

Development of a Digital Design Environment (DDE)
for the
Connecticut Department of Transportation

A Project Proposed for Inclusion
in the Connecticut SP&R Work Program

Prepared by:
Engineering Applications and the
Office of Information Systems

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INTRODUCTION AND BACKGROUND

Currently, the Connecticut Department of Transportation (ConnDOT) does not have a clear mechanism in place to store and obtain electronic Computer Aided Design (CAD) data and general project data (correspondence and other data) that have been paid for under professional consulting services. Electronic data from large corridor projects have been lost and data are typically not conforming to standards because deliverables are only on paper. Past CAD policies did not address the standardization and delivery of electronic data. Consulting services handles a majority of project designs for ConnDOT. Today's advances in digital technologies offer many opportunities to improve the long-established process used within ConnDOT. Examples of present conditions and issues follow:

- Professional consulting services develop the majority of contracts developed by ConnDOT. In the past, ConnDOT never stressed the importance of standardizing CAD designs, and organizing the electronic data for both internal design and consultant services together. Furthermore, there has never been a cost effective delivery process to obtain the electronic data that the State of Connecticut and Federal Government pays for. Advances in operational efficiency and project delivery are not possible without improvements in these areas;
- The reproduction of engineering drawings and documents is one of ConnDOT's most costly workflow processes. This is required for both design review and delivery of engineering drawings and documents for contractors to prepare project bid proposals. To improve this process and reduce reproduction costs, ConnDOT needs to begin developing the necessary applications that will allow in-house engineers and consultant engineers to deliver a common (standardized) design package (plans, specs and estimates) in electronic format;
- Mylar contract drawings, manually-signed, are not indestructible and can be modified. Mylars can be edited, copied and scanned, and the ConnDOT Mylar storage area is not under high security. Electronic document technologies (PDF) are available that can foster a more secure environment for contract drawing usage; and
- Digital signatures are required to accomplish the above and there is a need to reduce operational costs and to improve quality, by providing documents in intelligent (searchable) PDF format throughout the entire design development process. Digital signatures will enable compliance with both Governor Rell's Executive Order #3 and Federal ADA Laws since the documents would be generated from their source applications rather than from scanning processes.

- New York State DOT (NYSDOT) has already begun transitioning their design and construction process to be compatible to a new technology often referred to as High Value Data (digital terrain models, and roadway alignment geometry). The uses of High Value Data via GPS-enabled applications (Bentley OnSite) have also streamlined NYSDOT's inspection process by providing more accurate inspections, pay item tracking and reduced contractor disputes. ConnDOT is standardized on Bentley's InRoads™ for civil design, which outputs high value data.

The existing design development process is heavily dependent on paper. Typically, design submittals (Preliminary Design, Semi-Final, Final etc) require 18 sets of paper plans and corresponding design reports. Furthermore, at times project data and critical correspondence are lost and/or not taken into consideration as a project progresses from design through construction.

Electronic data for projects are currently stored in "Silos of Data", i.e. multiple discipline divided network drives or on user's local machines. This process leads to a loss of project data confluence and inefficiency throughout the entire project development process and into construction. ConnDOT's Engineering Application's Section has started to migrate to a project container environment using existing network server infrastructure; however, a more robust engineering content management system and network infrastructure is needed.

There is a need at ConnDOT to keep all project related data together for all disciplines throughout the entire project lifecycle using an integrated engineering content-management system that enables project teams, their information and their tools to work together as one. ProjectWise™ by Bentley Systems has been identified as being a system with the potential to provide these capabilities.

PROBLEM STATEMENT

The present Federal Surface Transportation Act (SAFETEA-LU) and FHWA/ConnDOT Stewardship agreement strives to promote greater oversight and efficiency in the delivery of transportation projects. Furthermore, Governor Rell's Executive Order Number 3, issued December 15, 2004, requires transparency in the state contracting process through establishment of a single location on the internet for all contract and agreement related documents.

