INDOT Intelligent Design and Construction (IDC)

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Mission Statement

• The use of intelligent 3D CAD models to support the lifecycle of transportation assets (roads and bridges) that provides predictive analysis and reporting capabilities that is data driven and allows the agency to make better operational and strategic management decisions.
The Business Opportunity

Figure 5.2 Asset data flow in the current practice at INDOT.

Figure 5.3 The suggested data flow.
IDC Areas of Emphasis

• Intelligent Design / Automated Machine Guidance (AMG)
  • Transition from 2D plan sets to 3D design models

• e-Construction
  • Transition to Paperless construction

• Asset Management
  • Better utilization of data from Design and Construction for Operations and Maintenance
e-Construction and Partnering FHWA Peer Exchange

• Hosted FHWA e-Construction and Partnering Peer Exchange
  • August 2018
  • Topics
    • 3D CAD Model as Contract Document
      • Utah DOT
    • e-Ticketing for Materials Delivery
      • Pennsylvania DOT
    • ROI e-Construction
      • Oregon DOT
    • ROI 3D CAD Models
      • Wisconsin DOT
Asset Management

• Progress to date:
  • RFID Tag Proof of Capability study
    • September 2017
    • Small Culverts, Panel and Sheet signs
    • Presented the results to the INDOT asset owners
  • WMS and ESRI Roads and Highways integration
    • Ongoing to overcome integration issues
  • Transportation Asset Management Plan
    • Draft version released April 2018
    • FHWA approved draft version Fall 2018
Intelligent Design / AMG

• Progress to date:
  • SS4 OpenRoads migration from SS2 InRoads
    • Completed training for INDOT staff August 2016
    • March 2017, SS2 InRoads removed from user computers except those working on older projects
    • Central Office Road Design has completed projects using SS4 OpenRoads creating 3D Models
  • Provided ContextCapture training to INDOT Land and Aerial Survey Office (LASO)
    • December 2017, Bentley Systems, Inc.
    • ContextCapture allows UAV / Drone / LiDAR / Conventional Survey data to be combined to created a 3D Mesh
  • Provided Subsurface Utility Drainage Analysis (SUDA) best practices and software overview to INDOT Hydraulics and Road Design groups
    • January 2018, Bentley Systems, Inc.
    • SUDA is 3D modeling software for utilities
Intelligent Design / AMG

• SS4 OpenRoads
  • SS4 OpenRoads migration from SS2 InRoads
    • Design in SS4 began July 2016 select Central Office Road Designers
    • Migration of existing projects less than seamless
      • Existing projects in SS2 remain in SS2
      • IRD point controls often lost in translation
  • New designs in SS4
    • Improved 3d Design
    • Improved Cross Sections
    • Non-perpendicular template areas much improved
    • Better Visualization
    • Steps on the Path to Connect Edition ORD
Intelligent Design / AMG

• Example 3d Design model
  • Intersection Improvement
    • Geospatially located Survey Data
    • Typical template design in 3d
    • Turning areas modeled
      • Simplified irregular design areas
      • Surface Templates and Terrain Models
  • Underdrain and Drainage Tie in
    • Accurate models of both existing and proposed underdrains
    • Simplified special grade calculation
    • Tie in to existing
Intelligent Design / AMG
SS4 SUDA

Provided Subsurface Utility Drainage Analysis (SUDA) best practices and software overview to INDOT Hydraulics and Road Design groups

- January 2018, Bentley Systems, Inc.
- SUDA is 3D modeling software for utilities

Using lessons learned from best Practices Analysis

- Aware of the large configuration effort required, we did the following simple alternative
- Implemented SUDA on unofficial pilot project
- Local configuration of SUDA for 3d location
- Clash Detection was primary goal
- Hydraulic flow modeling not considered
Example SUDA

