Digital Design Data for Asset Collection

ROAD SCHOOL 2022

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Derek Fuller, INDOT
Tim Haney, Parsons
Scott Lecher, HNTB

Agenda

- INDOT Digital Design Update
- ORD Implementation for INDOT Projects
- Taking Digital Design to Asset Management

INDOT MIS Geospatial Group

- Support INDOT's Geospatial Efforts
- GIS Support and CAD Support
- GIS Support
  - ESRI Suite of software's
    - ArcMap
    - ArcGIS Pro
    - Enterprise GIS
    - Roads and Highways
  - GIS Application Development
    - ESRI Field Maps and Survey123
    - Javascript, Python, HTML
    - ArcGIS Online
    - ArcGIS Portal

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INDOT MIS Geospatial Group

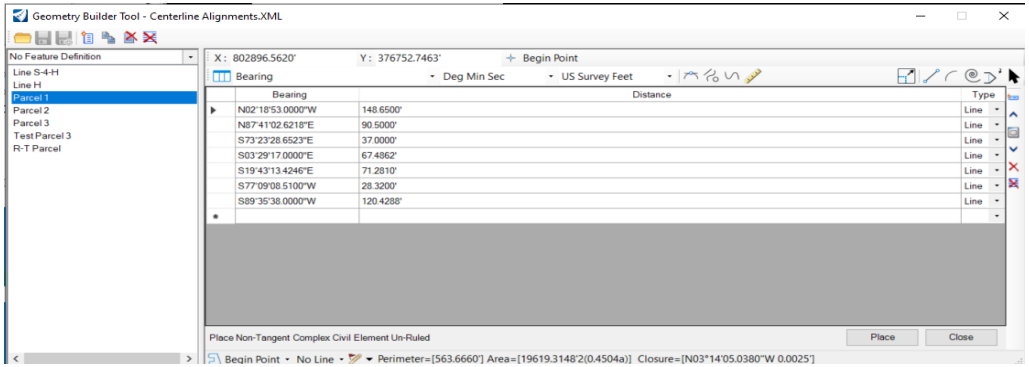
- CAD Support
  - CAD Civil Design Platform
    - Bentley Suite of software's
      - ProjectWise for Design file Storage
      - Leap Products for Bridge Design
      - InRoads/OpenRoads for Road Design
  - CAD Workspace Development
  - CAD Support Webpage
    - https://www.in.gov/indot/doing-business-with-indot/other-business/cad-support/
    - Beta ORD CONNECT Workspace available for download

ORD Implementation at INDOT

- Developed Beta Workspace in January 2020
- Piloting OpenRoads Designer CONNECT 2021 R1 internally
  - Manual annotation
  - Automated annotation
  - Sheet cutting
  - Fully test Beta Workspace
  - Anticipate Finish testing June 2022
- Implement into production after Pilot projects completed
  - Anticipate use on new projects starting January 2023

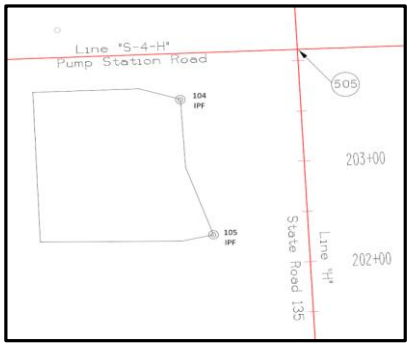
ORD Geometry

- Use ORD geometry tools to create/compute Right of Way
  - Start by establishing the geographic coordinate system for the dgn file
    - Setting up the coordinate system is essential for adding spatial data from other sources and exporting data for use in GIS and other spatial applications
  - Geometry Builder tool allows easy computation of alignments, parcels, etc.



ORD Geometry

- Add stationing to the alignment start point
- Use the Transform tool to translate and rotate parcel to monuments

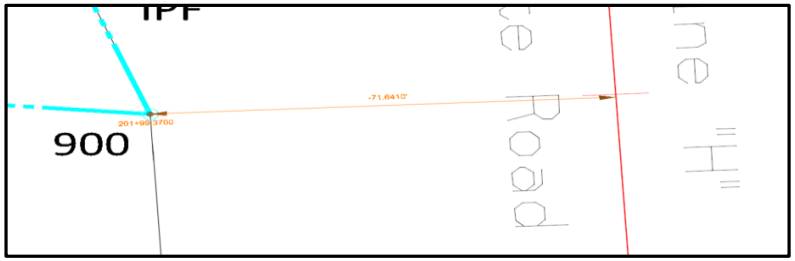


- Several methods to compute right of way taking
  - Graphically, using CAD features
  - Use Civil Accudraw tools

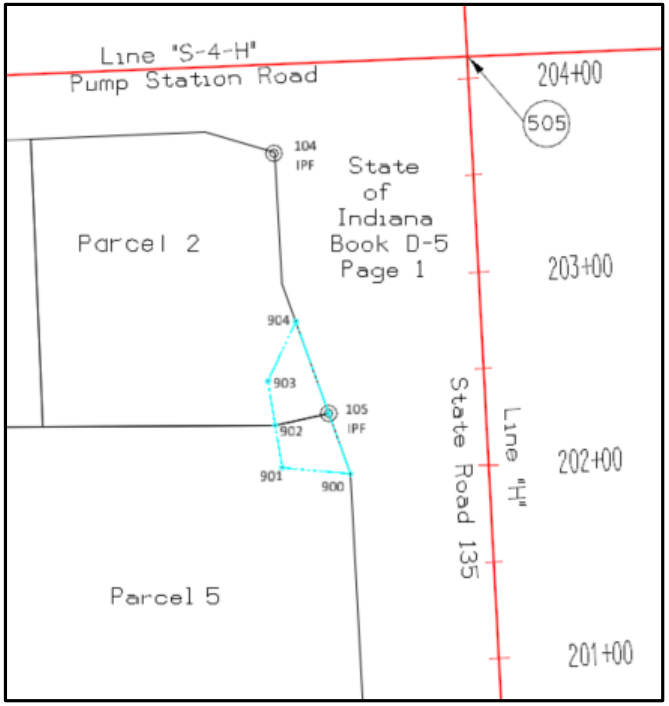
ORD Geometry

- Civil Accudraw
  - Advantage to using Civil Accudraw is dynamic capabilities
  - Station-Offset tool

