Alaska Department of Transportation & Public Facilities

Research & Technology Transfer

ALASKA DEPARTMENT OF TRANSPORTATION

Workflow Optimization

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13. ABSTRACT (Maximum 200 words)

The Alaska Department of Transportation and Public Facilities' (DOT&PF) evaluated the preconstruction process workflow. The primary focus of the research project was to determine whether work flows between different sections efficiently; identify any gaps, problems, bottlenecks, or rework due to current workflow practices; assess whether the transfer of information between sections occurs in a consistent format, and if there are any inconsistencies that result in rework; identify whether there are standardized technologies and tools used to generate preconstruction project work products in different sections and regions.

Overall, the research project found that current business practices and the use of supporting technology do not result in rework or inconsistency as internal work products flow between different functions. The research does not provide information from which to determine whether there would be business benefits to DOT&PF from changes to the process, organizational roles, or technologies used for project delivery. The principal focus for the research is work flow between sections.

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Alaska Department of Transportation and Public Facilities

Workflow Optimization Research Project

Final Report

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Final Report

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Executive Summary

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This is the executive summary of a research project to evaluate the Alaska Department of Transportation and Public Facilities' (DOT&PF) preconstruction process workflow. The primary focus of the research project was to:

- Determine whether work flows between different sections efficiently.
- Identify any gaps, problems, bottlenecks, or rework due to current workflow practices.
- Assess whether the transfer of information between sections occurs in a consistent format, and if there are any inconsistencies that result in rework.
- Identify whether there are standardized technologies and tools used to generate preconstruction project work products in different sections and regions.

A. Approach

The research team's findings and recommendations are based on the input received from the project's Technical Advisory Committee (TAC) team members, DOT&PF staff interviewees, A/E firms interviewed for the project, and Dye Management Group, Inc's body of knowledge relating to project delivery work flow in state departments of transportation.

B. Findings

Overall, the research project finds that current business practices and the use of supporting technology do not result in rework or inconsistency as internal work products flow between different functions. The research does not provide information from which to determine whether there would be business benefits to DOT&PF from changes to the process, organizational roles, or technologies used for project delivery. The principal focus for the research is work flow between sections.

Based on the information assembled through the interviews, the study finds the following:

- There is no loss of information or rework between different sections due to the use of inconsistent tools or formats.

- AutoCAD is consistently used in all regions as the primary Computer Aided Design (CAD) tool.
- Different coordinate geometry packages are used within DOT&PF; however, they are compatible with each other there are no examples of incompatible software adversely impacting preconstruction work flow.

C. Recommendations

The following recommendations address workflow improvement opportunities identified through the research:

1. Establish and implement consistent CAD standards across all regions.
2. Establish and implement standardized file naming and file storing conventions.
3. Leverage the benefits of existing information systems and the new document management system that is being implemented to retrieve project data stored within regions more efficiently.

The team has also determined some process-related efficiency issues that warrant further research. The areas where process-related improvement opportunities present themselves are identified below:

1. Need to improve timeliness in communicating design changes to avoid major revisions late in the preconstruction process.
2. Interviewees identified the need to have consistent project priorities within the Department.
3. Interviewees are concerned that there is no systematic procedure for ensuring knowledge transfer and retention given the current work force transitions that DOT&PF is experiencing. The difficulty in hiring and retaining design personnel is affecting understanding of workflow procedures and tools.

The TAC team members concur with the above observations and suggest that further research is required to evaluate the opportunities for improving the efficiency and effectiveness of the project delivery process.

I. Introduction

Dye Management Group, Inc. conducted an analysis of the preconstruction process work flow for the Alaska Department of Transportation and Public Facilities (DOT&PF).

A. Research Questions

The goal of the research project is to identify workflow hand-offs between different sections and identify improvement opportunities.

The three primary questions addressed by the project are:

- Is the workflow between different sections efficient, or are there any gaps, problems, bottlenecks or rework?
- Is the information transferred from one section to other in a consistent format, or does it require other sections to do rework and duplicate information?
- Is there consistency in the tools being used to generate information between different sections and between different regions?

B. Approach

A Technical Advisory Committee (TAC) consisting of DOT&PF members provided direction and high level input to the project. DOT&PF staff members from all three regions were identified for face-to-face interviews. The TAC team also identified an A/E firm from each region for input regarding workflow between DOT&PF and private sector partners in the preconstruction process.

