Lessons Learned from Re-Engineering a U.S. State DOT©

By:

Harry O. Ward, PE & Reed Adams, LS
Harken-Reidar, Inc. VDOT

September 15, 2015

Copyright 9/2015, Authors H. Ward, R. Adams – This material may not be duplicated, published or disseminated without the written consent of the Authors.

IHEEP 2015, Westin Convention Center, Pittsburgh, Pennsylvania
IHEEP Theme for 2015: “Educate / Engage / Deliver”

Becomes

“Engage / Deliver / Educate”

For our discussion!
AGENDA

Our discussion explains the inner-workings of a technology upgrade that the Virginia D.O.T. embarked on.

Hardware, Software, Procedures, Applications, Deliverables and all Staff (Field, Office, Management and Consultants) were involved. This is a Re-Engineering endeavor!

We will discuss:
• The justifying catalysts
• The planning efforts
• The imaginative implementation methods used
• The tangible/intangible outcomes of all this
• Outcome metrics such as the “ROI”
• How the new capabilities directly impacted production!
Seminar Timeline

Reed Adams, LS of VDOT will discuss:
• How this effort originated,
• How it was justified and
• Some examples of the behind-the-scenes preparations that occurred.

Harry O. Ward, PE will then discuss the implementation effort.

Then, Reed Adams will close it out with a discussion of Outcomes and Questions & Answers!
Top Catalyst's for Upgrading

1. Windows 7 Conversion
2. Data collector & office software
3. Current CAD Survey standards
4. Consultants
5. Staffing
5. Staffing

- 50% of existing staff in or near retirement age
- Institutional knowledge of existing software leaving the Department
- IT staff that wrote original software retiring as well
- Legacy system takes about >6 months to learn
4. Consultants

- Currently use industry/local standards
- Have to match a separate standard for the Department
- Converts data to Microstation from other platforms
3. Legacy Survey CAD Standards

- Existing level structure based on 1-64
- Elements attributes (color, weight, styles) have to be set when placed
- Cells not annotative
- Text not annotative
- Seed File set to imperial units
- Subsurface Utility Engineering – Designation qualities limited to text
2. Data Collector & Office Software

- Software (v1.0) was written by internal IT staff in 2000
- Data Collector and office software proprietary to the Department
- Data collectors use WinCE only – Functionally obsolete in 2014
- Almost impossible to edit in the office
- Setup or rod issues resulted in rerunning the field data again
- Software was database driven in rdb or mdb formats
- Produced N, E, Z, D format – no point numbers
- IT recommended going to “out of the box” software
- IT staff will be retiring and could not rewrite for Win7
- SurvCE was modified to incorporate the internal software
- No survey updates or changes since 2004 – V8i
2. Data Collector & office software

- Carlson SurvCE (VDOT version Pre-2014)
  - VDOT Store Point Screen
    - Text Only Screen with pull down menus
    - No visual feedback to the crews - post processed in office
    - Field editing limited to each setup
    - Linework has to be completed on each setup
    - Limited to total station only not GPS friendly for collection
    - No point numbers
    - Not industry standard
1. Windows 7 Conversion

- Department deadline for Win7 - April 1, 2014
- Additional fees for XP machines after this date
- XP machines would be removed from network environment
- Mandated by upper management
- Notified by IT July 2013 – no internal software modifications possible
Preliminary Planning

- Setup a Field to Finish committee
  - Representative from all 9 districts, CADD Support, and Central Office
  - Demoed other field to finish products
  - Concluded that Bentley would be used in office & Carlson SurvCE in field

- Mapped existing workflow – field & office

FIELD
- Reverse engineered old data collection coding to alphanumeric field codes
- Identified field codes that would need attribute data
- Identified necessary special/linking codes that would be needed for line work
- Notified Carlson that we would need technical assistance with making Carlson and Microstation talk
- Requested modifications to SurvCE to improve DOT experience
Preliminary Planning

- Office

- Reviewed levels, cells, line styles, and text and identified the following needs:
  - for new alphanumeric level naming structure
  - unique levels for all line styles
  - colors set by feature
  - all graphics will be Bylevel
  - cells that are annotative and unique
  - for unique line styles for subsurface engineering (SUE)(DATR, Abandoned, & Miss Utility) features
  - for annotative text with text styles pre-set and ready for use
  - ability to import a rw5 file or an ascii file from data collectors
Preliminary Planning

- Identified the following Professional Services needed from Bentley:
  - Obtained Harken-Reidar as a sub consultant for SurvCE setup
    - Setup, research, and establish initial feature codes, & libraries
    - Coordination with Carlson on how SurvCE and SS4 work together
    - Coordinate with Carlson on special/linking codes and templates
    - Create a custom training curriculum based on the new setup
  - Configure the Geopak Survey Manager database (.smd)
  - Configure DGN libraries for feature definitions, element templates, & settings
  - Modify existing cell library to new level structure
  - Develop new seed files based on US survey foot
  - Responsible for automating annotation of features based on attributes
  - Setup training for 9 districts – 1 day for SurvCE and 2 days of Microstation
  - Train existing Central Office staff to support the new system
Lessons Learned

Harry O. Ward, PE

VDOT Re-Engineering Implementation
Harken-Reidar Inc., was engaged by Bentley Systems to perform a Re-Engineering of VDOT’s, Location & Design Division. The first phase was to be completed under a very short, drop-dead deadline.