    - Tied to other Civil Elements (Alignment – Line H)
    - Click on the offset distance, stationing to modify dimensions
    - If alignment is modified, the point is modified accordingly



ORD Geometry

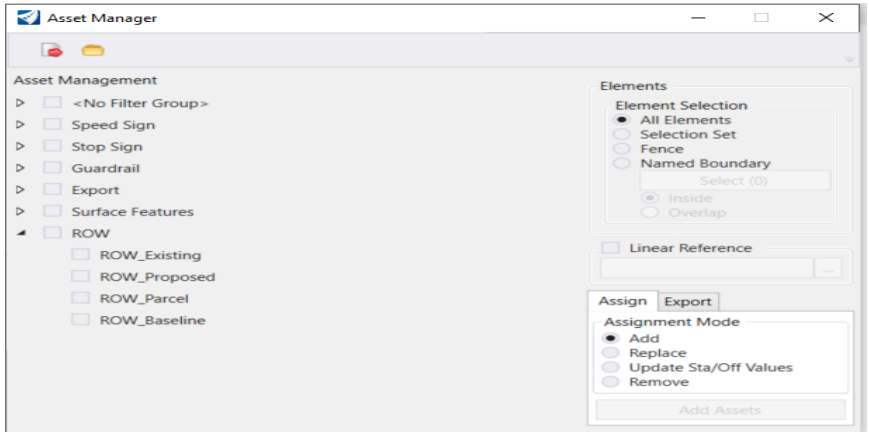


Exporting to GIS

- Item Types are used for exporting to GIS
  - Add attributes to CAD elements
    - Associated to elements
    - Easily exported with the element

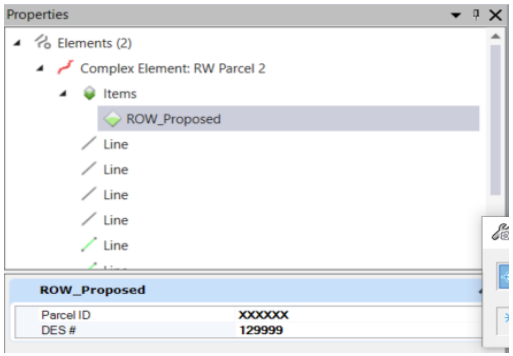
Exporting to GIS

- Asset Manager tool used to assign/add item types to elements
  - Item type “library” contained within Asset Definition File
    - Macro enabled Excel Spreadsheet (.xlsm)
    - Can be modified to contain any filter groups and item types you would like to add



Exporting to GIS

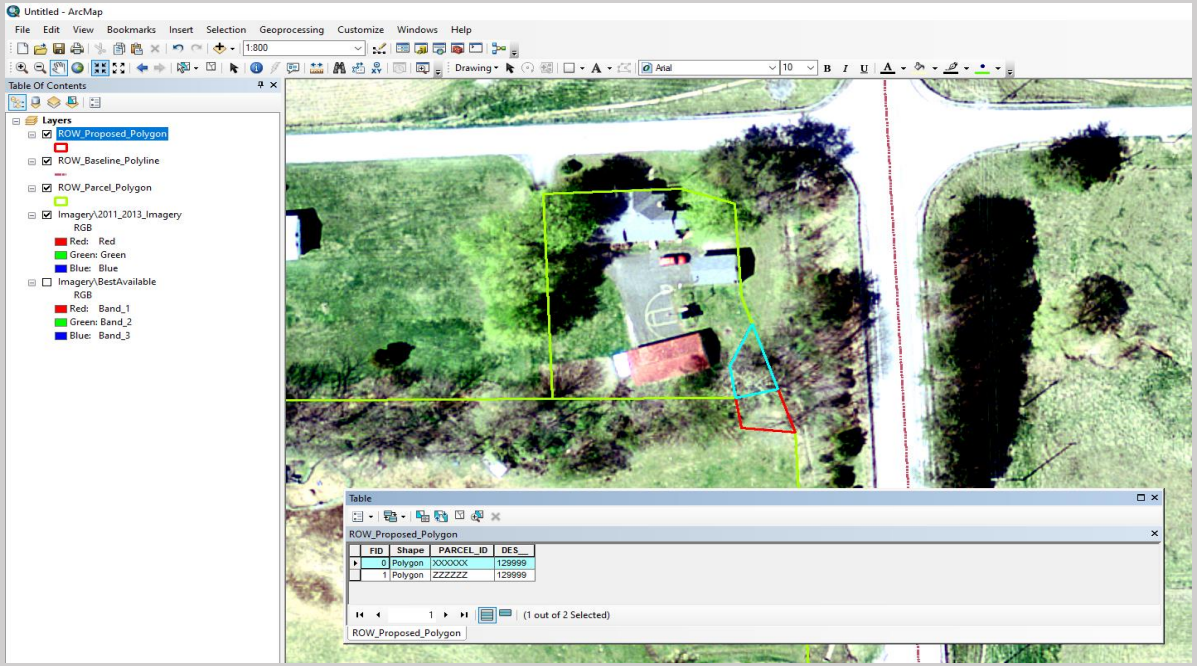
- Once Item Types are added to elements, populate the fields/attributes
  - Use the Properties tab to navigate to the item types and fill in as necessary