Structured interviews were conducted by the Dye Management Group, Inc. team in each region and included statewide headquarters. The interviews involved members from all sections of the DOT that are involved in the preconstruction process. These sections included planning, environmental, materials, right-of-way engineering, right-of-way locations (survey), utilities, highway design, aviation design, marine design, bridge design, preliminary design & engineering, drafting, GIS, traffic & safety, and contracts. The research team also interviewed members in the construction section to obtain their input.

The research team provided an interview guide and a work process flow chart to the DOT&PF members before the interviews.

The interviewees walked the research team through the workflow as is applicable to their sections, highlighting points at which they interact with other sections, the

format in which information is received, the tools they use to generate the information, and the format in which the information is transferred to other sections. The interviewees' opinions on what they believed to be the strengths and weaknesses of DOT&PF workflow practices were also noted. Based on their responses, the interviewees were asked to identify any improvement opportunities for the DOT&PF.

The research team interviewed three A/E firms identified by the TAC members, by telephone, to obtain the consultant industry perspective on the research questions. The research team then compared the information gathered from the participants/stakeholders to overall industry best practices to determine areas with improvement opportunities and to generate a set of improvement recommendations.

C. Contents

The report is organized into the following sections:

- **Section I. Introduction:** This section details the scope of the project, the report organization, and the analysis approach.
- **Section II. Findings:** This section provides a summary of the research findings.
- **Section III. Recommendations for Improvement:** This section lists the recommendations for improvement based on information collected during the interviews, coupled with industry best-practice knowledge based on Dye Management Group, Inc's body of knowledge.
- **Section IV. Observations on Other Issues:** This section details observations related to CAD tools and project delivery practices in the DOT&PF.

II. Findings

Presented below are the research findings. The findings are organized according to the research questions. Process-related findings that did not fall directly within the scope of the research questions are also mentioned within the summary of findings, and are marked appropriately.

A. Regional Variations

- DOT&PF has a highly decentralized preconstruction process and all three regions generally function autonomously.

- However, there are three specialized functions that are performed at the statewide level; foundations based in central region, bridge design & statewide GIS division based in southeast region (statewide headquarters). The statewide headquarters division also consists of traffic safety division.
- Southeast region has a marine design group which is not present in the other two regions.
- The Northern region faces permafrost conditions unlike the other two regions, and as a result, most of the construction work in the region is re-construction work. Overall, due to weather conditions prevalent throughout the State, a lot of construction work being performed by DOT&PF is re-construction.

B. Workflow between Sections

The research concludes that overall, the workflow between sections is efficient, with information being transferred from one section to the other in consistent formats, allowing for easy transfer of information. The research team came to the above conclusion based on the information transfer walk-through that the DOT&PF staff provided to them. The above conclusion holds true for all three DOT&PF regions.

The information generation that primarily starts at the right-of-way survey section flows through to right-of-way engineering, design, utilities and environmental sections, and other sections, while information gets continually added in the project to finally arrive at complete design drawings and specifications.

After the planning phase of the project is over, on a typical project, the survey section surveys the location planned for the project. Once the preliminary survey is complete, the information is transferred to right-of-way engineering, environmental, utilities, design, materials, traffic & safety, and any other sections that need this information to build upon. As these different sections design the project, and more information becomes available, this information is transferred to other sections to aid in completion of the design work. At the end of the design phase, the design section puts together a final design for the project and the contracts section assembles the specifications for the project. During this project progress, the various sections collaborate with each other at different stages.

For example, the environmental section collaborates with planning, traffic, design, and other sections while preparing a draft environmental document to obtain all information required to create the document. These sections, along with construction provide comments during in-house review of the environmental document.

All of the DOT&PF sections use AutoCAD as the primary Computer Aided Design (CAD) tool to generate the design drawing. In addition, all A/E consultants working with the DOT&PF also use AutoCAD as the primary tool.

The interviews and fact finding identified the following issues:

1. Need to improve timeliness in communicating design changes.

Since various sections collaborate with each other, any design revisions by one section must be communicated to other sections to avoid future workflow impacts. The design revisions can lead to major revisions to environmental permits and right-of-way work, and updating these sections immediately is of utmost importance. The interviewees identified that this communication was missing at times, and there was a need to have clear and timely communication consistently. Some examples of this communication gap are provided below:

- On occasions, poor communication between design and environmental sections can result in data requests and subsequent revision requests from environmental to design sections.
- Information on material sites is not updated by construction or maintenance sections on a regular basis in any centralized system. As a result, design, construction, or materials sections are not aware of any material sites being used. This can lead to an over-commitment of material sites and conflicts during the construction or maintenance phases. This issue was found to be more severe in the Northern region than the other two regions as most of the projects in other regions are contracted such that procuring materials is the responsibility of contractors.
- Little information from the planning section such as a project information package or initial scoping is available to guide the design section. As a result, the design section starts a project without having all the information that is available within the department. Also, the planning section rarely gets post-construction information as feedback from the construction or maintenance sections.
- The contracts section is not always updated with the latest versions of specifications, or informed of problems arising from old specifications. As a result, required changes are not made in the specifications to avoid future problems.

