challenge discussed, help contractors use the feature
		Best Practices and Construction Examples	Specific examples that Construction employees will often work with
Bluebeam	Beginner	Interface and Navigation	Provide a basic understanding and introduction to the software
		General Markup Tools	Primary function and use of Bluebeam by Construction peronnel
		Converting File Types	Important feature discussed that many people struggle with
		Document Manipulation	Understand how to combine, separate, extract, and delete pages
		Digital ID and Signing Documents	Inform users how to correctly incorporate sigantures on documents
		Use of the Flatten Tool	Frequently used tool discussed in cosntruction meetings
	Intermediate-Advanced	Viewing Multiple Drawing Sheets at a Time	Beneficial to view different sections of plans at once using split screen
		Effectively Redlining Plans and More Advanced Markup Tools	Most important and used feature in Bluebeam, users would benefit from additional training in advanced tools
		Interface Customization	Learn how to edit Bluebeam interface to maximize user productivity
CATS	Beginner	Introduction to CATS	Provide a basic understanding and introduction to the software
		Navigating, Searching, and Finding Projects	One of the key challenges discussed, learn how to efficiently navigate the software
	Intermediate-Advanced	Working with Contract Documents	Overview of CATS features, generating contract ID
		Supplemental Agreements	Primary use of CATS, step-by-step setting up and filling out SA
		Best Practices and Construction Examples	Specific examples that Construction employees will experience

In order to fully accommodate different user preferences, three forms of new training were investigated including a video demonstration, interactive software simulation, and PDF ‘go-by’ document. A meeting with the project advisory group was conducted on May 5th, 2021, to further discuss this proposed outline and format options. The proposed outline was well-received and feedback was provided for the topics. The following topics were suggested to include in the Bluebeam training material in addition to the proposed topics:

- The measure and scale tool, how to check the scale on a drawing, and how to calibrate the scale.
- Using layers and how to track markups.
- The as-built and shop drawing process (adding markups to as-builts and uploading to ProjectWise). The project advisory group provided a PowerPoint presentation covering the as-built tools and processes that they would like to be included in the Intermediate-Advanced Bluebeam training.

Following the meeting, the training outline was updated and shown in Table 7.

Table 7: *Updated Training Outline*

Software	Level	Module	Justification	Interactive	PDF
ProjectWise	Beginner	Interface and Navigation	Provide a basic understanding and introduction to the software	N	Existing
		Navigating, Searching, and Finding Documents	One of the key challenges discussed, learn how to efficiently search	Y	Existing
		Uploading and Extracting Files	Understand how to work with files in the system	Y	Existing
		Document Setup, Labeling, and Organization	Naming and setup is confusing, no standard to follow	Y	Y, Existing
	Intermediate-Advanced	Using Deliverables Management Effectively	Another key challenge discussed, help contractors use the feature	Y	Existing
		Best Practices and Construction Examples	Specific examples that Construction employees will often work with	N	Y
Bluebeam	Beginner	Interface and Navigation	Provide a basic understanding and introduction to the software	N	Y
		General Markup Tools	Primary function and use of Bluebeam by Construction personnel	Y	Y
		Converting File Types	Important feature discussed that many people struggle with	Y	Y
		Document Manipulation	Understand how to combine, separate, extract, and delete pages	Y	Y
		Digital ID and Signing Documents	Inform users how to correctly incorporate sigantures on documents	Y	Existing
		Use of the Flatten Tool	Frequently used tool discussed in cosntruction meetings	Y	Y
		Scale and Measurement Tools	Check the scale on a document, calibrate the scale, measuring tool	Y	Y
	Intermediate-Advanced	Viewing Multiple Drawing Sheets at a Time	Beneficial to view different sections of plans at once using split screen, comparing and overlaying documents	Y	Y
		Advanced Markup Tools: Stamps and Hyperlinks	Most important and used feature in Bluebeam, users would benefit from additional training in advanced tools	Y	Y
		Advanced Markup Tools: Layers	Discuss Bluebeam layers and tracking markups	Y	Y
		As-Built Plan Process	Follow along with PPT as-built process, link to PW	Y	Existing ppt
		Interface Customization	Learn how to edit Bluebeam interface to maximize user productivity	Y	Y
		Bluebeam Studio	Using BB Studio, see studio documents	N	Existing
CATS	Beginner	Introduction to CATS	Provide a basic understanding and introduction to the software	N	Existing
		Navigating, Searching, and Finding Projects	One of the key challenges discussed, learn how to efficiently navigate the software	Y	Existing
	Intermediate-Advanced	Working with Contract Documents	Overview of CATS features, generating contract ID	Y	Existing
		Supplemental Agreements	Primary use of CATS, step-by-step setting up and filling out SA	Y	Existing
		Best Practices and Construction Examples	Specific examples that Construction employees will experience	N	Y

6.5 | Training Program Development

Following the approval of the training topics, the Bluebeam training development began. After meeting with GDOT IT personnel, resources were provided to create more standard material that aligned with GDOT's IT branding guidelines. The guidelines included information on the style of text, graphics, callouts, and shapes, along with proper language, grammar, naming conventions, and syntax. Additionally, one more topic was added to the Bluebeam training outline: a review of Bluebeam Studio. Bluebeam Studio was discussed as a new feature currently being investigated by the department.

While the focus of the training program was the video demos, additional materials were created to provide users with multiple viewing options depending on personal preferences and training necessity. The training program involved the development of the following materials:

1. Video demo: Provide the user with an engaging but non-interactive step-by-step video of actions being carried out in the software.
2. Interactive Software Simulation: The "do it yourself" version of the video demo. A number of the video demos are accompanied by an interactive element that requires users to physically click through a number of prompts to complete the specified action in the software. This material was targeted at new users needing more hands-on training.
3. PDF go-by: If a PDF go-by document did not already exist for the training topic, one was developed that walked through and described the same actions displayed in the video demo in the form of a visual PDF document. This material was targeted at more confident users that may just need a refresher or quick reference on a specific topic.

The first topics approved by the research advisory group covered the following Bluebeam topics: use of the flatten tool, document manipulation basics, and scale and measurement tools.

The video demos, PDF guides, and interactive modules were provided to the research advisory group for review and approval. Following the approval, development of the beginner Bluebeam topics continued and proceeded to the intermediate/advanced topics.

In order to develop the ProjectWise training material, access to the applications was essential. Additionally, specific Bluebeam training topics, Bluebeam Studio and the As-Built Plan Process, were linked to ProjectWise and thus required access to the application. After working with the GDOT project advisory group and GDOT IT personnel, a spare laptop was acquired for training material development purposes. ProjectWise was installed on the laptop, along with the most recent version of Cisco which was used to VPN to the GDOT network. Because the screen capturing software Adobe Captivate was installed on a desktop located at the University of Georgia's STRENGTH's lab, the GDOT laptop was accessed via a remote desktop connection. The connection allowed for both ProjectWise and Adobe Captivate access to successfully record the training material. Following the Bluebeam training development, the ProjectWise beginner content was developed. The research project will continue through 2022 with the development of the intermediate/advanced ProjectWise content and CATS content.

6.5.1 | Training Topic List and Description

The following sections provide a review of the modules developed as part of this research, the material produced for each topic, and a description of the topics covered in each module. While the training program is asynchronous, the modules are numbered for organizational purposes.

6.5.1.1 | Beginner Bluebeam

The beginner Bluebeam training material is comprised of 7 modules that walk through basic actions and tools in Bluebeam. This material is targeted towards new Bluebeam users and those that find the program challenging or difficult to use.

6.5.1.1.1 | Interface and Navigation: PDF Guide and Video Demo

This module provides an overview of the Bluebeam interface and a tour of the various tools and actions available in the program. Beginning with the top menu bar, each item is briefly reviewed including the Revu, File, View, and Document dropdown menu. Next, the left toolbar is investigated where the toolbar icons are described including the File Access, Tool Chest, Measurements, Properties, Search, and Studio panel icon. While a description is provided for each icon, additional Bluebeam modules are mentioned that indicate where additional training is found. The navigation bar is then reviewed including tools to navigate documents, split screen features, and zoom options. Finally, the markups list found below the navigation bar is briefly introduced. Because this module provided an overview of the interface, an interactive module was not required and thus not developed for the topic.

6.5.1.1.2 | Document Manipulation: PDF Guide, Video Demo, and Interactive Module

Document manipulation techniques were discussed as a major challenge in the survey and accompanying construction meetings. This module aims to walk through various document manipulation techniques used on a regular basis by construction personnel. The module begins by describing where the document manipulation tools are found including the Document tab and by right clicking on a page in the Thumbnails section. Next, the module reviews the tools available including how to insert, delete, and extract pages from a document, combine files, replace pages, and rotate pages using a sample 8-page drawing set. Finally, the module describes how to pin the document manipulation tools to the toolbars for easy access. Toolbar and interface customization are the focus of the Interface Customization module.

6.5.1.1.3 | Converting File Types: PDF Guide, Video Demo, and Interactive Module

This module aims to review the various file conversion options offered by Bluebeam and how to execute a file conversion. First, the module shows where the file conversion options are found under the File dropdown menu, followed by a brief description of the options including image files and Word, Excel, and PowerPoint files. Next, multiple file conversions are shown, starting with a PDF to a Word document conversion. The Word document is then converted back to a PDF and opened up in Bluebeam. Finally, two additional examples are shown converting a PDF document to a JPEG image file and an Excel workbook file.