At this time, ConnDOT does not have the capabilities of fulfilling the "total" requirements of the Executive Order, which is to provide plans, specs and estimates in a centralized internet portal environment. There is need to address and remediate this situation through the development of an integrated engineering content-management information system with

capabilities that support the needs of project teams in a digital design environment.

OBJECTIVES

The overall objective is to develop a digital design environment to utilize and evaluate electronic data systems to improve the efficiency and effectiveness of ConnDOT's project-delivery workflow by streamlining and improving workflow in the design process. This development project will be geared to reduce the time needed to access plan archives; to provide for the submission and review of engineering documents and drawings; and to benchmark current paper workflow processes and the newly installed digital design environment (encompassing electronic document generation, management, signatures, project advertisement and support services). The result will be to demonstrate the cost-effectiveness of a secure, efficient, standardized project design platform that helps reduce project costs, decreases project development times, and provides both accountability and storage for project documents.

PROJECT GOALS AND MILESTONES

To achieve the project objectives, the following project milestones are anticipated to be required:

- Form a technical committee (TC) that includes ConnDOT engineering and information systems personnel and FHWA;
- Benchmark project workflow parameters using existing methods for small, medium and large projects. Consider benchmarking projects in all modes of transportation{An interim report will be required after necessary piloting has commenced};
- Create a development, production and staging environment of ProjectWise and begin using the system on pilot transportation infrastructure projects. ProjectWise will serve as ConnDOT's primary engineering content management system;
- Acquire and implement necessary hardware and back-up system (equipment) to fully implement ProjectWise;
- Develop a construction plan archive system using ProjectWise;

- Develop a system/application for digital plan sheet management and indexing. This would be a production tool/application that will improve the management/organization of CAD Contract Sheet Files and how they are published to PDF. The proposed application should significantly decrease the amount of time required to generate/modify contract sheet files and publish Portable Document Format (PDF) Contract Sheet Files;
- Develop an Oracle database interoperability plan for compatibility with CORE Project Costing and other department systems;
- Deploy and test the developed application(s) on selected pilot projects involving both consultant engineers and in-house engineers;
- Include future deployment of ProjectWise and other CAD applications in ConnDOT's current software deployment applications;
- Design, purchase and implement an interoperable/scalable Oracle database for ProjectWise and for future interoperability with ESRI, AASHTO or other Oracle based applications;
- Develop the application of PDF Technology in the design environment (Reviewing, Commenting, Collaboration and As-Built Drawing Creation), develop a customized interface specifically designed for ConnDOT's typical design review workflow, and apply the applications on the selected pilot projects. The interface would have to integrate with ProjectWise and with Microsoft Outlook™ and incorporate the functionality of Adobe Acrobat's™ collaboration /commenting features. The goal of the collaboration system is to streamline workflows, retain comments and improve communication in ConnDOT's design review process;
- Continue development of ConnDOT's CAD standards (in-progress) and develop custom applications that can be used by both in-house engineers and consultant engineers. Design custom applications to automatically configure remote clients PC's to ConnDOT's future CAD Standards and serve as a quality control mechanism to assure that the latest CAD standards are reflected in the CAD Design and PDF contract sheets;
- Purchase, install and deploy any necessary equipment and applications so that the processes may be applied to selected pilot projects;

- Develop an implementation plan, and task based scope of work to procure and/or utilize state forces for custom application development and scanning services (on a defined sample set) for digitally archiving the Construction Plans located at the Engineering Records Center - Pascone Place.
- Develop ProjectWise Geospatial and server infrastructure to begin showing project locations and other Department assets geospatially.

BENEFITS

ProjectWise is a product that allows all project team members to work together as one using the most up-to-date and accurate design data. The system will offer the following benefits:

- A Digital Design Environment (DDE) is anticipated to form the foundation for complying with Governor Rell's Executive Order #3. It is anticipated that ConnDOT's complete sets of contract documents will be delivered to an internet portal or other electronic delivery method once project data are organized more efficiently and converted to PDF as intelligent, secure documents in an organized structure. Projectwise is anticipated to meet the requirements for an acceptable DDE for ConnDOT's use;
- ProjectWise is anticipated to improve contract quality, project data organization, production, delivery and communication of ConnDOT projects for both consultant engineers (CE) and in-house engineers. Once fully implemented, all design submittals are anticipated to be accomplished via a secured network connection rather than the current hand truck of paper. Bentley Systems Inc. is reporting that clients that have successfully implemented ProjectWise have achieved a 185% return on investment;
- ProjectWise is anticipated to be a solution that allows for improved oversight and transparency in the contract development process. The improvements are anticipated to include better access to freedom of information requests and legal inquiries;
- Consultant engineers and in-house engineers are anticipated to have all the tools and instructions necessary to deliver standardized electronic project data;
- A substantial reduction in paper plotting over time is anticipated, although the need for paper plotting will never completely disappear. For design submittals, it is anticipated that during discipline review, plotting will

only be necessary if an engineer has a need to plot specific sheets of a plan set. It is anticipated that the use of the development system on pilot projects, through benchmarking, will quantify savings of paper cost in Engineering and during advertising plan printing (industry claims savings of 50% and 75%, respectively, are possible);

- Conversion of contract documents (plans and special provisions) to PDF are anticipated to enable a future online bidding system and to provide for intelligent documents with searching and measuring capabilities. PDF is anticipated to be an ideal choice because it is an open standard and a software purchase is not required to view PDF documents;
- Digital submission of PDF Plans, design reports and specifications are anticipated to lay the groundwork for a future where automated design reviews reduce the design review time, provide for a multi-discipline review, and provide for a common database repository for review comments. Figure 1 represents a comparison of the existing and proposed timelines for design submittals. Additionally, Appendix D and E outline both the existing and proposed design submission processes.