2. Interviewees are concerned that there is no systematic procedure for ensuring knowledge transfer and retention given the current work force transitions that DOT&PF is experiencing.

- Many experienced DOT&PF preconstruction employees are nearing retirement, and there is a large gap between the experience of retirees and new employees.
- Retirement of the experienced members can pose major problems if knowledge is not transferred to other team members and retained within DOT&PF; as new staff members may not be aware of the work flow to follow, leading to delays or miscommunication on the project.
- Interviewees mentioned that DOT&PF has difficulties hiring people at certain experience levels, as well as retaining staff members. This impacts work flow when positions remain unfilled and employees do not yet know DOT&PF procedures and tools.
- The interviewees acknowledged that there is no standardized process for knowledge transfer or knowledge retention within the DOT&PF, and expressed the need to have such a process in place.

C. Transfer of Information: Formats Used

The research team found that information is transferred consistently using compatible formats between different sections. The research indicates that all sections use AutoCAD as the primary drafting tool and the native AutoCAD format to transfer data between each other. The format used to transfer other data is also consistent and no problems were identified with the formats being used.

The research team did find a few areas of opportunity related to standardization of CAD standards and use of a standardized file naming and filing structure. These are listed below:

1. Designers, drafters, and other CAD users tend to use different CAD standards, resulting in drawings that are inconsistent.

- There are no predefined standards for CAD drawings that are generated. As a result, font tables, line widths, symbols, etc. can vary from project to project and region to region.
- This can lead to miscommunication, and while it is generally an inefficiency, can also lead to major mistakes and rework on projects.

- Draft CAD standards were developed in the Southeast region 2 to 3 years ago, but have not been accepted or formalized in the region.
- The environmental permit document does not have well defined standards, resulting in unnecessary iterations with the design section while creating the environmental permit documentation.

2. Use of different coordinate systems exists, but does not result in work flow issues due to adequate reference information being generated that allows for coordinate system conversions. However, there are no established standards around reference data collection.

- Different coordinate systems are used during project design. The two main coordinate systems being used are the State Plane Coordinate System (SPCS), and the local coordinate system. The use of GPS coordinates is increasing for preliminary surveying. With the increased number of systems, it can become difficult to convert from one to other if the right amount of information is not collected. It is therefore important to establish some standards related to data collection to ensure that the right amount and type of information is gathered.

3. DOT&PF section members experience difficulties retrieving project information stored within DOT&PF.

- There is no central repository for all latest files or a well-defined filing structure for all work-in-progress documents. This leads to various sections, and staff among these sections naming and filing documents differently, making it difficult to retrieve information. The interviewees indicated that this situation affects design and drafting sections the most.
- There is no central document management system that allows easy storage and retrieval of information. This results in completed project information residing in parts in various sections. For example, bridge design data is stored by the bridge design section and has to be specifically requested by other sections when needed.
- As-built drawings are not stored consistently in all regions. All the regions are moving to storing as-builts electronically, but there is no standardized filing system, making data retrieval very difficult.
- Some interviewees mentioned that the same information is requested from consultants multiple times. Interviewees mentioned aerial drawings as a prime example of this situation.

D. Consistency in Use of CAD and Related Tools among Tools Being Used

For design packages used within AutoCAD (coordinate geometry tools), two of the three regions use Autodesk Land Development Desktop (LDD). The Northern region primarily uses Eaglepoint's COGO software, while most of the surveyors in the region's surveying section use PacSoft's CivilMaster.

1. The primary CAD tools being used by all regions are consistent, and various tools being used to incorporate other information are inter-compatible and do not result in any rework.

- All DOT&PF sections use AutoCAD as the primary drafting tool.
- Section-specific tools, like gINT to store test hole information (materials section), ArcGIS for GIS information (materials section), Intersection magic for collision diagrams (traffic & safety), BidTab to record bid information (contracts) exist, and are consistent between regions.
- There is no rework being done due to differing softwares or tools being used. Data is transferred between different sections efficiently, including right-of-way plans, utility plans, bridge designs, and others, and can be used by other sections most of the time.
- Different regions use different coordinate geometric packages in addition to AutoCAD. Autodesk's Land Development Desktop (LDD) software and Eaglepoint's COGO software are the two primary softwares being used, followed by PacSoft's CivilMaster software.
- All the three softwares mentioned above can read data created in other softwares efficiently, and there is no rework due to the use of the different softwares.
- In the case of Northern region, PacSoft's CivilMaster is primarily being used by the surveying section, and Pacsoft has discontinued the software and its support. DOT&PF will therefore ultimately need to upgrade to either LDD or Eaglepoint's COGO to ensure that proper support is available to end-users.
- The A/E firms interviewed also use AutoCAD as their primary drafting tool.