6.5.1.1.4 | Use of the Flatten Tool: PDF Guide, Video Demo, and Interactive Module

The flatten tool was a frequently discussed tool in the construction meetings. This training module aims to address the challenges and confusion brought up with the flatten tool in the meetings. First, a brief overview of the tool is provided including what the tool does and why it is used. Next, the module reviews how to flatten individual markups on a drawing, followed by how to flatten an entire document. The module walks through the various options provided by the interface when flattening a document including flatten options and document recovery options. Finally, in order to edit the document once again, the unflatten tool is reviewed.

6.5.1.1.5 | General Markup Tools: PDF Guide, Video Demo, and Interactive Module

As the primary use of Bluebeam in the Office of Construction, the General Markup Tools module was the most critical Bluebeam module developed. The module aims to provide a general overview of the markup tools in Bluebeam and how they are applied and edited on a drawing. Specifically, the module begins with a description of how the markup tools are accessed in the interface, both under the Tools dropdown menu and Tool Chest icon. Next, various markup tools are discussed and applied to a sample drawing sheet including the textbox, typewriter, note, callout, 1 and 2D

sketching, cloud, and cloud plus markup. Because much of the editing options are similar across markup tools, the text callout editing options are extensively discussed including how to edit the color, adjust the size, and add a border to the markup. Once various markups are applied to the drawing, the group and lock tools are discussed as an effective method to work with multiple markups at once. Finally, the markups list is reviewed where the full list of markups and accompanying markup properties are shown.

6.5.1.1.6 | Scale and Measurement Tools: PDF Guide, Video Demo, and Interactive Module

While not initially brought up in the survey or construction meetings, the project advisory group discussed the addition of a module to discuss how to check the scale on a document, how to calibrate the scale, and the various measurement tools offered in Bluebeam. This module aims to address these concerns, beginning with the Bluebeam interface scale options. First, the Measurements icon is reviewed where there are options to set a preset scale or calibrate a new scale. This module is concerned with the calibration scale option. After calibrating the scale, the module reviews various measurement tools including the length, polylength, perimeter, and area tools. The tools are applied to a sample roadway drawing sheet. Finally, the module indicates where the measurement tools are stored in the markups list, similar to other markup tools.

6.5.1.1.7 | Digital ID and Signing Documents: Video Demo and Interactive Module

Applying a digital signature in Bluebeam was one of the few existing GDOT training documents available for Bluebeam. Following along with the existing document, this module reviews how to create a Digital ID in Bluebeam. Next, the module shows how to apply a signature to the Digital ID and the various editing and appearance options available. Finally, the Digital ID is applied to a sample drawing sheet. Because an existing training document is available, a PDF guide was not developed for this topic.

6.5.1.2 | Intermediate/Advanced Bluebeam

The intermediate/advanced Bluebeam training material is comprised of 6 modules that walk through more advanced tools and actions in Bluebeam. While the program was designed to be asynchronous, it is recommended new users first view the beginner material, as the below module topics are targeted toward more advanced Bluebeam users.

6.5.1.2.1 | Viewing Options in Bluebeam: PDF Guide, Video Demo, and Interactive Module

One of the primary challenges associated with Bluebeam was the inability to use the program effectively and efficiently to its full capacity. A specific challenge was discussed on how to view multiple drawing sheets at a time when reviewing plans. This module aims to review the various viewing options in provided in Bluebeam. First, the module reviews the different viewing options for a single page including the fit page, fit width, and actual size options. Next, the single page, continuous pages, side-by-side, and continuous side-by-side viewing options are investigated and discussed. Additionally, the split screen tools are shown as a means to view separate documents at once, using a synchronized view and unsynchronized view. Finally, the Compare and Overlay tools are investigated using an old and updated version of a drawing sheet.

6.5.1.2.2 | Advanced Markup Tools: Stamps and Hyperlinks: PDF Guide, Video Demo, and Interactive Module

While the General Markup Tools module describes the basic markup tools, this module aims to review two more advanced markup tools frequently used by the Office of Construction: the stamp and hyperlink tool. The stamp tool is discussed first, beginning with a review of the prebuilt stamps provided by Bluebeam including the Approved and Date & Time stamp. Multiple stamps are applied to a sample drawing. Next, the module reviews how to create and edit a custom stamp. After the stamp tool review, the module investigates the hyperlink tool. Four hyperlink options are

described including the Jump to, Snapshot View, Hyperlink, and Open option. After applying multiple hyperlinks to the sample drawing, the module reviews how to edit and make the hyperlinks visible.

6.5.1.2.3 | Layer Tools: PDF Guide, Video Demo, and Interactive Module

Working with Bluebeam layers was discussed as a challenge by the project advisory group. This module provides an overview of the layer tool and walks through how to create layers and layer configurations. First, the module walks through the creation of multiple new layers in the interface. Next, the module shows how to assign individual and multiple markups to layers. Various layer options are discussed including layer visibility, and print/export options. Finally, layer configurations are discussed. The module walks through how to create, name and edit a new layer configuration. As with previous modules, the markups list is once again reviewed to indicate that layer properties are shown in the list.

6.5.1.2.4 | As-Built Plan Process: Video Demo, and Interactive Module

The project advisory group indicated the importance of the As-Built Plan Process for construction operations and requested the process be shown in the Bluebeam training program. This module follows along with a As-Built Plan Process PowerPoint presentation provided by the project advisory group that outlines both the electronic As-Built Plan and Shop Drawing Review process. Beginning, in ProjectWise, the module reviews how to copy a drawing sheet from the current set of plans folder into the As-Built plans folder. Next, the drawing is stamped with an As-Built stamp and checked back into ProjectWise. Shop drawings are produced in Bluebeam and then submitted through ProjectWise Deliverables Management that tracks the receipt and status of submittals, along with alerting individuals when submittals arrive and are due. Specifically, in Bluebeam, this module walks through how to combine markups from multiple reviewers into one master drawing.

Because an existing PowerPoint presentation was available outlining the As-Built Plan steps, a PDF guide was not developed for this topic.

6.5.1.2.5 | Interface Customization: PDF Guide, Video Demo, and Interactive Module

The Bluebeam interface is completely customizable to fit specific user workflow needs. This module aims to walk through the various options to customize the interface to better fit specific user needs which would allow for a more efficient use of the program. First, the module describes the prebuilt profiles offered by Bluebeam including the Revu, Revu Advanced, Quantity Takeoff, and Field Issues profiles. Next, a custom profile is created. The remainder of the module focuses on interface customization, starting with the left toolbar where various icons are moved and hidden from view. Next, the top menu toolbars are edited and customized. Finally, the module walks through how to save and export the custom profile.

6.5.1.2.6 | Bluebeam Studio: Video Demo

The final module in the Bluebeam training program reviews how to get started using Bluebeam Studio. Bluebeam Studio is a cloud-based service that allows multiple users to collaborate and markup a document real time. The project advisory group indicated Studio is a new feature in the Office of Construction and thus would benefit from being included in the training program. This module follows along with two existing GDOT documents pertaining to registering, creating, and working in a Bluebeam Studio account. First, the module walks through how to create and login to a Studio account. Next, the Studio session tools are described including how to begin a session, join a session, invite users to a session, and upload plans to a session. The module describes how all activity is recorded in the session including markups. Finally, options are reviewed on how to leave and conclude a session, followed by creating a session report. Because existing training

documents were available for Bluebeam Studio and the module provided an overview of the session features and tools, a PDF guide and interactive module was not developed for this topic.

6.5.1.3 | Beginner ProjectWise

The beginner ProjectWise training material is comprised of 4 modules that walk through basic actions and tools in ProjectWise. The training modules build off and follow similar topics outlined in the existing GDOT ProjectWise training guides, discussed in Section 2.2.1. Because existing PDF guides are available, the ProjectWise topics focused specifically on video demo and interactive module development.

6.5.1.3.1 | Interface and Navigation: Video Demo

This module introduces ProjectWise Explorer and provides a tour of the different panel and menu bar sections in the interface. First, the module begins with opening ProjectWise Explorer from a GDOT desktop. Next, an overview of the interface is provided including the folder structure, toolbars, and document panels. Each folder and document in ProjectWise are associated with two icons, indicating the access/permissions of the file and the application the file is associated with. The module walks through these access/permission icons including the read only, checked out, and locked icon. Finally, the address bar is briefly reviewed. Because this module provided an overview of the ProjectWise interface, an interactive module was not required and thus not developed for this topic.

6.5.1.3.2 | Navigating, Searching, and Finding Documents: Video Demo and Interactive Module

A primary ProjectWise challenge discussed in the survey and accompanying construction meetings was the inability to effectively search and find documents and/or projects in ProjectWise. This module aims to review the ProjectWise Explorer search tools and follow along with the existing

PDF training document “Using ProjectWise Searches.” First, the Quick Search bar is reviewed where there are options to conduct a Full Text, All Content, and Document and Folder Properties search. The module conducts a search example using the Full text search option. Next, it was discussed how to create, save, and apply a custom search. This module creates a “PI number” search to more effectively search for a project by PI number. Following the Quick Search bar options, the module reviews the advanced search options: Search by Form and Search Builder. Finally, the module reviews how to save searches to the ProjectWise interface for future use.

6.5.1.3.3 | Uploading and Extracting Files: Video Demo and Interactive Module

This module reviews various aspects of working with documents in ProjectWise and follows along with two existing PDF training documents: “ProjectWise Explorer Fundamentals” and “Working with Documents in ProjectWise.” First, the module walks through the various methods to open a document from the ProjectWise Explorer interface including open, check out, and export. Next, the module reviews the various methods to check in a document once work has been completed including check in and import. The 3 document creation methods are then described including saving a new document created in an application, drag and drop a document or documents into the ProjectWise interface, and using ProjectWise new document creation tools. Specific attention is given to the first two options, as these are the recommended document creation methods.