The upgrades, technologies, the capabilities and the additional features, all had to be implemented within a declared timeframe. No production could be lost due to upgrade.

And all of this after 15 years of a Static environment!
Engage

There were 2 Training Phases:

1. Field Training on new hardware and new field software
2. Office Training on the new OpenRoads© software

Scheduled about 6 months apart and each spanned 6 months.

Although integrated, each phase was independent

This training was requested to be customized for VDOT because they wanted to be in production following the first Phase of training. It made sense to use actual VDOT Project Data since virtually no learning curve was allowed.
Since the training was customized toward VDOT, we created:

- Customized Curricula
- Accompanying data sets
- Training Manuals w/ Theory, Procedures & Applications
- Training Support files
- Libraries
- System Configurations & Support Files
- Conversions and Data Migrations

Imaginative Delivery Methods:
- Classroom vs. Actual Field venue for Field Training
- Training files with Outcomes built into the data sets
Lessons Learned

Educate

The training material was developed, the training delivery methods established and now the education commenced.

Expecting pushback from at least some, we found none! The attendees were enthusiastic and attentive.

Deadlines caused Training to be scheduled for January through March in Virginia. We battled snow and ice storms, training room conflicts, traveling issues and “Snow Duty”.

There were 9 State Districts Plus 30 Consulting firms involved & 1,000’s of miles of travel between districts. Training rooms had to be prepared with software and data sets.
Lessons Learned

Customized Curricula – Field Training

### Agenda for Training

- Review and training on new codes
- Data collection screens
- Line collection features (start, end...)
- Special coding available
- Editing field book data, pole heights & setups
- Using map screen to review data
- Adding and editing notes, etc.
- Tips for collectors (GPS/Robotic/TS modes)
- If time permits Follow-up with stakeout
- What can be imported from Bentley

(items numbers with page numbers)

### Items Provided for Training

- Harken-Reidar SurvCE Training Manual, Hardcopy
- Carlson SurvCE .PDF User Manual, provided digitally on Carlson website
- A SurvCE Field Code Library, provided digitally
- Additional digital files required for SurvCE to be loaded onto data collectors, include symbol libraries, GIS Attribute Libraries...
Customized Curricula – OpenRoads Training

VDOT OpenRoads - Terrain Modeling & 3D

Best field practices for collecting data
Discuss algorithms for DTM’s
Discuss breakline collection, (Abutments/Headwalls)
When to edit a TIN or correct the source data
Discuss the things that need to be edited/rectified

Creating TIN’s from breaks and spots
Old method, New method, Creating TIN from data
  Creating TIN from previous GEOPAK jobs...
Creating from SS3 functionality – from DGN Data and from Survey fieldbook data
Adding spots, breaks or voids to the survey

Editing the surface – Using New and Old tools
Merging TINS
Volume Reports
Working with Feature lines, EP’s, Crowns
  Connecting gaps, modifying the feature lines, adding, deleting and modifying vertices

VDOT OpenRoads – Alignments/Linear Geometry

Create using survey input
Learn other methodologies, Bearing/Distance, etc.

Extensive instruction in use of Civil Accudraw

Using SS3/4 methods for creating data
Learning Dynamic Objects & Parametric Control

Create using graphics – from existing DGN graphics
Annotation – need feature definitions!
Report Generation
Importing Centerlines to/from data collectors – DWG, DXF, Import to DGN?

Developing Geometry from multiple criteria
Exporting data, LandXML, other?
Lessons Learned

Manuals & Accompanying Data Sets

GEOPAK, InRoads
"Open Roads" Training

Field Training for OpenRoads

Virginia Department of Transportation
Bentley®
Channel Partner

Bentley Institute

Harken-Reidar
Lessons Learned

Libraries, System Configurations & Support Files

Dwg, Dxf, Bmp, DgnLibs, F-2-F

Conversions/Data Migrations, Dgn > Dwg
Lessons Learned

Training Methods – Office/Field Combo

Learning the Data Collector Software on a PC in the Office Using **Simulator** Software

Learning the Data Collector Hardware & Software **Live** in the Field
Lessons Learned