- After adding Item Types, elements can be exported using Asset Manager tool

Exporting to GIS

- Item types are preserved as attributes in GIS



Tim Haney:
Road Design Experience

- Nearly 16 Years of Experience
- Stay up to date on the latest technologies

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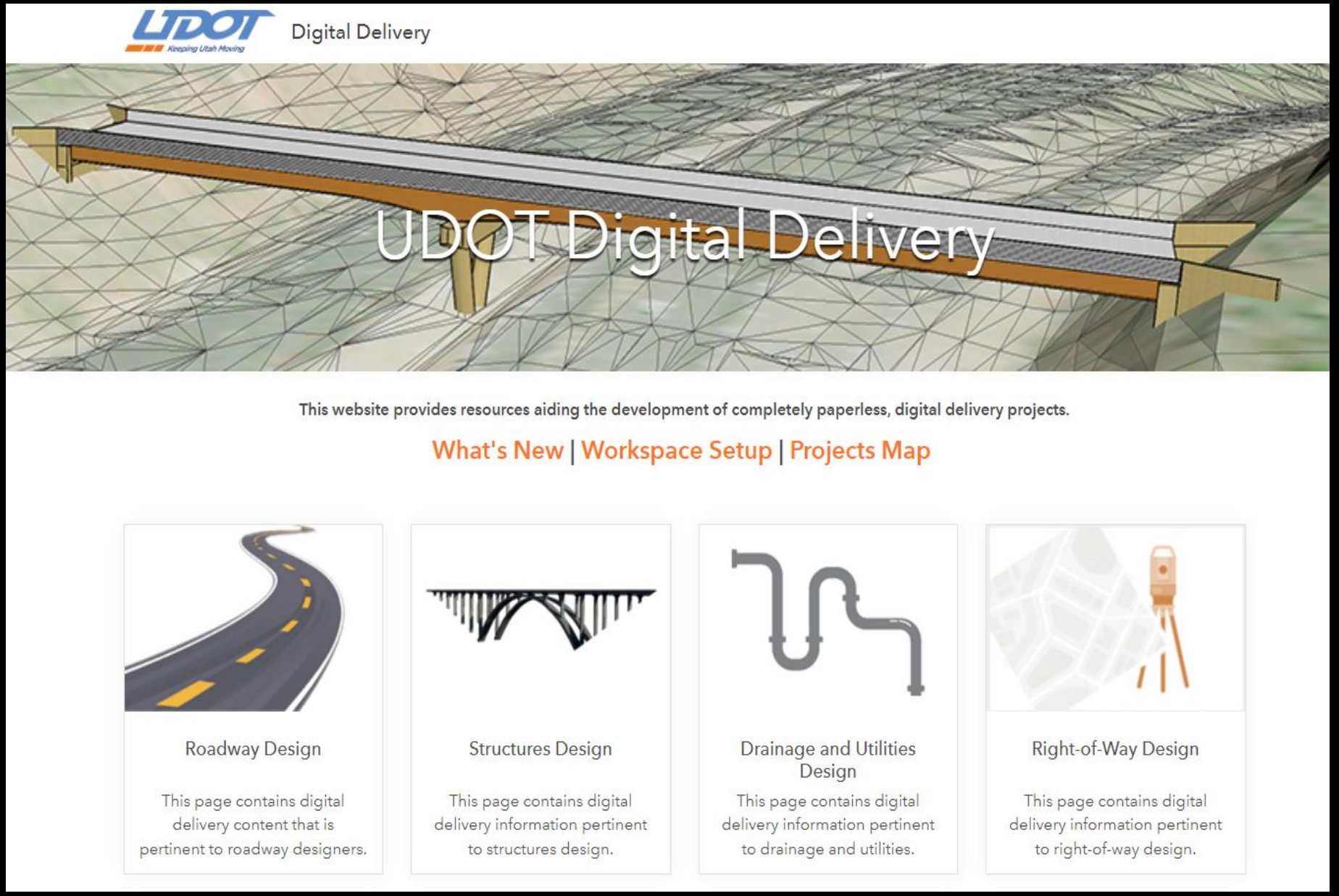
Hastings Bridge Project (Hastings, MN)
A Technology Transition Success Story

DOT Digital Delivery (DD) is Already Happening

https://www.enr.com/articles/53614-tech-focus-new-initiatives-push-state-dots-to-adopt-digital-workflows

Government | Building Information Modeling (BIM) | Information technology

Tech Focus: New Initiatives Push State DOTs to Adopt Digital Workflows



Other DOT Examples

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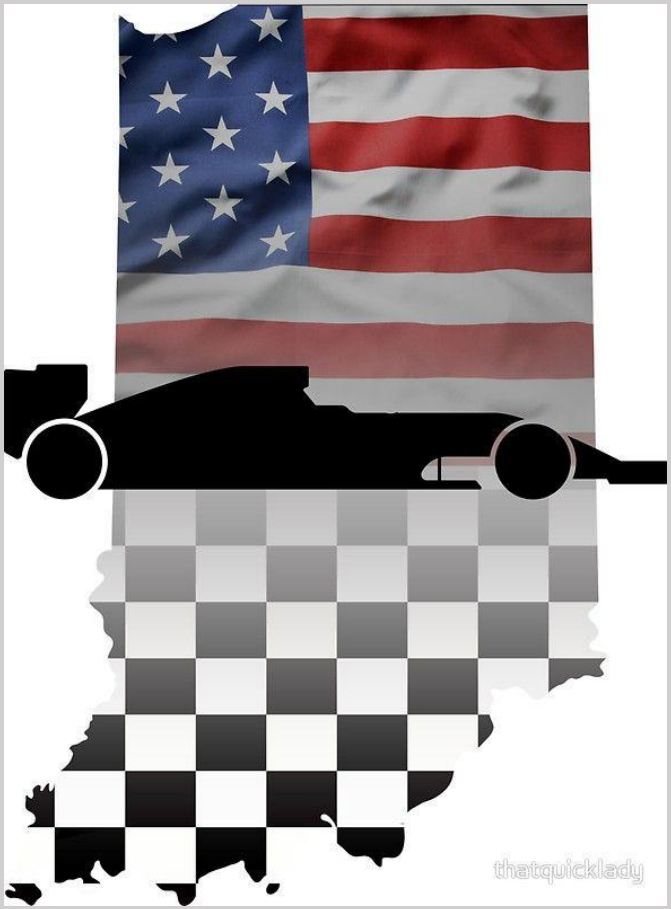
Out with the old, In with the new