6.5.1.3.4 | Document Setup, Labeling, and Organization: Video Demo and Interactive Module

A primary challenge discussed with ProjectWise was the inconsistencies and non-uniformity of the file naming system. This final module developed focuses on the document setup, labeling, and organization of folders in the ProjectWise interface. Specifically, this module provides an overview of the project folder structure and walks through how to add or delete folders if

necessary. A meeting was held on November 1st, 2021 with the project advisory group to discuss the specifics of this module and how to develop a standardized folder naming system across the state. The District 1 go-by discussed in Section 6.3 is used as a reference guide for the training module.

6.5.2 | Sample Training Material

This section provides sample training material and discussion from the beginner Bluebeam General Markup Tools module. As discussed in the beginning of Section 6.5, the PDF training documents provide the user with a quick reference guide of actions carried out in the video demos and interactive modules. Screenshots from the General Markup Tools PDF guide are shown in Figure 32 and Figure 33.

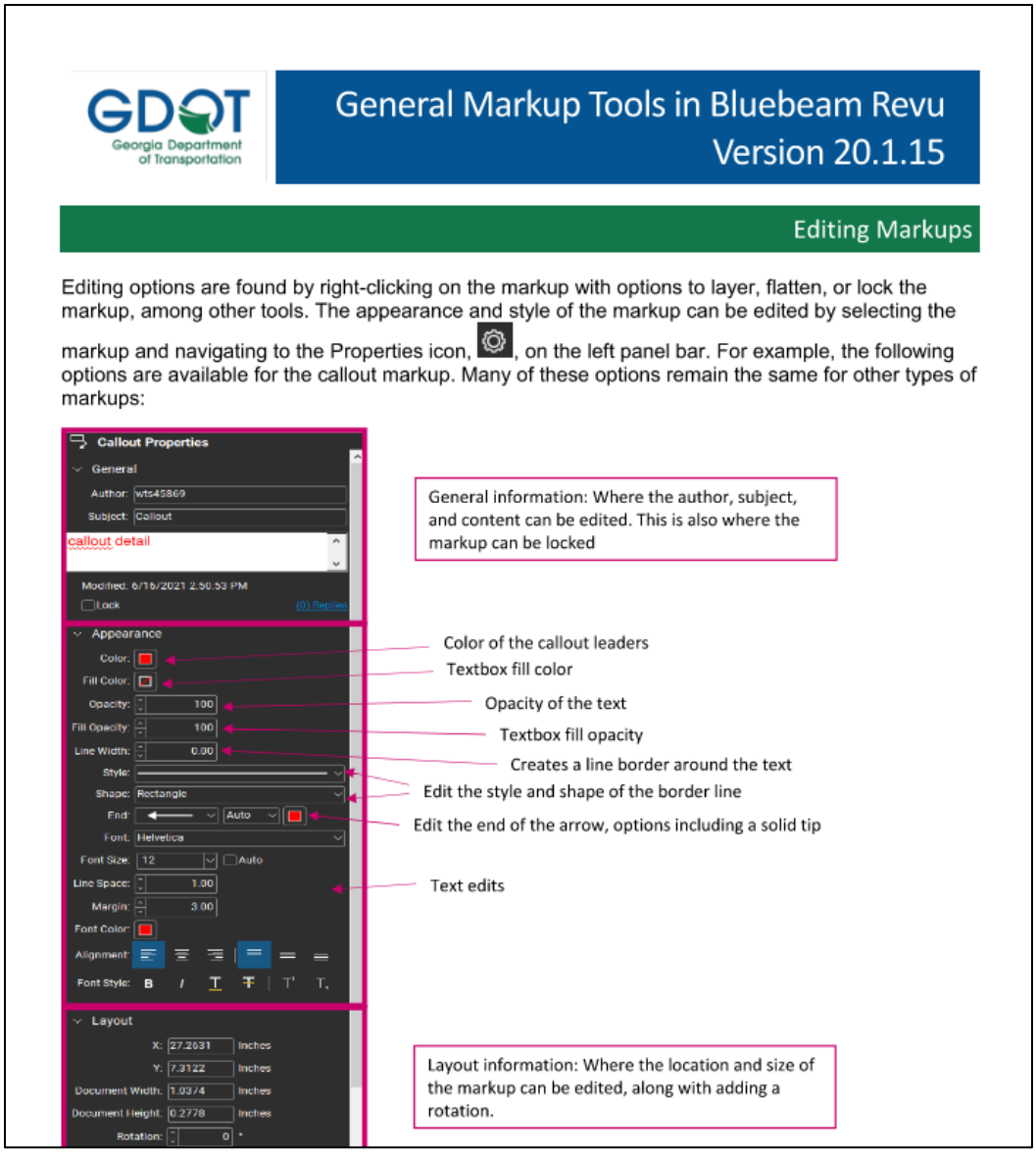

Figure 32: *General markup Tools PDF Guide: Screenshot 1*

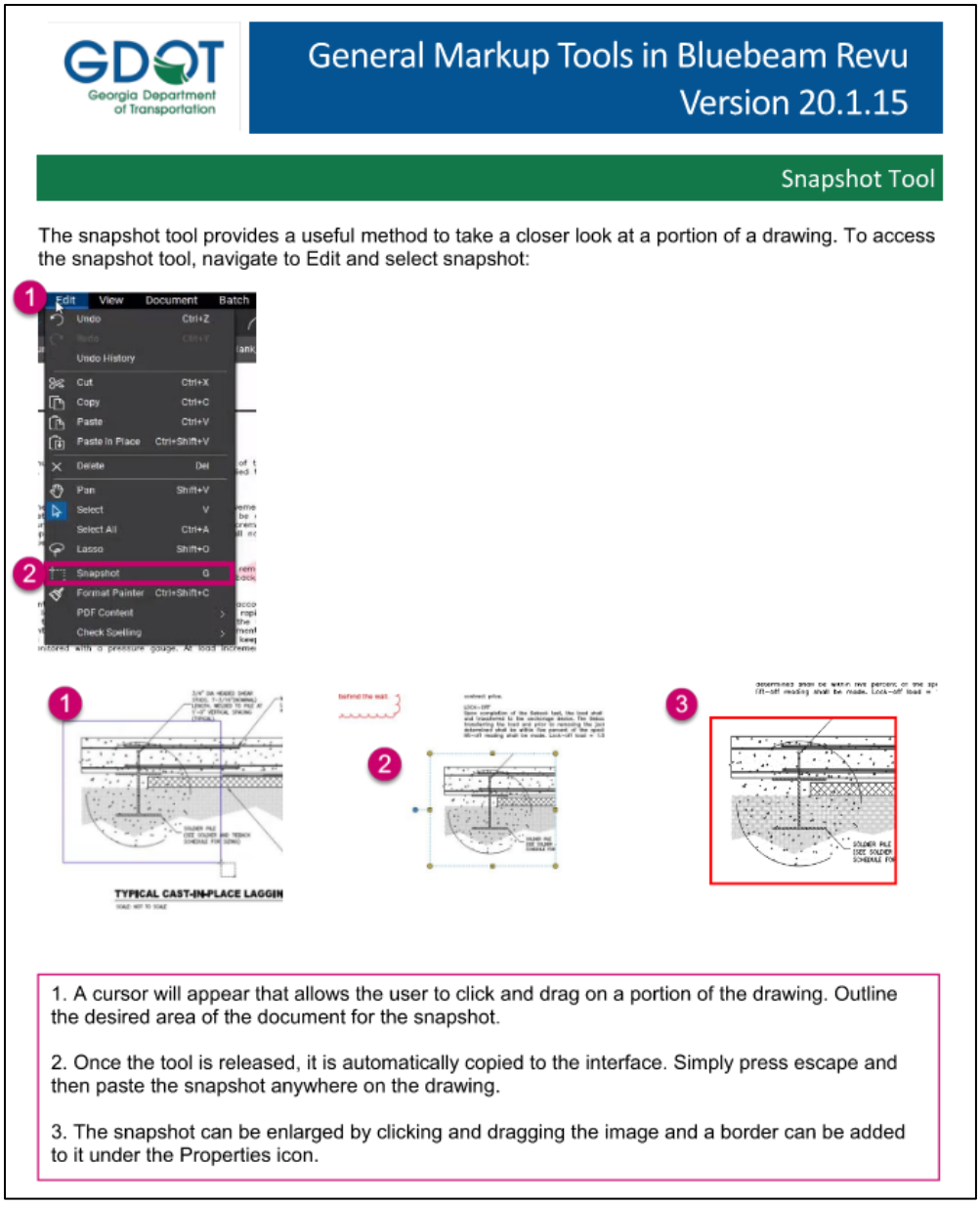

Figure 33: *General markup Tools PDF Guide: Screenshot 2*

The PDF training documents use callouts and numbered steps to walk through actions being carried out in the software. Each document is organized by sections, as seen in Figure 32 with Editing Markups and Figure 33 with the Snapshot Tool. After a brief description of the

tool/process, the PDF guide displays screenshots, callouts, and/or numbered steps that indicate how to progress in the software.

The video demos provide the user with an engaging but non-interactive step-by-step video of actions being carried out in the software. Screenshots from the General Markup Tools video demo are shown in Figure 34 and Figure 35 discussing the same features as the PDF guide.