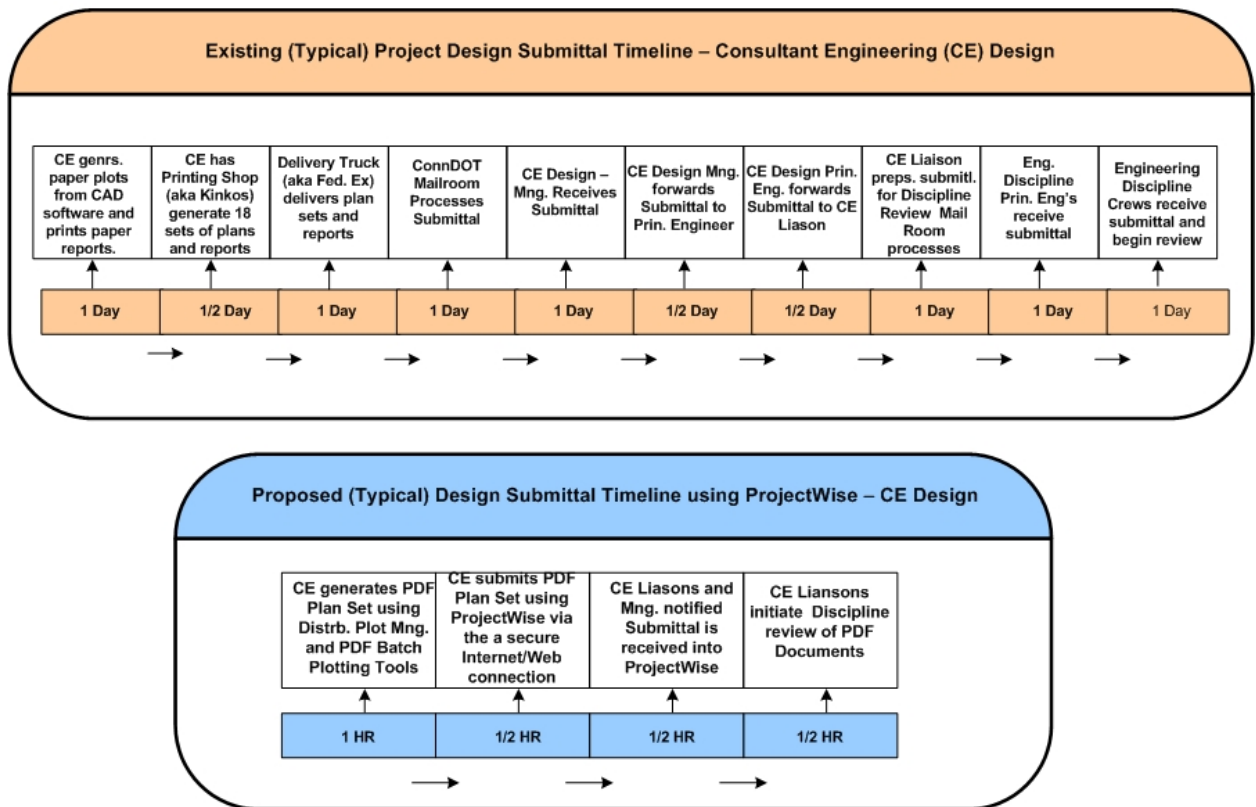


Figure 1 - Typical Project Submission Timelines

- ProjectWise is anticipated to provide GIS functionality at ConnDOT to the extent that project limits can be located

geospatially on a "user friendly" state map interface. This is anticipated to allow managers and engineers to access project data "real-time" in the proper geospatial location, and be interoperable with future GIS applications at ConnDOT;

- Projectwise is anticipated to allow integration of data from GPS-enabled earth-moving and construction equipment in order to save time and money during the construction process. ConnDOT is anticipated to benefit from the development of a protocol for future use of High Value Data as a deliverable; and
- ProjectWise and associated CAD data are anticipated to become a foundation for developing ConnDOT's GIS for infrastructure management.

IMPLEMENTATION

Engineering Applications will lead and coordinate a multi-disciplined technical committee to perform oversight of the development project and to help facilitate decision making and direction on the project. Management from the highest levels of ConnDOT will be periodically briefed regarding the development project. It is anticipated that high level support for the development project will be sought through the issuance and or revision of a Commissioner's Policy Statement(s) requiring all internal and external ConnDOT engineering resources to utilize a standardized digital design and construction environment for all pilot projects.

The Office of Construction has suggested utilizing engineers from District Offices during the development of this project. Additionally, an evaluation plan will be developed that includes benchmarks and clear documentation about the feedback, difficulties and successes of the developed applications and processes that are implemented on pilot projects.

WORK PLAN AND DELIVERABLES

Work plan tasks and deliverables can be found in Appendices B and C.

BUDGET ESTIMATE (EQUIPMENT, SOFTWARE AND STAFFING)

Budget: Refer to Appendix A for the Office of Information System's (OIS) preliminary project cost estimate. It is anticipated that a three year cost will be approximately \$3,230,000. At this time, the budget includes additional software, major hardware, and preliminary estimates for consultant services. It is anticipated that Engineering Applications and OIS Engineering Support will charge personnel expenses to the Direct Cost Accounting System (CAD Account), while OIS Business Systems Staff will charge to overhead.

COST ESTIMATE - CONNDOT INVOLVEMENT BY OTHER UNITS

Other Units at ConnDOT are anticipated to be involved. As indicated above, Engineering Applications recommends that a technical committee be formed in the first month of this project, composed of department designees primarily from Engineering and OIS, with ex-officio liaisons from Research and FHWA-CT. The anticipated time required of the technical committee is anticipated to be minimal throughout most of the research project (a few hours every quarter). The majority of development and implementation personnel costs are anticipated to be for the services of both Engineering Applications staff and Office of Information Systems staff.