…but "We've always done it this way"

Current “State” of OpenRoads



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INDOT ORD Timeline

- INDOT OpenRoads Designer Beta Workspace
  INDOT_ORD_Workspace_Beta.zip
  Download - (3/9/21) (right click to download file)
  More Information: This is the standalone INDOT Workspace for OpenRoads Designer. This workspace is currently a work in progress and currently does not have SUDA content beyond what Bentley provides out of the box. Civil content is compatible with the 2020 R3 ORD release. Please keep in mind that we're a ProjectWise shop first, so there may be references to our ProjectWise system that may need adjusted for your environment. To install, unzip the file and place the ProgramData folder at the root of your C: drive for the workspace to fall in the correct location for a default ORD installation.

- ✓ March 2020 - Road School – Derek and Tim give similar presentation. Purdue and Joint Transportation Research Program (JTRP)
- ✓ January 2020 – INDOT releases initial ORD Workspace for testing
- ✓ March 2020 – INDOT releases Alpha ORD WorkSpace and Parsons begins modifications for their use on INDOT Projects
- ✓ February 2021 – Parsons, INDOT, and Bentley hold meeting to provide feedback on Stage 2 Plans
- ✓ March 9, 2021 – INDOT Releases latest BETA WorkSpace (ORD 2020 R3 Version)
- ✓ March 2022 Road School - You are here!
- ✓ Summer 2022 INDOT Internal ORD Testing Complete
- ✓ Early 2023 INDOT Plan to implement complete ORD WorkSpace

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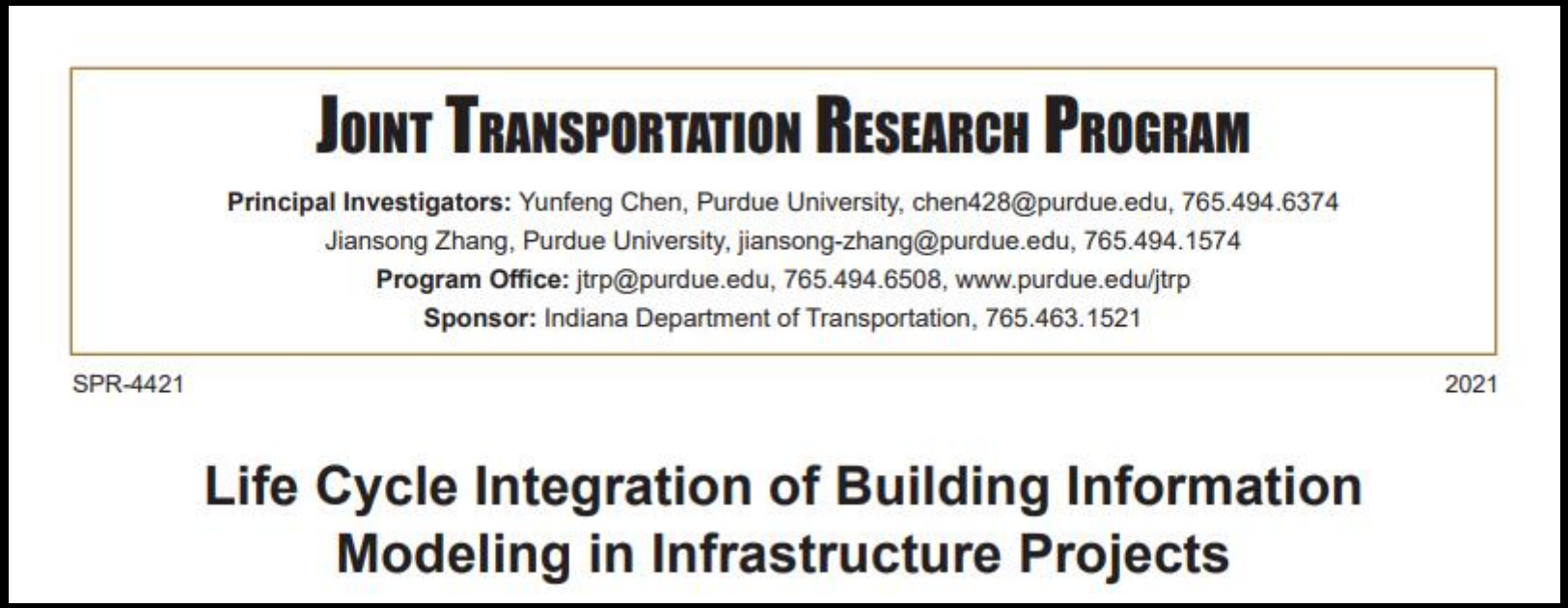

JOINT TRANSPORTATION RESEARCH PROGRAM

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Jiansong Zhang, Purdue University, jiansong-zhang@purdue.edu, 765.494.1574
Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp
Sponsor: Indiana Department of Transportation, 765.463.1521

SPR-4421 2021

Life Cycle Integration of Building Information Modeling in Infrastructure Projects

Four main challenges of BIM Implementation identified along with potential solutions:

- **Isolation of project phases (process factor)**
- **Incompatibility of project technologies (technology factor)**
- **Unclear definition of requirement and responsibility of project stakeholders (people factor)**
- **Imperfect information collection and sharing (information factor)**

https://docs.lib.purdue.edu/jtrp/1775/

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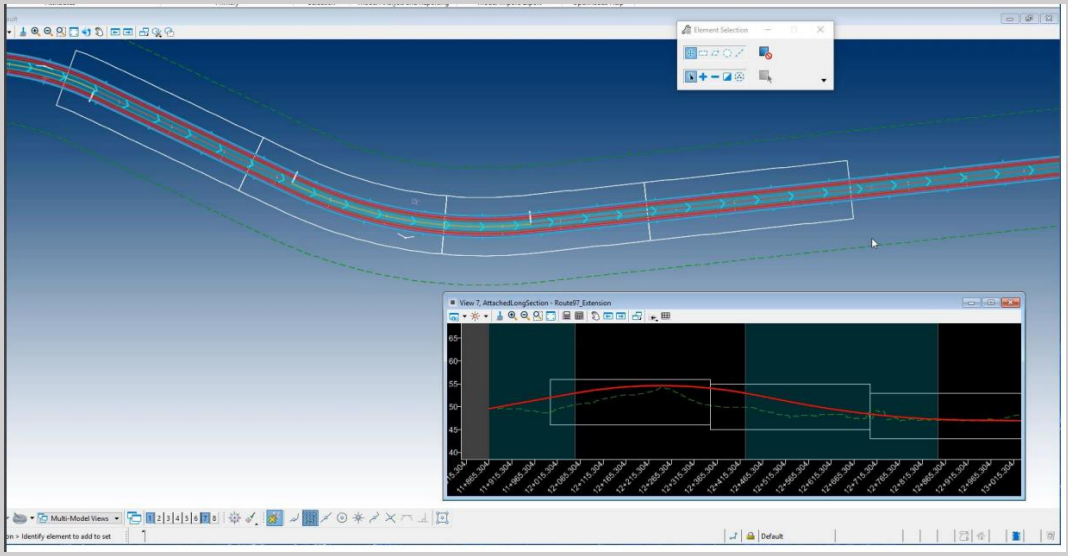
Lessons Learned

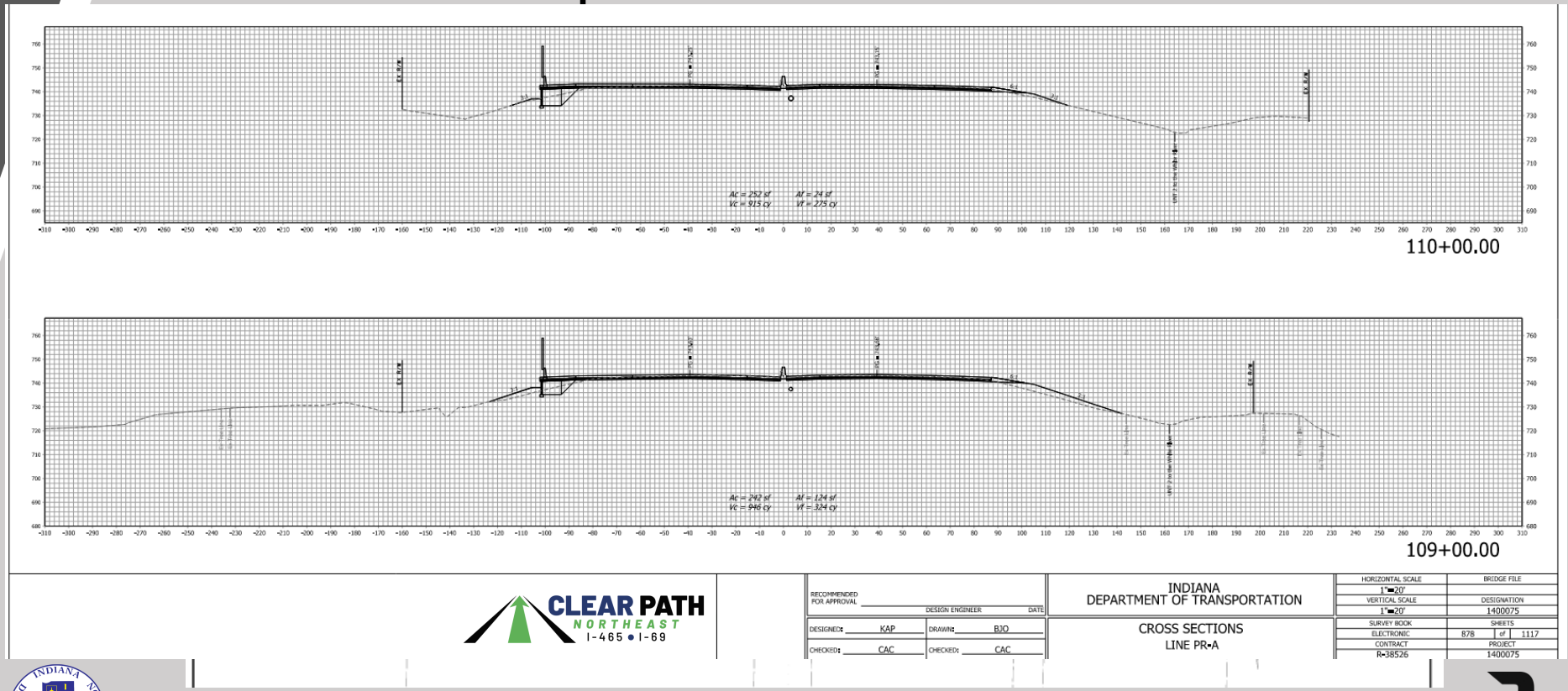
- Annotation
- Plans Production
  - What is a Named Boundary?