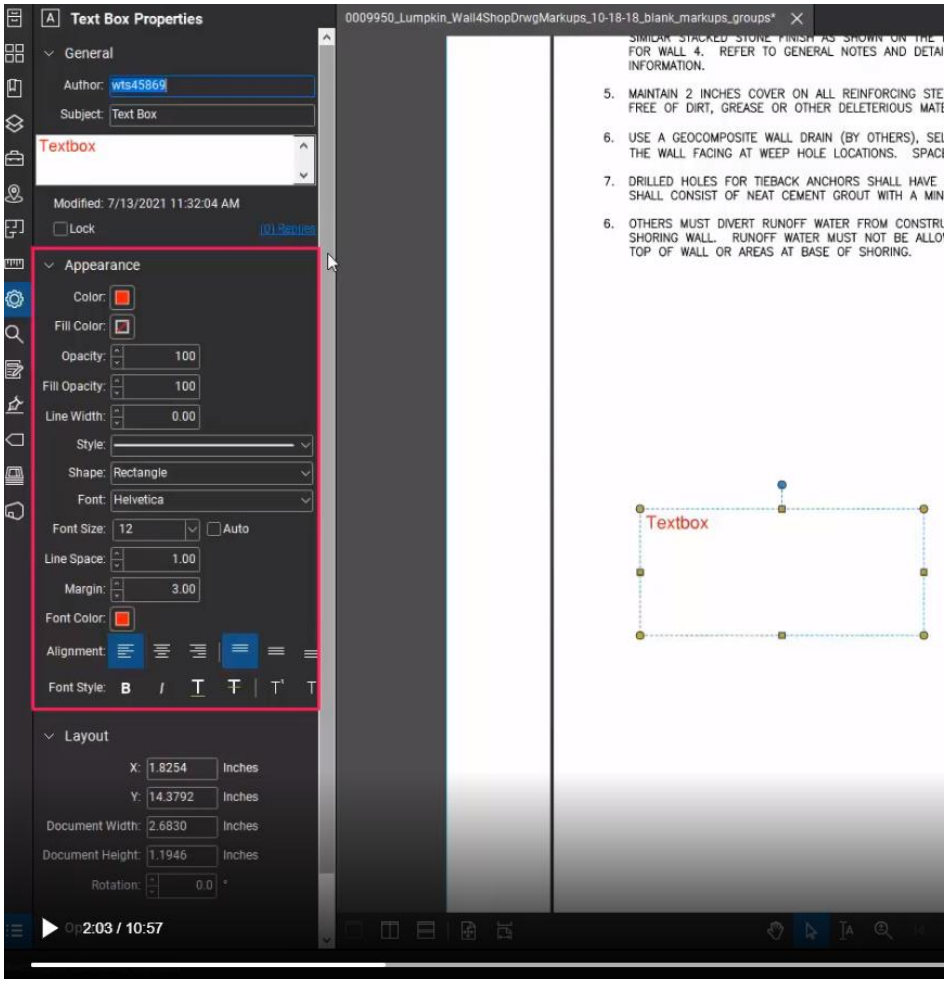

Figure 34: *General Markup Tools Video Demo: Screenshot 1*

Figure 34 shows the video demo walking through the editing options of a textbox. Similar features displayed in the PDF document, Figure 32, are discussed and the textbox is edited to highlight

these options. Similar callouts are used in the video demos as the PDF documents. Figure 35 shows the snapshot tool being applied and edited in the interface. Once again, the steps outlined in the PDF document, Figure 33, are described in further detail in the video demo.

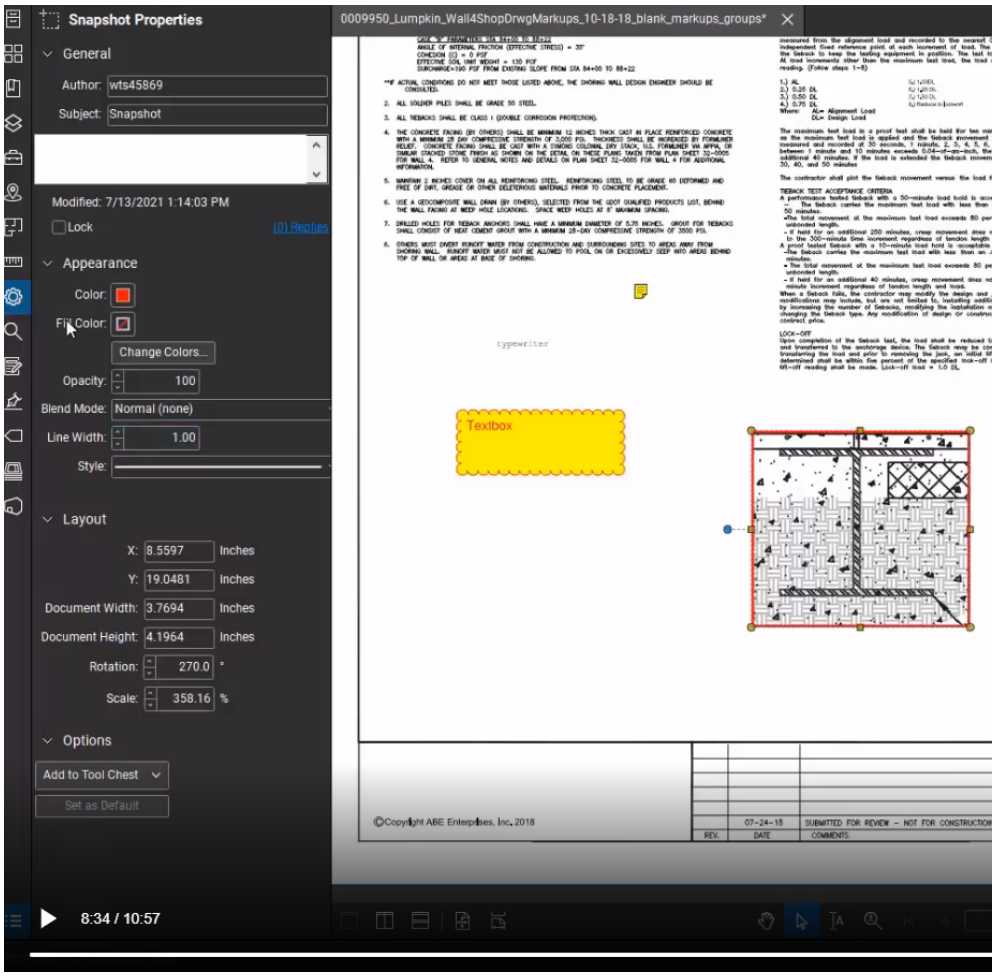

Figure 35: *General Markup Tools Video Demo: Screenshot 2*

The final piece of the training program is the interactive module. The interactive module provides the user with the opportunity to walk through the software actions on their own using on-screen prompts. Figure 36 and Figure 37 display a screenshot from the General markup Tools

interactive module where the user is asked to edit a textbox markup that was applied to a sample drawing sheet.

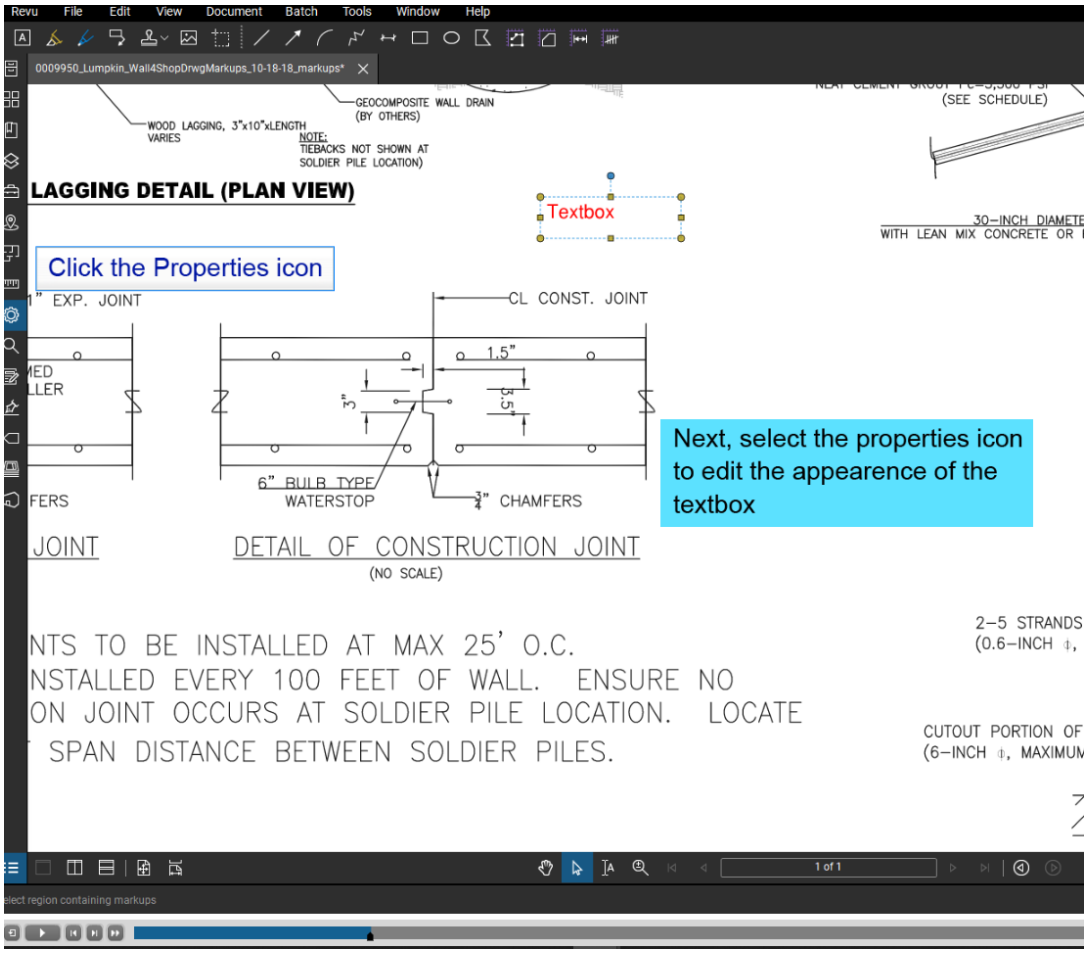

Figure 36: *General markup Tools Interactive Module: Screenshot 1*

The interactive module uses various callouts and prompts to walk the user through the software actions discussed in the PDF guide and video demo. Specifically, this interactive module asks the user to add a fill color and border to the textbox, as shown in Figure 37.