Training Methods – Office/Field Combo

New Data Collector Hardware

New Data Collector Software
## Lessons Learned

<table>
<thead>
<tr>
<th>What Went Right</th>
<th>What Went Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client’s IT Support</td>
<td>Using Non-Standard Builds</td>
</tr>
<tr>
<td>Scheduling 100+ DOT Attendees</td>
<td>- Max Attrib Size Exceeded</td>
</tr>
<tr>
<td>- 30+ Consulting Firms</td>
<td>- Cleanup after Crash</td>
</tr>
<tr>
<td></td>
<td>- Civil Accudraw Issues</td>
</tr>
<tr>
<td>System Administration</td>
<td>Conflicts</td>
</tr>
<tr>
<td></td>
<td>- Snow Duty</td>
</tr>
<tr>
<td></td>
<td>- Inclement Weather</td>
</tr>
<tr>
<td></td>
<td>- Shifting Venues</td>
</tr>
<tr>
<td></td>
<td>System Issues</td>
</tr>
<tr>
<td></td>
<td>- Privileges Problems</td>
</tr>
<tr>
<td></td>
<td>- Part SS2, Part SS4</td>
</tr>
</tbody>
</table>
Lessons Learned

Reed Adams, LS

Reed Adams’ ROI & closing comments
Field Crews

- Able to see real-time results of data collection
- Able to edit any data in the rw5
- Able to run multiple lines simultaneously across setups
- Able to get phone support directly from vendor
- Able to see all feature categories or individual categories
- Able to bypass attribute information when not necessary
- Able to control a features Terrain Model Attribute
- Able to template typical section of curb
- Special codes are icon driven for simplicity
- Able to run all equipment from one platform
- Able to identify a features type & GIS status
- Able to identify if a feature is part of the DTM
- Able to upgrade hardware
- Training time reduce by 75%
- Rework reduced by 50%+
Carlson SurvCE – Current Version
- Interactive user interface
- Code Categories
- Linking code selection visualized
- Features attributable for annotation
- Results shown on an interactive screen
- Edits can be performed anytime
- Compatible with GPS/RTK
- Bentley will map same results with proper coding

Return on Investment @ 18 months

Virginia Department of Transportation
Bentley
Bentley Institute
Harken-Reidar
Return on Investment @ 18 months

✓ Office – SS4

- Able to automatically import annotations with rw5 or ascii files
- Creates a Terrain Model (DTM) in the background on import
- All data stored in the dgn format
- Settings stored within the dgn file and are editable
- Features are pre-set for DTM
- Better tools for DTM editing
- Heads up display essential for editing features
- Independent control of point and line features
- Visualization of crew setups
- Real time reprocessing of changes
- Able to process files independently in the same file or as a whole
Return on Investment @ 18 months

✓ **Aftereffects**
  - Created a change oriented environment
  - Staff and consultants interacting more positively
  - Developed a sidebar menu to shortcut survey commands for drafting

✓ **Consultants**
  - Positive responses to the change
  - Able to fill 3 Microstation classes full of consultants (48)
  - Consultants have provided great feedback which have been incorporated
  - Some have incorporated our field coding into everyday workflow
Return on Investment @ 18 months

✓ Consultants – What they are saying!

➢ Woolpert

“Real time drawing adjustments when editing field data and/or TIN components makes visualization immediate versus re-processing data a big plus on efficiency and quality.

The use of many additional levels, now with names, creates a separation of items allowing for quicker processing, CAD efforts and QA/QC efforts.

The use of SS3 has allowed for a more integrated field to finish product.”

• Judy Beale, LS - Survey Project Manager
Consultants – What they are saying!

JMT

“The process started from ground zero, but has really made the processing of survey data very convenient.

I specifically work in the Subsurface Utility Engineering aspect for our company. A line string that used to have to be completely recoded in the data collector, can now be changed in a simple one step process.

Ultimately, we are able to provide a product that presents data such that designers will know the existing conditions of a survey in more depth to assist in future roadway projects.”

- Lannie White Survey Technician
Return on Investment @ 18 months

✓ Consultants – What they are saying!

➢ Rice

“VDOT’s Microstation tool set has proven to be our “go to” platform for processing data directly into the dgn format. With Select Series 3, additions such as named levels, Carlson data collector support and surface creation utilities helps to streamline our work flow, and when working with the new VDOT 2014 standard, greatly increases our productivity.

VDOT’s willingness to support their consultants by listening to feedback about the tools and by adding functionality “when/where needed” is perhaps the software’s biggest asset.”

• Mike Taylor, LS Project Manager
Return on Investment @ 18 months

- Consultants – What they are saying!
  - ATCS
    “The ability to process field data directly within Bentley has presented a significant time savings for us, making us more efficient. The program also permits us to edit or correct codes directly within the application. This permits us to provide services to VDOT more efficiently, thereby lowering the overall cost to the Commonwealth.”

- Tami Lenox, LS - Virginia Survey Manager
Lessons Learned from Re-Engineering a U.S. State DOT ©

Harry O. Ward, PE
HWARD@HARKEN-REIDAR.COM

Reed Adams, LS
REED.ADAMS@VDOT.VIRGINIA.GOV