**DDE Implementation and Maintenance Costs For First Five Years
Project Costs by Year for DOT00930164PE**

		YR1	YR2	YR3	YR4	YR5	TOTALS
Hardware	Federally Funded	760,000	0	200,000	0	0	960,000
	State Match	190,000	0	50,000	0	0	240,000
	CAD Account	0	0	0	31,500	31,500	63,000
	Hardware Total	950,000	0	250,000	31,500	31,500	1,263,000
Software	Federally Funded	222,266	36,546	56,546	0	0	315,357
	State Match	55,566	9,136	14,136	0	0	78,839
	CAD Account	250,000	250,000	250,000	295,682	320,682	1,366,364
	Software Total	527,832	295,682	320,682	295,682	320,682	1,760,560
Consulting	Federally Funded	26,400	600,000	700,000	0	0	1,326,400
	State Match	6,600	150,000	150,000	0	0	306,600
	CAD Account	75,000	75,000	75,000	75,000	75,000	375,000
	Consulting Total	108,000	825,000	925,000	75,000	75,000	2,008,000
Personnel	Federally Funded	0	0	0	0	0	0
	State Match	0	0	0	0	0	0
	PS Dollars	0	0	0	0	0	0
	Personnel Total	0	0	0	0	0	0
Grand Totals	1,585,832	1,120,682	1,495,682	402,182	427,182		
Project	Federally Funded	1,008,666	636,546	956,546	0	0	2,601,757
Project	State Match	252,166	159,136	214,136	0	0	625,439
Operating	CAD Account	325,000	325,000	325,000	402,182	427,182	1,804,364
PS	PS Dollars	0	0	0	0	0	0
	Total	1,585,832	1,120,682	1,495,682	402,182	427,182	5,031,560

Total Federal Project Dollars: \$3,227,196.00

Federally Funded	1,008,666	636,546	956,546	0	0	2,601,757
State Match	252,166	159,136	214,136	0	0	625,439
Total	1,260,832	795,682	1,170,682	0	0	3,227,196

**Resources normally within CAD Account will still charge CAD Account. OIS personnel to remain under PS.

*Federal Participation in Maintenance Costs is not possible. All maintenance costs anticipated to be covered by CAD Account.

APPENDIX B - HIGH LEVEL TASK SCHEDULE

ENGINEERING APPLICATIONS		Project No. 93-H049/SPR-2253 DDE Development			2006 Q1 Q2 Q3 Q4 2007 Q1 Q2 Q3 Q4 2008 Q1 Q2 Q3 Q4 2009 Q1 Q2 Q3 Q4 2010 Q1 Q2 Q3 Q4											
ID	Task Name	Description	Duration	Start	Timeline (Gantt Chart)											
1	TASK 1 - ProjectWise Engineering Document Management System (Development System)	The purpose of this task is to continue the development of the ProjectWise Development System including caching server concept testing, Oracle Systems Integration and performance testing. Additionally, to continue working on Pilot Projects.	524.57 days?	Wed 12/5/07	[Gantt bar from Q4 2007 to Q2 2008]											
117	TASK 2 - TIP/STIP - Procurement / Purchasing / Administrative	The purpose of task is for establishing the Project in TIP/STIP, and to facilitate procuring task based Engineering Application Developers	420.71 days?	Mon 10/15/07	[Gantt bar from Q4 2007 to Q1 2008]											
122	TASK 3 - ProjectWise Engineering Document Management System (Staging and Production System Development)	The major purpose of this task is for the purchasing and set-up of all major ProjectWise Hardware (Servers).	520.76 days?	Mon 4/14/08	[Gantt bar from Q2 2008 to Q3 2008]											
140	TASK 4 - Engineering Application Development	The purpose of this task is for the initiation of task based consultants to assist in the development of the Digital Design Environment and the development of specialized CAD Configurations required for the successful delivery of Projects.	674.29 days?	Mon 6/30/08	[Gantt bar from Q3 2008 to Q4 2009]											
143	TASK 5 - ProjectWise Archive System Development (Engineering Records Center Scanning)	The purpose of this task is to develop an implementation plan, and task based scope of work to procure and/or utilize state forces for custom app. development and scanning services (on a defined sample set) for digitally archiving the Const. Plans.	247.43 days?	Mon 10/13/08	[Gantt bar from Q4 2008 to Q1 2009]											
160	TASK 6 - End User Training and Documentation	The purpose of this task is for the development of end-user training and necessary documentation.	259.86 days	Mon 5/5/08	[Gantt bar from Q3 2008 to Q4 2008]											
160	TASK 7 - Staging and Production System Piloting	The purpose of this task is to begin piloting the use of digital submissions, digital signatures, and digital design reviews.	452.14 days?	Fri 7/11/08	[Gantt bar from Q4 2008 to Q2 2009]											
200	TASK 8 - Project Reporting and Benchmark Requirements	The purpose of this task is for documenting according to Federal SPR Guidelines all the necessary project statuses, results, and lessons learned.	789.64 days	Mon 12/24/07	[Gantt bar from Q4 2007 to Q4 2009]											