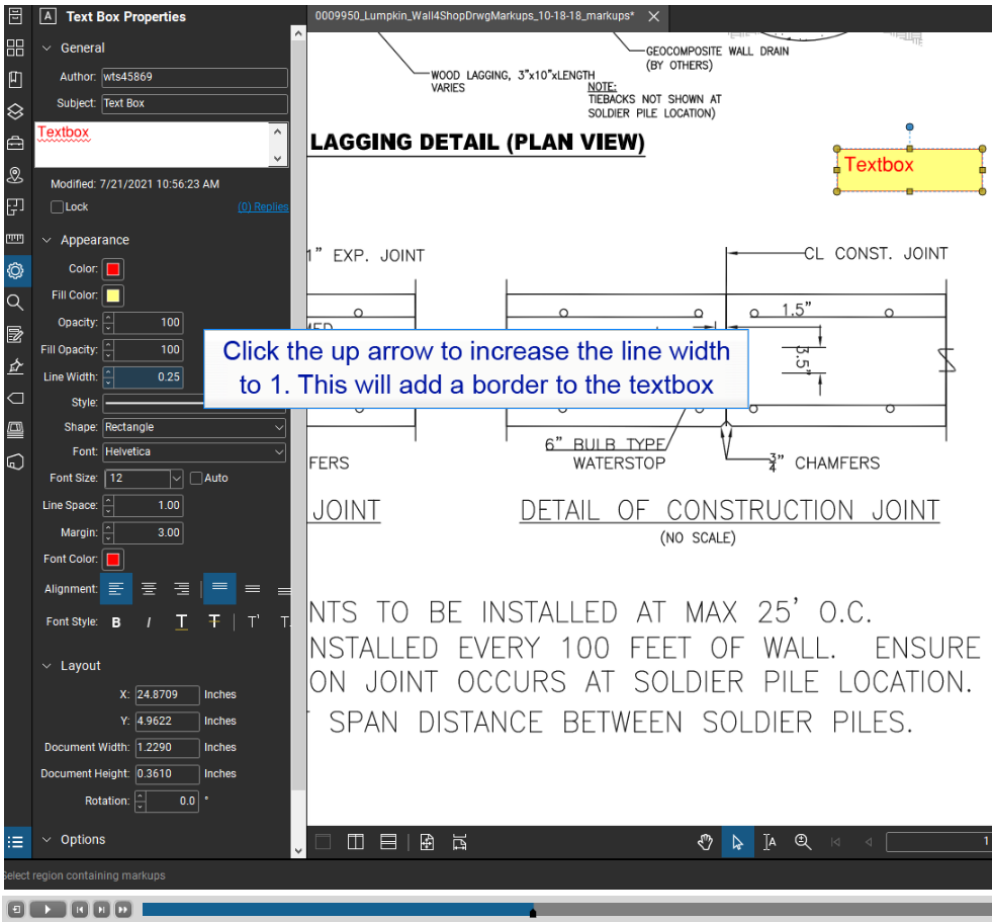

Figure 37: *General markup Tools Interactive Module: Screenshot 2*

The combination of PDF training guides, video demonstrations and interactive modules create an engaging and multi-layered training program that software users of varying experience levels and preferences can utilize to further enhance their efficiency with the e-construction software.

6.6 | Training Program Publishing

The project advisory group requested the new training material be housed in two locations:

1. The Certifications and Training (CEIT) public site, under the Training Modules section
2. The Office of Construction internal site on the MYGDOT page

Significant coordination with the Office of IT was needed to post a set of sample materials, 3 video demos, 3 PDF documents, and 3 interactive modules covering the flatten tool, document manipulation, and scale/measurement tools to the specified locations to test the training accessibility. Before publishing the material, the Office of IT offered various recommendations for the material, primarily dealing with the style and format to keep consistent with existing IT training. The updates are outlined in the following sections.

6.6.1 | PDF Documents Updates

GDOT formatting additions including header, callouts, and sub headers were included. Additionally, style updates with GDOT training colors and guidelines were included. Specifically, the GDOT heading and subheading details are shown in Figure 38 with the General Markup Tools and Document Manipulation training guides.

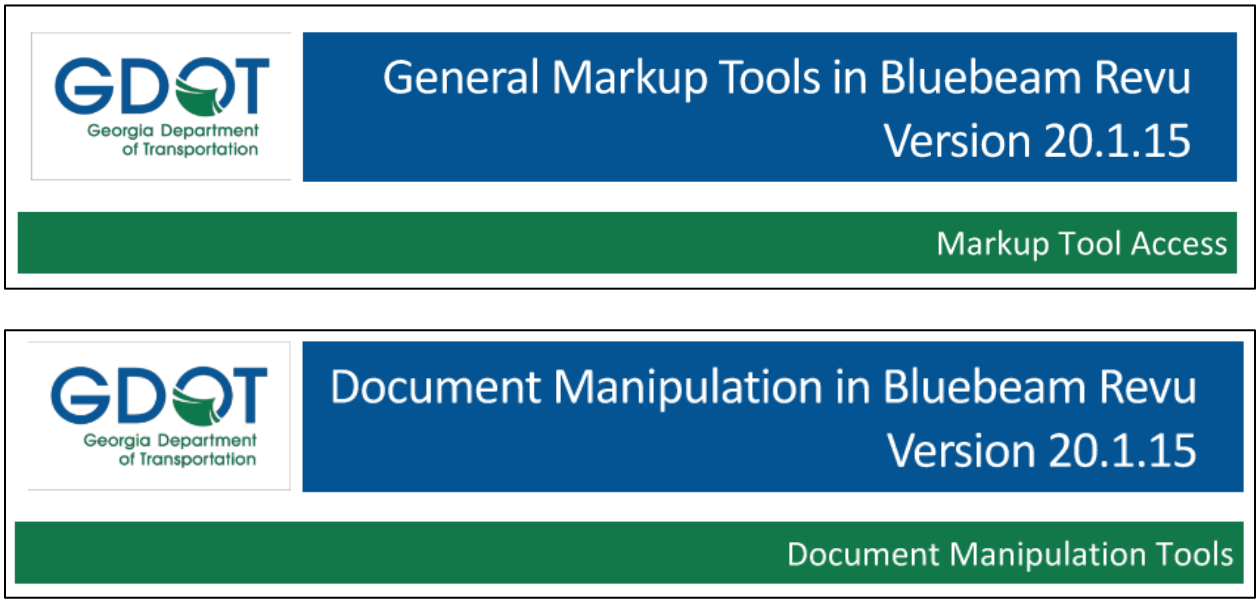

Figure 38: *GDOT PDF Guides Header and Sub Header*

An additional update requested by IT was incorporating supplementary numbered step-by-step instructions in the documents, rather than written instructions in paragraph form. An example of this type of update is seen in Figure 39, taken from the Document Manipulation training document.

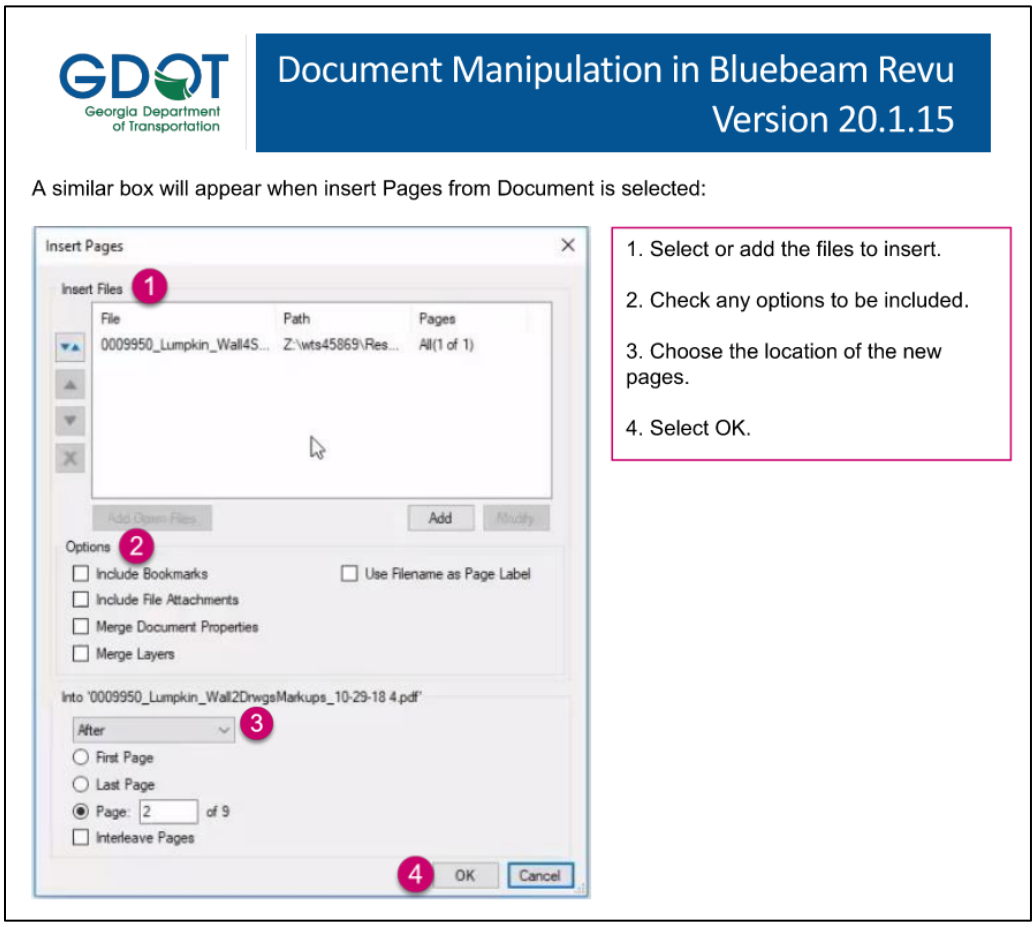

Figure 39: *PDF Guide Numbered Step-by-Step Instructions*

6.6.2 | Video Demo Updates

The addition of beginning slides that outline the goals and objectives of the videos were recommended. Additionally, minor format/content updates throughout the videos were required. An example of a beginning slide is shown in Figure 40 from the Document Manipulation video demo where 3 primary module goals are defined.