- Urban small structure replacement
  - Numerous Existing Utilities
  - Proposed Structure larger than existing
    - Existing Dual pipe arches failing
    - Reinforced Concrete Box replacement
- Possible Conflicts Identified
  - Sanitary Sewer 24” immediately underneath existing pipes
  - Sewer Interceptor backfill loss under structures
  - Fiber likely runs under (through new) structures
  - Gas likely runs under (through new) structures
  - Water likely conflicts with new structure
  - Power Pole foundation in close proximity to structure excavation area
Intelligent Design / AMG
Intelligent Design / AMG
Intelligent Design / AMG

• Ongoing Efforts
  • Improved Patching Table
    • Locate Patching Geographically
    • Remove guesswork for Field Employees
    • Leverage ESRI ArcCollector App
    • Better utilization of Pavement distress scanning data
  • LiDAR
    • Make use of Oregon DOT lessons
    • Improved accuracy
    • Better Design tolerances
    • Cost savings with less change orders
  • Bentley Open Roads Designer ORD
    • Workspace Migration
    • Plan Pilot project
    • Implementation
eConstruction Projects

- Intelligent Design and Construction
- AASHTOWare Project
- PWL Wizard
- eFCR
- HMA Tracker
eConstruction Projects

- Quality Checklists
- eTicketing
- OnDemand Training
- GPS/Rover Grade Control
- Digital As-Buils/Asset Management
Legacy Project Information Flows

- Design
- Construction Drawings
- Construction
- 2D to 3D
- 3D to 2D
- Built Environment
- Field Review
- Inspection
- Operations & Maintenance
- Redline
- As-builts
Information Mobility Goals

- Streamline Field Inspection
  - Easy to use
    - Click onto graphics to access specs, check lists & forms
    - Graphical indexing and status visualization of all inspections
- Queries, benchmarking, audits, litigation research and analytics
- Automated population of Asset Management databases
Construction Inspection
Field Review – View Settings

Default top view showing current location

View commands
Field Review

Adjust view composition based on Specs and Item Extensions

Scroll down
Field Review

SS1: 611E10400

Inspections
Admin
Installation Plan
Field
Excavation
Installation
Backfill
Admin
Post Installation

Pull out Inspections panel

Inspection regimen appropriate for component type
New Inspection
Select bookmark to access specs
Save
Expand
Quality form for Admin Installation Plan automatically appears without selecting because only option currently available
Use markers, data points & key-ins to graphically define inspection limits.

Fill out and save form
Graphical definition of inspection limits not required in this case as the entire component length is default when saving form.

Green color indicates that all checklist items on quality form for Installation Plan passed.

Can change inspection form and limits on the day of inspection. Afterward, the inspection is locked.

Field Excavation, Installation and Backfill now available for inspection. Field Post Installation remains unavailable.
Field Review – Field > Excavation

Keyin length

Indicator placed at defined length

Red color denotes failed inspection item

Save form

Fill out form
Field Review – Field > Installation

Inspections
611E10400-24" CONDUIT, TYPE B

Admin
✓ Installation Plan
Field
✓ Excavation
✓ Installation

Quality Form
Quantity Form
Workflow Form

Item 611 Pipe

Fill out form. Note TBD indicates incomplete.
Other Forms: Field > Installation > Worksheet Form

Item 611 Pipe Installation Worksheet (1 of 2)

- Date
- ContID
- AltID
- Project No. (Part Code)
- Item No.
- Item Desc.
- Location
- Co/Rt/Sec
- Contractor
- Plan Page
- Pipe Material
- RCP
- Type of Pipe
- Pipe Markings
- Type of Joints (611.08)
- Joints Installed Satisfactorily?
- Yes
- No
- Materials: All tested and approved prior to incorporation into the project.
- Balloon Ref.
- Station to Station
- Plan Qty.
- Remarks
- Daily Total Field Measured
- LF (metres)
- Remarks

TRENCH & BEDDING CHECKS (ACTUAL FIELD MEASUREMENTS)

- Check Stations & Location
- T
- W
- B
- S
- O.D.
- Initial
- Date

*Note: Field invert elevation checks are required for Types A, B, and C Conduits.
Field Review

Pull out Inspections panel

Inspection regimen appropriate for component type
Field Review – New Inspection Geometry Definition

Create other paving areas
Inspection Office
Inspection Office – Failed Inspections

Of the two failed asphalt inspections, one ‘Reported’ and one ‘In Progress’

Click onto pie slice

Both failed asphalt inspection workflows with the Contractor
Inspection Office – Failed Inspections

Chart reflects selected element

Select element
To review failed quality questions, a forms push button appears if single element or single pie slice selected.