- Incorporating drainage design

INDOT ORD Workspace

- Parsons INDOT Project Examples utilizing Beta WorkSpace



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3D Model

CLEAR PATH
NORTHEAST
I-465 • I-69

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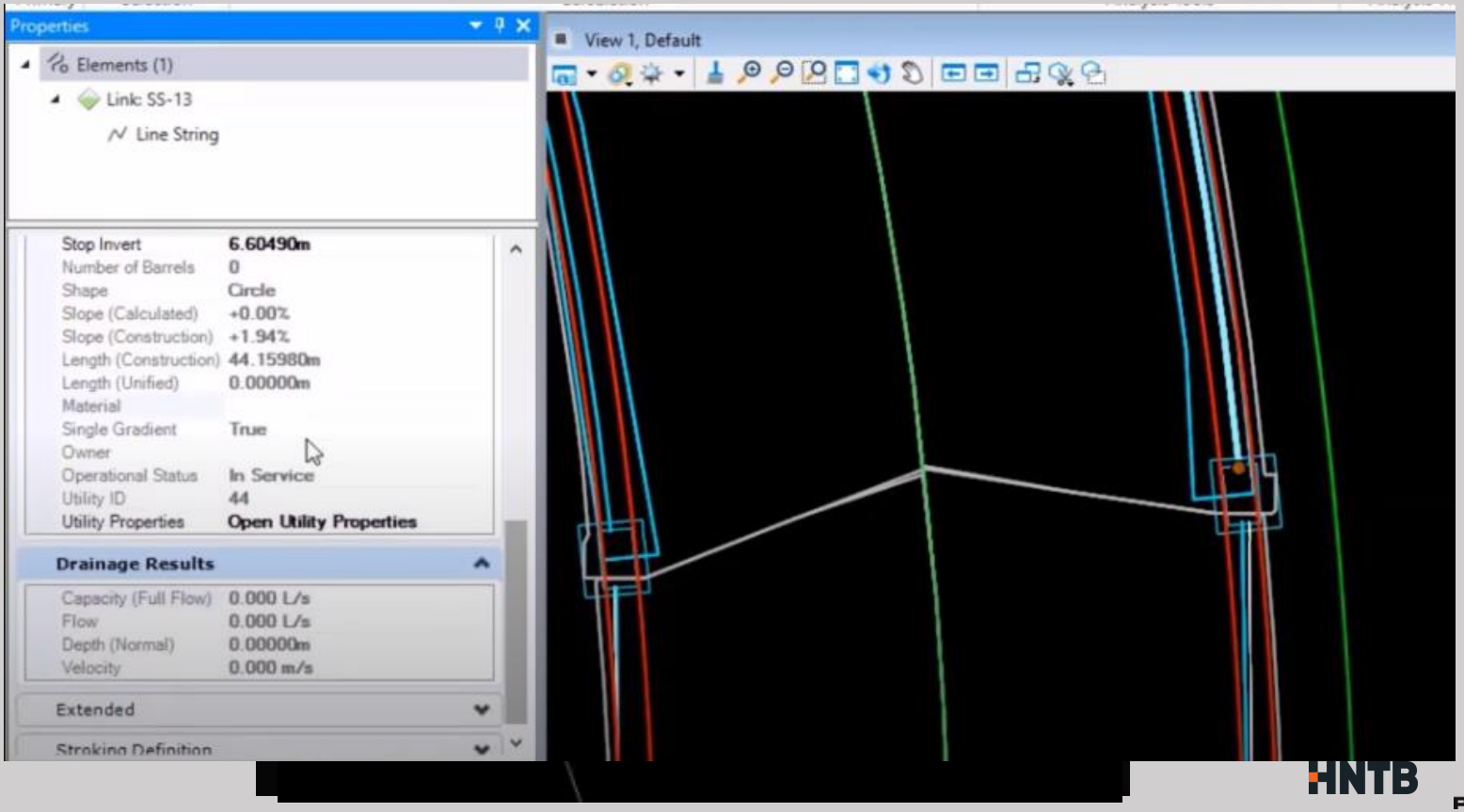
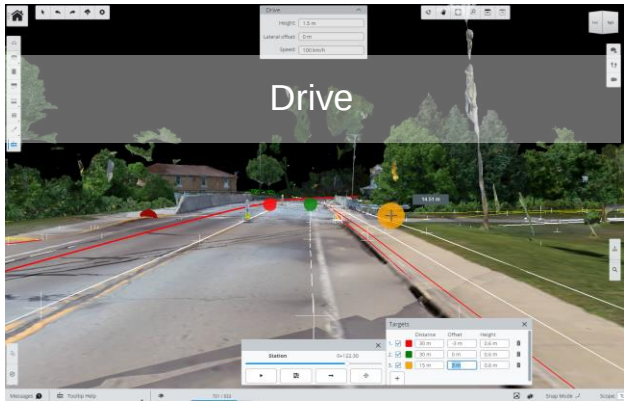
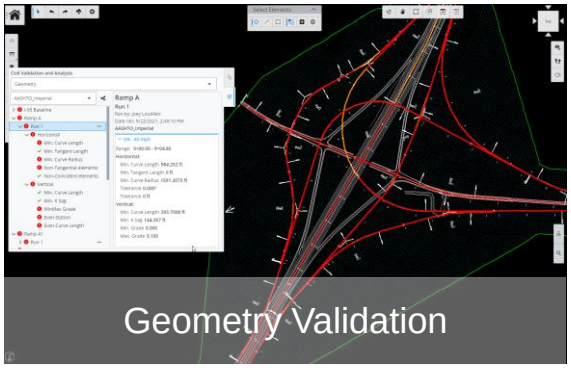
ORD CONNECT Version 2021 R2