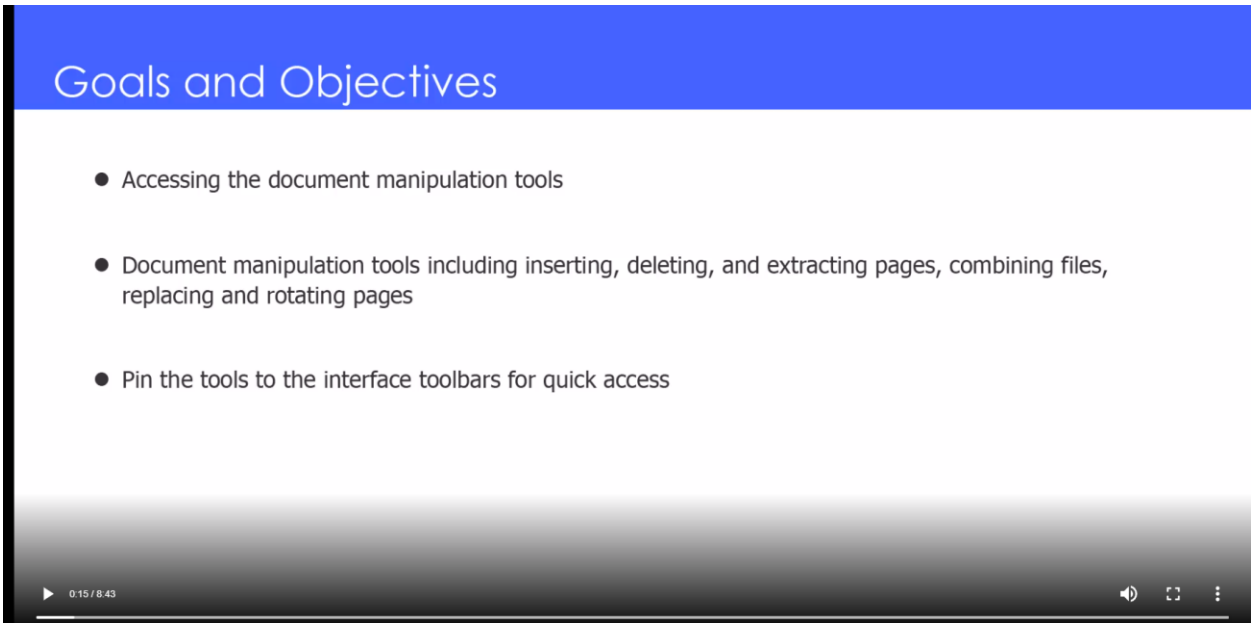

Figure 40: *Document Manipulation Video Demo Goals and Objectives Slide*

6.6.3 | Interactive Module Updates

Significant workflow updates were recommended that included placing textbox instructions first, followed by arrow indicators if the user mis-clicks. An example of this is shown in Figure 41, where an arrow indicator appears after a mis-click showing the user where to click to progress through the module.

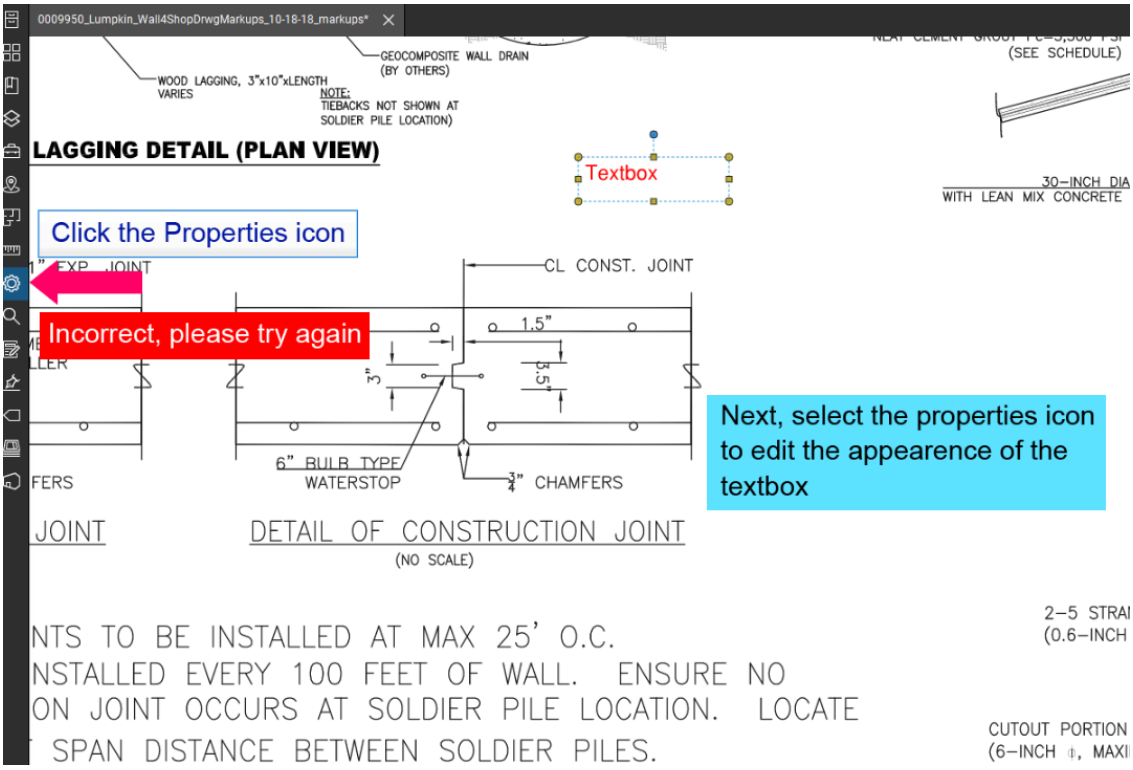

Figure 41: *Interactive Module Workflow Update*

Similar to the video demos, a beginning slide containing module objectives was added. Additionally, a click action was created at the end of the modules that require users to click in a specified area to end the module. Finally, an interactive module "navigation guide" was developed that outlines how to navigate and complete the interactive modules.

Following the updates, the material was posted to the two specified locations, along with the internal MYGDOT training tutorials page. Because no Bluebeam training currently exists, the Office of IT created a Bluebeam icon on the training page to house the new material. Additionally, a Bluebeam section was created for the content on the CEIT page and internal Office of Construction site.

6.7 | Training Program Promotion

One of the primary obstacles with new training implementation is successfully promoting the material to maximize user engagement. As previously discussed in Section 6.2.3 and Section 6.4, 25.00% of survey respondents were unaware of the existing ProjectWise material. Additionally, District 1 and 2 construction personnel indicated they were unaware of both the ProjectWise training material and CATS training material located on the internal MYGDOT page. In order to fully implement and promote the new ProjectWise, Bluebeam, and CATS training programs, Task 5 of the research project requires the "Delivery of updated Construction Manual and training modules through an in-person workshop." This workshop will occur in late summer or early Fall of 2022 and will be led by the UGA research team. The proposed format of the workshop will be an in-depth presentation by the UGA research team covering the 3 training programs developed, followed by an open discussion to hear feedback and answer any questions from construction personnel.

Specifically, the UGA research team will walk through the training organization and training modules, provide a brief description of each training topic, highlight the beginner and intermediate/advanced structure, and review the 3 types of training materials available. Because the training material will be housed in multiple locations, the UGA research team will review exactly how to locate and access the material, both on the public website and the internal MYGDOT page. Finally, the meeting will aim to address any comments, questions, or concerns from the construction staff and promote additional ideas from the staff about how to improve future e-construction training. The following list outlines the proposed workshop agenda:

1. Welcome and Introductions.
2. Training Program Purpose: Discuss the challenges associated with the three software programs ProjectWise, Bluebeam, and CATS and the need for additional on-demand training.
3. Training Program Development: Briefly review the process of the training program development i.e. the survey conducted and accompanying construction meetings to obtain a list of training topics.
4. Review the Bluebeam, ProjectWise, and CATS training modules and provide a description of the goals and objectives of each module.
5. Review the 3 types of material offered: PDF training documents, video demos, and interactive modules and the benefits of each one.
6. Walk through how and where to access the training material.
7. Open discussion: Provide time for construction personnel to share feedback with the training programs.