2. Other Findings

Not all available electronic information is used efficiently to avoid re-work.

- Some sections, especially bridge design, feel uncomfortable sharing design documents electronically with other sections for the fear of other sections inadvertently modifying parts of the document. While this is a valid concern, it is important to share information in such a way that some parts of the document are locked for editing, while other parts can be modified or copied to speed up the design process.
- The lack of electronically re-usable bridge designs was not considered a major problem by any section, but an inefficiency by the environmental section.
- In the Northern region, the materials section collects information electronically, but transfers that information on paper to the design section. This information, however, is not geo-referenced.
- The Environmental section in the Southeast region does not have access to AutoCAD, resulting in inefficient back-and-forth communication between environmental and design section. A free AutoCAD file viewer could be used by DOT&PF to address this issue.

3. Process-related: Other

- It is a common perception that right-of-way, environmental and utility sections are brought into the project late into the process, resulting in delays on the project. A more in-depth analysis involving actual project data is required to validate this concern.
- The process of distributing bridge shop drawings involves mailing hard copies of shop drawings to other regions. This process is time consuming, and options to transfer information electronically should be investigated.
- The interviewees mentioned during the course of interviews that better AutoCAD training for new hires as well as refresher and advanced courses for current DOT&PF staff will be helpful in improving efficiency. The interviewees also mentioned that the engineers and technicians are missing opportunities to integrate designs with readily available spatial (GIS) data due to lack of proper training.

III. Recommendations for Improvement

Presented below are the primary recommendations for improvement:

1. Establish and implement CAD standards in all regions, building on draft CAD standards established in the Southeast region.

- The CAD standards (layering standards, line widths, symbols, etc.) should be developed using the draft standards developed in the Southeast region as the starting point and improved upon through input from other regions.
- Implement survey data collection standards to ensure that data collected can be efficiently re-used
- A working group should be established to establish CAD standards, and get support of end-users in this initiative.
- Input from A/E firms in establishing these standards can provide better insight and ease the process for the DOT&PF.
- Assign an executive sponsor for establishing CAD standards and overseeing their implementation to ensure user buy-in to the process.

2. Establish and implement standardized file naming and file storing conventions

- Standardized file naming and storing conventions will vastly improve the retrieval of existing information, reducing any re-work or extensive information requests.
- A core group should be created to establish these standards, and get support of end-users in this initiative.
- Design an implementation plan after the standards have been established to ensure streamlined implementation of the standards.
- The standards can be implemented one region at a time. Based on feedback received from implementation in the first region, the standards as well as the implementation plan can be modified to better serve DOT&PF's needs.

3. Leverage the benefits of existing information systems and the new document management system that is being implemented to retrieve project data stored within regions more efficiently.

- The Stellent document management system is under the initial phases of implementation within the DOT&PF, and the Qualified Products List (QPL) module has already been implemented under the Stellent system. With the existence of a document management system, it seems intuitive to leverage the system to achieve maximum benefits from the technology available at hand.

IV. Observations on Other Issues

A. Use of CAD Tools

- The current users reported no barriers to workflow due to software tools in use, including the CAD tool (AutoCAD). The A/E firms also mentioned that the tool set being used is sufficient, and all A/E firms interviewed use AutoCAD as their primary drafting tool.
- Although not addressed by this research, management raised the question of whether DOT&PF would be more productive if it moved to MicroStation from AutoCAD. Currently 47 out of 50 State DOTs, plus the USDOT (FHWA) use MicroStation. Such an assessment would need to determine whether benefits would outweigh the costs and the associated of risks involved in any change. Further, management would need to prioritize such a change against other competing change initiatives.
- The interviewees expressed the need to have standardized and on-going training for AutoCAD and/or ensure that CAD users understand the options they have to obtain technical support.
  - Design a standard curriculum to train new users on how to use AutoCAD and the DOT&PF CAD standards once they are established.
  - Have a refresher course so that CAD users get a chance to refresh their skills every few years.
  - Ensure that CAD users understand the options available for technical support through DOT&PF's current relationship with Autodesk.