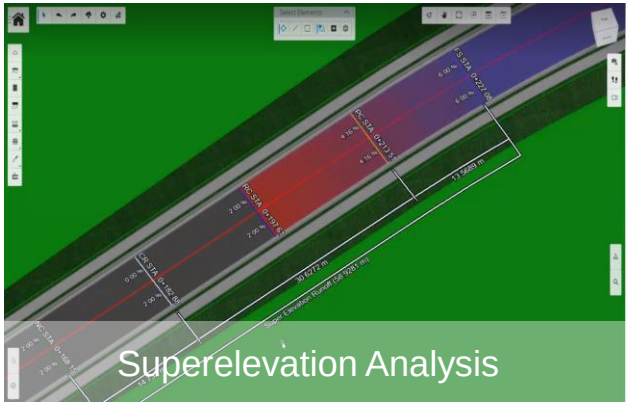
- Enhancements include:
  - Water Quality Drainage Inlets

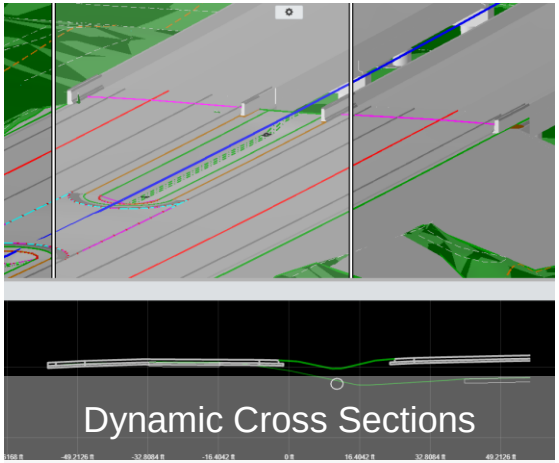


Civil iTwin Validation Tools (Early Access)









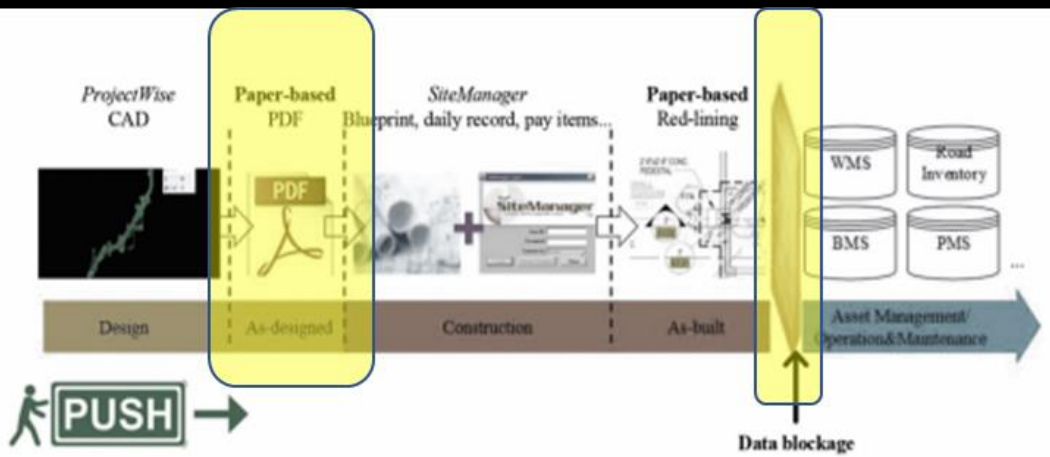
iTwin®

- Drive
  Interactive drive-throughs for line-of-site validation
- Superelevation Analysis
  Examine and validate roadway elevations
- Geometry Validation
  Automated method to check, identify deviations, navigate and mark-up horizontal & vertical alignments
- Dynamic Cross Sections
  Create cross sections with ease for design validation

Experience

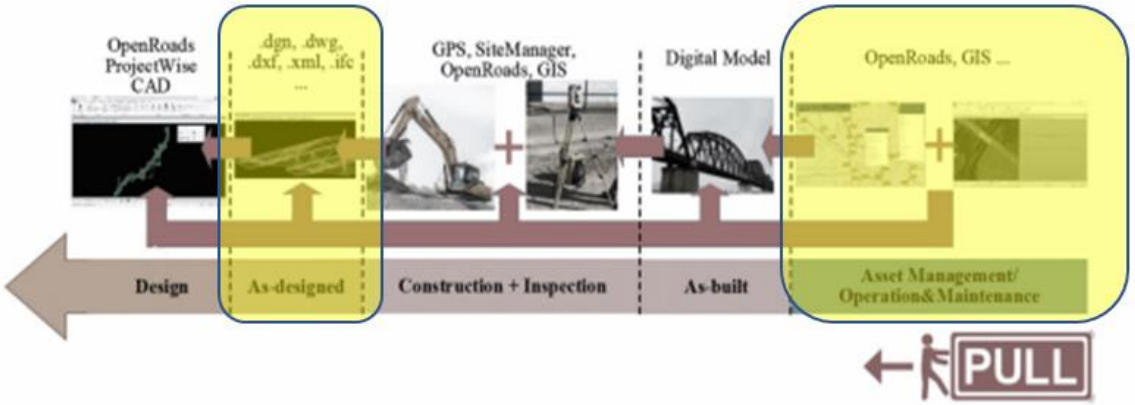
- Background in Roadway Design and Construction
- Current technology focus
  - OpenBIM for Infrastructure
  - CAD/BIM integration with GIS

Process Flows



Note: Figure from *A Synthesis Study on Collecting, Managing, and Sharing Road Construction Asset Data* (Cai et al., 2015).