7.0 | CONCLUSION/RECCOMENDATIONS

This study investigated the development of an innovative and engaging training program to increase usage and understanding of agency-wide software programs ProjectWise, Bluebeam, and CATS for use by the Georgia Department of Transportation Construction staff. An extensive literature review was conducted at the national, state DOT, and commercial level to determine optimum e-construction training practices. Noteworthy training practices included short and relevant video modules with a specific topic focus, well-organized training topics that are easily accessible/navigated, and training that is workflow specific to DOT needs. In order to comprehensively understand GDOT Construction staff's specific software and training challenges, a Qualtrics survey was developed and provided to district construction staff and their constituents. Further meetings were conducted with District 1 and 2 construction staff, managers, and inspectors to elaborate on the survey results and understand specific software challenges. Following the survey analysis and subsequent construction meetings, a complete training program was developed for Bluebeam, ProjectWise, and CATS.

The training topics were structured around beginner and intermediate/advanced topics. Three types of materials were developed as part of the training program: PDF go-by documents, video demonstrations, and interactive software simulation modules. Both the video demonstrations and interactive software simulations were developed in Adobe Captivate. The different levels and training materials were developed to account for multiple user experience levels and learning preferences. This study focused on the development of the Bluebeam topics and beginner ProjectWise topics outlined in Table 7. The Bluebeam material focused on frequently used tools

and processes conducted by construction personnel including working with and manipulating documents, markup and measurement tools, interface navigation and customization, the GDOT As-Built Plan and Shop Drawing Review process, and getting started with Bluebeam Studio. The beginner ProjectWise material focused on interface and navigation, effectively searching, uploading and extracting files, and document organization in the interface. Close collaboration with the project advisory group and Office of IT was required to update the format and style of the training material. The Bluebeam material was posted to the internal MYGDOT Training Tutorials site, the internal MYGDOT Office of Construction site, and the public Certifications and Training site. An in-person workshop was proposed for the summer of 2022 to deliver, outline, and discuss the ProjectWise, Bluebeam, and CATS training programs.

In order to successfully adopt and implement e-construction technologies, effective training must be developed with the end user in mind. The end user, i.e., construction personnel, must take an active role in the training program design and development to ensure meaningful content is created. As this research showed, although there was minimal existing training material for ProjectWise and Bluebeam, various District Construction personnel had developed guides and recommendations for using the software. By building off these guides and recommendations, the new training programs provide more standardized on-demand material that construction personnel across the state are able to utilize. Additionally, software experience and training preferences are often varied amongst DOT employees. Through the development of a multi-level training program delivered through a variety of materials, the training content impacts a broader range of users and therefore has a more significant impact across the DOT.

7.1 | Recommendations and Feedback

As previously stated, this research study will conclude in November 2022. The remaining material left in the training programs include intermediate/advanced ProjectWise topics and CATS topics. Continued collaboration is needed with the project advisory group to develop the ProjectWise and CATS training material, specifically with Deliverables Management and construction-specific tasks in CATS. The following recommendations are made to maximize the training program effectiveness and enhance software use for ProjectWise, Bluebeam, and CATS:

- Conduct further meetings with the project advisory group to understand Deliverables Management tasks and challenges that should be highlighted in the training.
- Investigate existing GDOT PDF training documents concerning Deliverables Management and determine documents that would benefit from video and interactive modules.
- Work closely with the project advisory group to obtain examples of day-to-day operations in ProjectWise and Deliverables Management that would be important to highlight in the training.
- Concerning the CATS training program, further investigation is needed into the existing CATS training material to understand how the Office of Construction could benefit from more specific training. The existing training should be edited, modified, and updated to reflect Construction needs and topics outlined in Table 7.
- Finally, the promotion of the training programs is extremely important to ensure the material is fully taken advantage of. The material will be presented at an in-person workshop in late summer of 2022. It is recommended Construction managers and other Construction personnel across the districts be present at the meeting. Recommendations should be provided to Construction personnel on how to navigate the programs including

using the video demos as initial training, using the PDF documents as quick reference guides for more confident users, and using the interactive modules as additional interactive training for less confident users.

The following general recommendations are made to maximize training program effectiveness and enhance software use for DOTs:

- The training development team should work closely with the end user (i.e., Office of Construction) to determine specific training challenges and needs.
- Video modules should not exceed 10 minutes and should be specific topic focused.
- Training material should be asynchronous, to allow for users of different experience levels to take advantage of the training.
- Video modules should be accompanied with supplementary material to account for various training preferences.
- Promotion of the training material in-house is crucial to maximize user engagement.

REFERENCES

Basinger, Katie, et al. "Creating Active Learning in an Online Environment." *2021 ASEE Virtual Annual Conference Content Access Proceedings*, July 2021, doi:10.18260/1-2--36870.

"Construction." *U.S. Department of Transportation/Federal Highway Administration*, www.fhwa.dot.gov/construction/econstruction/.

"e-Construction How-To Guide" *Florida Department of Transportation,* 2015, https://www.fhwa.dot.gov/construction/econstruction/florida/howto.pdf.

"EDC 4 e-Construction and Partnering Webinar Series." *U.S. Department of Transportation/Federal Highway Administration*, www.fhwa.dot.gov/construction/econstruction/webinar.cfm.

"Training the 21st Century e-Construction Workforce." *U.S. Department of Transportation/Federal Highway Administration,* July 2019, https://www.fhwa.dot.gov/construction/econstruction/hif19024.pdf

Mansell, Todd. "How to Implement a Training Program for Your Construction Crew." *For Construction Pros*, 1 Oct. 2019, www.forconstructionpros.com/home/article/12002367/how-to-implement-a-training-program-for-your-construction-crew.

Elmedorp, Edwin and Ridgell, Robert. *e-Construction confessions from the field*. Lecture, Lincoln, NE, September 2018.

Cassar, Cathy et. al. *Michigan DOT Partnering With Industry for a Digital Tomorrow.* Lecture, Lincoln, NE, Septmeber 2018.

"Revu, Digital Workflow Solution with Studio." *Bluebeam, Inc.*, www.bluebeam.com/solutions/revu. Accessed August 2020.

"Training." *Bluebeam, Inc.*, www.bluebeam.com/training/.

"Bentley Institute LEARNservices Training Programs, Communities." *Bentley Institute LEARNservices Training Programs, Communities*, www.bentley.com/en/learn/for-users/training-programs. Accessed August 2020.

"Document Management Software: PROJECTWISE: Bentley Systems." *Document Management Software | ProjectWise | Bentley Systems*, www.bentley.com/en/products/brands/projectwise. Accessed August 2020.

"ProjectWise Design Integration." *Worksharing and Collaboration Software*, www.bentley.com/en/products/product-line/project-delivery-software/projectwise-design-integration. Accessed August 2020.

"Access and Training." *Texas Department of Transportation*, www.txdot.gov/inside-txdot/division/transportation-programs/mppm/training.html. Accessed June 2020.

"ALDOT ELearning." *Alabama Department of Transportation*, www.enterprisetraining.com/aldot/index.html. Accessed June 2020.

"Cadd Design." *CADD Design Standards and Procedures for Consultants*, www.scdot.org/business/CADD-Design.aspx. Accessed June 2020.

"CADD Info." *Montana Department of Transportation*, www.mdt.mt.gov/business/contracting/cadd.shtml. Accessed June 2020.

"CADD & ProjectWise PROGRAMS: Highway Engineering Design Processes." *Colorado Department of Transportation,* 10 Aug. 2021, www.codot.gov/business/designsupport/cadd. Accessed June 2020.

"CADD Services Support", *MoDOT,* design.modot.mo.gov/cadd/index.html. Accessed June 2020.

"CADD Support." *Wyoming Department of Transportation*, www.dot.state.wy.us/home/engineering_technical_programs/cadd_support.html. Accessed June 2020.

California, State of. "Proval Training Videos." *ProVAL Training Videos | Caltrans*, dot.ca.gov/programs/construction/training/proval-training-videos. Accessed June 2020.

"Computer Aided Engineering Services." *MnDOT CAES Unit - Tech Sheets / Help*, www.dot.state.mn.us/caes/tech.html. Accessed June 2020.

"Cad Support." *Doing Business with INDOT*, 9 Aug. 2021, www.in.gov/indot/doing-business-with-indot/other-business/cad-support/. Accessed June 2020.

"Construction." *Construction | Nevada Department of Transportation*, www.dot.nv.gov/doing-business/contractors-construction/construction. Accessed June 2020.

Dalto, Jeff. "Testing Employees after Training: Best Practices for Workforce Training Assessment." *Vector Solutions*, 4 May 2015, www.vectorsolutions.com/resources/blogs/testing-employees-after-training/.

"Doc Express." *Arkansas Department of Transportation*, 4 Mar. 2021, www.ardot.gov/divisions/construction/doc-express/. Accessed June 2020.

"DOTSC - Tech Training Section." *DOT Support Center*, www.ugpti.org/dotsc/training/. Accessed June 2020.

"Education and Training Schedule." *Education and Training Schedule | ADOT*, azdot.gov/motor-vehicles/professional-services/authorized-third-party-services/education-and-training-schedule. Accessed June 2020.

"ELearning." *Odot*, www.transportation.ohio.gov/wps/portal/gov/odot/programs/ltap/all-events/elearning#page=1. Accessed June 2020.

"Engineering Standards/Guides/Manuals." *Mississippi Department of Transportation*, mdot.ms.gov/portal/engineering_standards_guides_manuals. Accessed June 2020.