B. Project Delivery Process Improvement Opportunities Pending Detailed Research

The interviewees identified the need to improve the project delivery process to ensure efficient and successful completion of projects on time and within budget. For example, the interviewees identified that there was a need to have consistent project priorities and to avoid stopping and starting design work and to ensure that the most important projects are worked on at the right time. An important point that was mentioned was that with the narrow construction season in the state, careful work planning is needed to have plans ready and projects awarded before the start of the construction season.

There is a large body of knowledge and current research on best practices for project delivery in DOTs. Although out of the scope of this research project, a number of

interviewees pointed to issues relating to project management & project delivery practices that impact efficiency and could provide opportunities for business improvement. Interviewees mentioned that some of the areas that can help improve project delivery and provide opportunities for business improvement are project communications, constructability reviews, value engineering, and utility relocation among others.

The TAC team members concur with the above observations and suggest that further research is required to evaluate the opportunities for improving the efficiency and effectiveness of the project delivery process.

APPENDIX

A. TEAM MEMBERS AND PARTICIPANTS

Team Members and Participants

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A list of Technical Advisory Committee members, participants interviewed in each region, and A/E firms interviewed over the telephone are provided in this appendix.

Technical Advisory Committee (TAC) Team Members

Name	Region	Section
Clint Adler	Northern	Research & Technology Transfer
Jeff Currey	Northern	Materials
Janet Brown	Northern	Environmental
Gerry Welsh	Central	Design
Burke Barton	Southeast	IT, PD&E
Jim Evensen	Southeast	PD&E

Participants – Northern Region

Name	Section	Title
Clint Adler	Research & Tech. Transfer	Research Engineer (Project Manager for this effort)
Tim Sprout	ROW/Engineering	ROW Engineering Assistant
Erin Anderson	Utilities	EA3
Janet Brown	Preliminary D&E	Group Chief/Engineering Manager
Colleen Ackiss	Traffic & Safety	Traffic & Safety Chief
Jeff Currey	Materials	TAC team member
Jim Sweeney	Highway Design	E1 & Locations/Design Liaison
Chuck Howe	Environmental	Environmental Coordinator
Jerry Rafson	Planning	Planning Chief
Steve Masterman	Materials	Regional Geologist
Scottie Sexton	ROW/Locations	Locations Supervisor
Chuck Eckert	Contracts	Engineering Associate
Craig Shelton	Contracts	Engineering Associate
Judy Biggane	Drafting	Drafting Supervisor

Participants – Central Region

Name	Section	Title
Tom Schmidt	Aviation Design	Squad Leader
Todd Vanhove	Planning	Planner
Michael Kimlinger	Traffic & Safety	Engineer
John Linnell	Highway Design	Squad Leader
Angela Parsons	Materials	Materials Engineer/ GIS Support
Jerry Ruehle/Brian Elliott	Environmental	Env. Team Ldr/Env Mgr.
Rick Oldford	Contracts	Review Engineer
Laurie Holland	Project Control	Chief
Nancy Gartin	Drafting - Hwy Design	Drafting Supervisor
Gerry Welsh	Prel. Design	Lead Designer
Mike Stewart/Rory Redick	Utilities	Agreement Writer
Bob Keiner/Bob Ramsey	ROW - Surveys	Engineering Associates
Louise Hooyer/John Curtright	ROW Engineering	Land Surveyors
Chris Jones	IT	(Stellent Development)

Participants – Southeast Region

Name	Section	Title
Jim Lowell	Construction	Regional Special Projects
Verne Skagerberg	Planning	Transportation Planner
Carolyn Morehouse	Traffic	Regional Traffic Safety
Dan Fagnant	Traffic	Traffic Engineering Assistant
Burke Barton	IT, PD&E	IT/CAD Manager
Ben White	Environmental	Environmental Impact
Fred Thorsteinson	Utilities	Regional Utilities Engineer
Rich Pratt	Bridge	Chief Bridge Engineer
Jack Stickel	GIS	Transportation Planner
Tim Reed	ROW (Locations)	Survey Mapping
Mike Knapp	Materials (Hydrology)	Regional Hydraulics Engineer
Joel Osburn	Design (Marine)	Engineering Associate
Darryl Lester	Design (Hwy)	Engineer

Name	Section	Title
Leonard Robertson	Design (Hwy)	Drafting Tech
Rick Kauzlarich	Right-of-way	(Stellent Development)

Participants – A/E firms

Name	Firm
Ron Gebhart	PDC Engineering, Inc.
Lance Mearig	USKH, Inc.
Stewart Osgood	Dowl Engineers