If chart pie slice selected that represents multiple inspections, scroll arrows become available.

Corresponding element highlights when scrolling through inspection instances.

Resulting modal shows inspection form.
Inspection Office – Failed Inspections

Element to Spec Mapping

Spec
- (Select All)
- 200 Earthwork
- 300 Bases
- 400 Flexible Pavement
- 450 Rigid Pavement
- 500 Structures
- 600 Incidental
  - 601 Slope and Channel Protection
  - 602 Masonry
  - 605 Underdrains
  - 606 Guardrail
  - 607 Fence
  - 608 Walls, Curb Ramps and Stairs
  - 609 Curbing, Concrete Median
  - 610 Cellular Retaining Walls
  - 611 Pipe Culverts, Sewers, Drainage
  - 613 Low Strength Mortar Backfill
  - 614 Maintaining Traffic
  - 615 Roads and Pavements for Commercial
  - 616 Dust Control
  - 617 Reconditioning Shoulders
  - 618 Rumble Strips on Shoulders
  - 619 Field Office

Chart: Photos

Currently selected photo

Currently selected photo

Photo location references
Inspection Office – Status Visualization

Select chart with table that summarizes inspections

Inspection summary table

Select icon to show inspection form

Corresponding inspection highlights

Select element
### Quality Checklists - Grouping

#### Pay Item

- **715-05053 PIPE, UNDERDRAIN, OUTLET 6 IN.**

- **TRENCHING**
- **INSTALLATION**

<table>
<thead>
<tr>
<th>Check/Info</th>
<th>ID</th>
<th>Description</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>715-006</td>
<td>Each section of pipe shall have a full firm bearing throughout its length, true to the line and grade given. All pipes which settle or which are not in alignment shall be taken up and re-laid.</td>
<td>715</td>
</tr>
<tr>
<td>Information</td>
<td>715-007</td>
<td>Fully bituminous coated and lined pipe and pipe-arches shall only be placed when the ambient temperature is 35°F or above.</td>
<td>715</td>
</tr>
<tr>
<td></td>
<td>715-008</td>
<td>Were concrete and clay pipe laid with hub upgrade, with the spigot end fully extended into the adjacent hub, and with all ends fitted together tightly?</td>
<td>715</td>
</tr>
</tbody>
</table>

**Show More**
# Quality Checklists - Cross Referencing

## Pay Item

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>203-02055</td>
<td>EMBANKMENT</td>
<td></td>
</tr>
<tr>
<td>203-016</td>
<td>Were shale, shale and soft rock mixtures, or soft rock placed in 8 in. maximum loose lifts?</td>
<td></td>
</tr>
<tr>
<td>203-030</td>
<td>If embankment for new pavement is to be placed over existing roadbeds, were removal of the surfacing material, breaking the base, and disposal of removed material in accordance with 202.05?</td>
<td></td>
</tr>
</tbody>
</table>

- **202-009**: Pavement layers or courses removed as indicated in plan?  
  - **Section**: 202

- **202-010**: Concrete walks and steps removed as indicated in plans?  
  - **Section**: 202

- **202-011**: Concrete curbs and gutters or stone curbs removed as indicated in plans?  
  - **Section**: 202

[Show More]
Quality Checklists – Pictures or Videos

Pay Item

715-05053 PIPE, UNDERDRAIN, Outlet 6 IN.

... 715-047 Precast imnots shall be cast as a single complete unit except for the toewall which shall be cast in place and they shall be set and leveled on a 6 in. thick bed of coarse aggregate
Questions?

• Contact Information:
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