"FDOT CADD Training." *FDOT*, www.fdot.gov/cadd/main/fdotcaddtraining.shtm. Accessed June 2020.

Henri, Maria, et al. "A Review of Competency-Based Learning: Tools, Assessments, and Recommendations." *Journal of Engineering Education*, vol. 106, no. 4, 2017, pp. 607–638., doi:10.1002/jee.20180.

Holsapple, Clyde W., and Anita Lee-Post. "Defining, Assessing, and Promoting e-Learning Success: An Information Systems Perspective*." *Decision Sciences Journal of Innovative Education*, vol. 4, no. 1, 2006, pp. 67–85., https://doi.org/10.1111/j.1540-4609.2006.00102.x.

"Kansas Dept. of Transportation - KART Service Accounts." *Kansas Dept. of Transportation - KART Service Accounts*, kart.ksdot.org/. Accessed June 2020.

"Location and Design Division." *VDOT*, https://www.virginiadot.org/business/locdes/projectwise.asp. Accessed June 2020.

"LPA Certification Training and Course Material." *LPA Certificaion | MaineDOT*, www.maine.gov/mdot/lpa/ccm/. Accessed June 2020.

Maier, Francesca. “Re: State DOT Training Implementation for e-Construction Software.” Received by Will Shirley, 11 July 2020.

“Manuals, Standards and Publications - Mdot SHA.” *MDOT State Highway Administration*, www.roads.maryland.gov/mdotsha/pages/Index.aspx?PageId=65. Accessed June 2020.

“MicroStation.” *MicroStation | CAD/D Section | NH Department of Transportation*, www.nh.gov/dot/cadd/microstation/index.htm. Accessed June 2020.

“Mitchell, Alexa, et. al. *Creating a Roadmap to Implement e-Construction Practices and Strategies for Assessing and Procuring Technology.* EDC 4 e-Construction and Partnering Webinar Series. 28 March 2018.

New York State Department of Transportation. “ProjectWise Web CONNECT Edition.” *New York State Department of Transportation*, www.dot.ny.gov/main/business-center/engineering/cadd-info/general/projectwise. Accessed June 2020.

“NJDOT Engineering.” *Official Site of the State of New Jersey*, www.state.nj.us/transportation/eng/#Design. Accessed June 2020.

“Online Services.” *Pennsylvania Department of Transportation*, www.penndot.gov/Doing-Business/OnlineServices/Pages/OnlineServices.aspx. Accessed June 2020.

“Program Management.” *New Mexico Department of Transportation (NMDOT)*, dot.state.nm.us/content/nmdot/en/Program_Management.html. Accessed June 2020.

“Projectwise.” *Design Software*, www.dot.ga.gov/PS/DesignSoftware/Projectwise. Accessed June 2020.

“ProjectwiseDigital Project Resources.” *CT.gov*, portal.ct.gov/DOT/Engineering-Applications/ProjectwiseDigital-Project-Resources. Accessed June 2020.

"Projectwise." *Oregon Department of Transportation : ProjectWise : Doing Business : State of Oregon*, www.oregon.gov/ODOT/Business/Pages/ProjectWise.aspx. Accessed June 2020.

"ProjectWise Support." *MDOT*, mdotjboss.state.mi.us/SpecProv/projectwisesupport.htm. Accessed June 2020.

"Projectwise." *WSDOT*, www.wsdot.wa.gov/Mapsdata/geometrix/projectwise.htm. Accessed June 2020.

"Roadway Design Cadd Roadway Design - Corridor Modeling, Hearing Maps, Microstation & Geopak." *Connect NCDOT*, connect.ncdot.gov/projects/Roadway/Training/Forms/AllItems.aspx. Accessed June 2020.

"Roadway Design Training – Tutorials and Training Guides." *Tennessee State Government - TN.gov*, www.tn.gov/tdot/roadway-design/training/roadway-design-training---tutorials.html. Accessed June 2020.

Robinson, Randall. Personal Interview. 26 July 2020.

"Software & Support." *Software & Support | KYTC*, transportation.ky.gov/Highway-Design/Pages/Software-and-Support.aspx. Accessed June 2020.

"Standard Details, REVISED November 2018." *Idaho Transportation Department*, apps.itd.idaho.gov/apps/standarddetails/standarddetails.htm. Accessed June 2020.

"State of Rhode ISLAND: Rhode Island Department of Transportation." *Rhode Island Rhode Island Department of Transportation*, www.dot.ri.gov/business/contractorsandconsultants.php. Accessed June 2020.

"State Transportation Innovation Council." *Pennsylvania Department of Transportation*, www.penndot.gov/about-us/StateTransportationInnovationCouncil/Pages/default.aspx. Accessed June 2020.

"Statewide Environmental Office Training." *Alaska Department of Transportation and Public Facilities*, dot.alaska.gov/stwddes/desenviron/resources/training.shtml. Accessed June 2020.

The State of Delaware - Department Of Transportation. "Design Resource Center." *Delaware Department of Transporation*, deldot.gov/Business/drc/index.shtml?dc=cadd#horizontalTab3. Accessed June 2020.

"Training and Development." *WV Department of Transportation*, transportation.wv.gov/highways/training/Pages/Online-Training.aspx. Accessed June 2020.

"Training & Assistance." *Mass.gov*, www.mass.gov/topics/training-assistance. Accessed June 2020.

"Training Courses." *Wisconsin Department of Transportation*, c3dkb.dot.wi.gov/Content/c3d/trn-cors.htm. Accessed June 2020.

"Training." *Iowa DOT*, iowadot.gov/training. Accessed June 2020.

"Training." *La DOTD*, wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Administration/LPA/Pages/Training.aspx. Accessed June 2020.

"Training." *Official Nebraska Deparment of Transportation Website*, dot.nebraska.gov/business-center/lpa/boards-liaison/training/. Accessed June 2020.

"Training." *Technology Transfer Center*, idot.illinois.gov/transportation-system/local-transportation-partners/county-engineers-and-local-public-agencies/technology-transfer-center/index. Accessed June 2020.

"UDOT Digital Delivery." *UDOT Digital Delivery*, https://digitaldelivery.udot.utah.gov/. Accessed June 2020.

"VAOT CADD Help (Sharepoint)." *Home - CADD Help*, outside.vermont.gov/agency/VTRANS/external/CADD/default.aspx. Accessed June 2020.

Weisner, Kathryn, et al. "The Age of e-Construction." *National Association of County Engineers*, Sept. 2017, www.countyengineers.org/nace-news-17sep_6.

Weisner, Kathryn. "Re: State DOT Training Implementation for e-Construction Software." Received by Will Shirley, 10 July 2020.

APPENDIX

Survey Questionnaire

Block 1: General Information

Please provide your name, GDOT office and position, and your contact information for any follow up questions/comments.

Name	
Office	
Position	
Contact Information (email)	

How often does your office use ProjectWise, Bluebeam, and CATS?

	Never	Sometimes	Often	Always
ProjectWise	○	○	○	○
Bluebeam	○	○	○	○
CATS	○	○	○	○

In general, how confident are you with using the 3 software programs? 0 being no knowledge at all and 100 being an expert user.

Beginner Intermediate Expert
0 10 20 30 40 50 60 70 80 90 100

ProjectWise

Bluebeam

CATS

Please provide a brief overview of how your office currently uses ProjectWise, Bluebeam, and CATS.

ProjectWise

Bluebeam

CATS

←

→

Block 2: Training Information

How often does software training occur in your office?

- Daily
- Weekly
- Monthly
- Quarterly
- Yearly
- Never
- Training only occurs if an issue/need arises
- Other: Please indicate below

What type of software training is currently used in your office? Please select all that apply.

- PDF documents
- Online or in person classes
- Videos/modules
- Powerpoints/presentations
- Commercial training material (i.e. Bentley)
- Other: Please indicate below

For your office operations, what software (ProjectWise, Bluebeam, or CATS) is the top priority for new training? Please rank the three programs, with 1 being top priority.

ProjectWise

Bluebeam

CATS

←

→

Block 3: ProjectWise, Bluebeam, and CATS Challenges

Please provide any current office challenges associated with ProjectWise, Bluebeam, and CATS.

ProjectWise

Bluebeam

CATS

Does your office find the existing GDOT ProjectWise training and workflows to be effective training material?

- Very effective
- Effective
- Somewhat effective
- Not effective
- Unaware of existing ProjectWise training material

Concerning the previous question, what is missing from the existing ProjectWise training materials?

Compared to traditional material (PDFs and short videos outlining key concepts), would your office be interested in more interactive online training for ProjectWise, Bluebeam, and CATS?

- Yes
- No

Along with developing GDOT specific training material, is it also important for the new training modules (concerning ProjectWise and Bluebeam) to include training on general software features and operations, or is the commercial material provided by Bentley and Bluebeam adequate for general software features?

- No further general software training is needed
- General software training is needed

← →

Block 4: Construction Manual Use

How often does your office use the construction manual?

- Very often
- Often
- Sometimes
- Not very often
- Rarely
- Never

←

→

Block 5: Construction Manual Challenges

How effective do you find the construction manual as far as incorporating e-construction processes and technologies?

- Very effective
- Effective
- Somewhat effective
- Not effective

In your opinion, what sections of the construction manual are outdated related to e-construction?

Regarding CATS, Bluebeam, and ProjectWise, what are major areas that should be included and/or improved in the construction manual?

ProjectWise

Bluebeam

CATS

Do you have any recommendations on how the construction manual can be updated to improve collaboration among the project team?

What is a task related to ProjectWise, Bluebeam, and CATS that the construction manual could help streamline?

ProjectWise

Bluebeam

CATS

→