APPENDIX C – TASK DELIVERABLES

TASK 1 - ProjectWise Engineering Document Management System (Development System)

Subtask 1A - Project Concept Development
Subtask 1B - Technical Requirements Oracle/PW – Confirmation / Documentation / Testing
Subtask 1C - Staff Requirements/Roles
Subtask 1D - Proof of Concept and Development System Piloting

TASK 2 - Procurement / Purchasing / Administrative

Revise the Draft SP&R Proposal (FHWA and the Division of Research to Review)
Resubmit RPM using NHS funding
TIP/STIP RPA
FHWA Authorization
Finalize Equipment List and Specifications and Phase 1 Framework (FHWA Approval Required)
Purchase ProjectWise and Framework Architecture Equipment/Hardware
RFP Development - Systems Integration Services / AEC App Development
Receive proposals from Systems Integration Services/ AEC Application Development
Proposer(s) are selected based on a "Qualifications Based Selection Criteria"
Eng. Apps. Develops a "Scope of Work" based on the objective(s) of this report
Selected Proposer(s) estimate cost for the proposed scope of work
Contract Negotiation/Agreement/Authorization Phase
Development of a Multidiscipline Project Team to Facilitate PDF Development
Selection of Pilot Projects is documented and solicited by Engineering Applications

TASK 3 - ProjectWise Engineering Document Management System (Staging and Production System Development)

ProjectWise Network Set-Up
ProjectWise Back-Up System Set-Up
ProjectWise Caching Servers Set-Up
ProjectWise Integration Server Application Installation/ Configuration
ProjectWise Database Server Set-Up
ProjectWise WebServer Set-Up
ProjectWise Admin Set-up and Workflow Development
Software Deployment System Testing
ProjectWise Explorer/Admin Client Deployment (Script Logic Development)
ProjectWise Plot Organizer Client Deployment (Script Logic Development)
Adobe Acrobat Deployment for Digital Signatures / Comment and Review (Script Logic Development)
Microstation and Inroads XM Deployment (Script Logic Development) (Not Part of Project)

TASK 4 - Engineering Application Development

DDE Installer for Environment
Adobe Acrobat Customization for Design Review
Wireless Tablet Technology Integration and Development for Review of Plans
MicroStation and CAD Systems Configuration Development
Automated CAD Standards Checking Application Development
AutoCAD DDE Workspace Config. for Facilities Design Projects

TASK 5 - ProjectWise Archive System Development (Engineering Records Center Scanning)

Develop Implementation Plan
Develop QA/QC Procedural Plan
Develop System On-Going Maintenance Plan
Possible RFI/RFP Development for Scanning Services
Database Systems Integration with old Dbase Program
System Implementation and Scanning Commences

TASK 6 - End User Training and Documentation

Microstation XM, Inroads XM, and Plot Organizer Training (Not Part of This Project)
Projectwise Explorer Training for all users
Adobe Acrobat/Reader Training for all Projectwise users
Create Web based training videos
New Application Training
Append the DDE Manual
Documentation of script logic software installations

TASK 7 - Staging and Production System Piloting

Pilot Project # 6 - Define Goals
Pilot Project # 7 - Define Goals
Pilot Project # 8 - Define Goals
Pilot Project # 9 - Define Goals

TASK 8 - Project Reporting and Benchmark Requirements

Quarter Report #1
Quarter Report #2
Quarter Report #3
Quarter Report #4
Quarter Report #5
Quarter Report #6 - Interim Report (Benchmarking Comparison)
Quarter Report #7
Quarter Report #8
Quarter Report #9
Quarter Report #10
Quarter Report #11
Develop and submit draft final report and executive summary

APPENDIX D - EXISTING CONNDOT DESIGN PROCESS