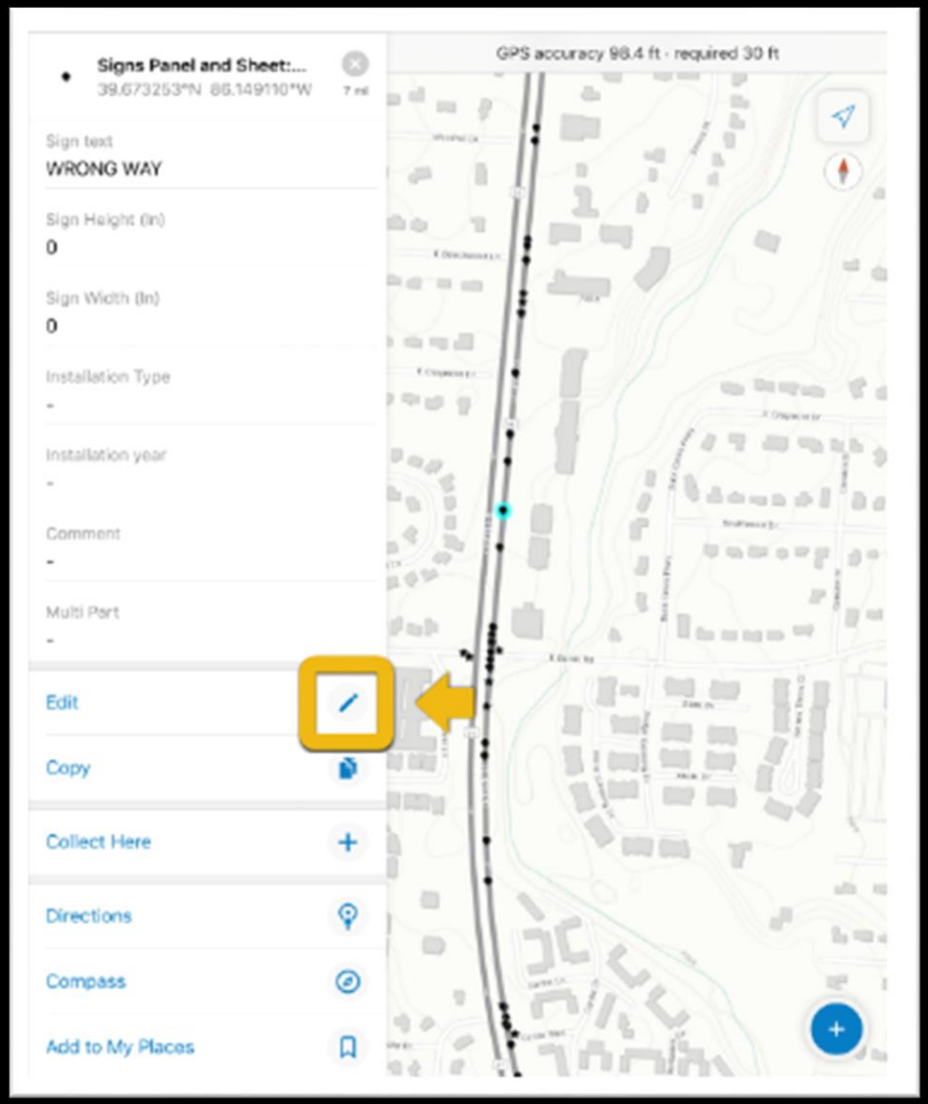
Figure 5.1 Current push-based workflow at INDOT (Cai et al., 2015).



Note: Figure from *Case Study of Building Information Modeling Implementation in Infrastructure Projects* (Guo et al., 2021).

Figure 5.2 Proposed pull-based workflow (Guo et al., 2021).

Post-Construction Asset Collection



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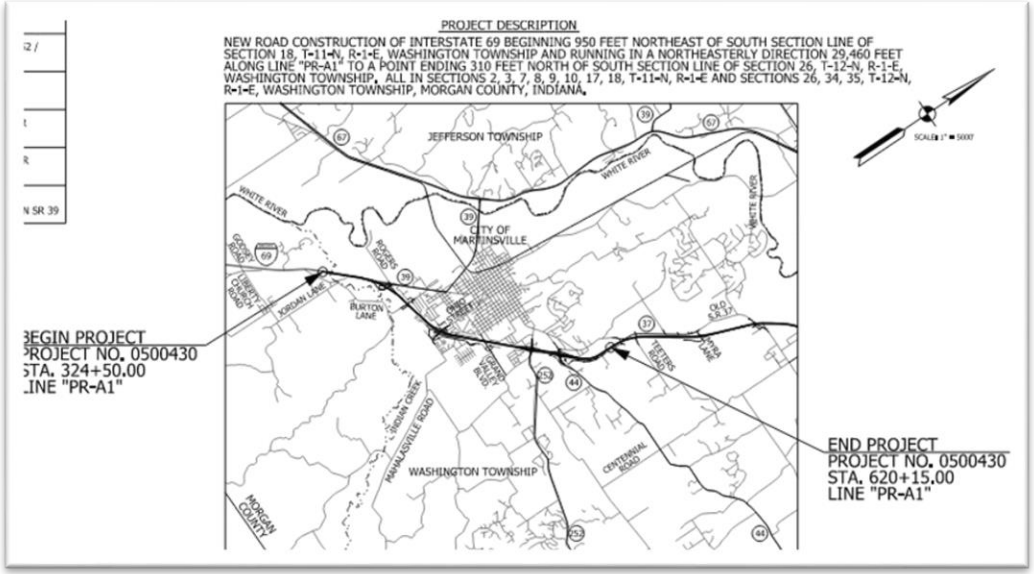
Hypothesis

- Inventory of underground assets is best accomplished during construction
  - Traffic Control/Workzone Safety
  - Assets are exposed for visible inspection
  - Construction Inspection staff already tasked with confirming size / location per plans
- Post-Construction process could be utilized during construction
- Stormwater Assets are well-suited to collection during construction
- Inspector workload will be lessened if they are primarily confirming “as-designed” information versus entering everything manually on-site

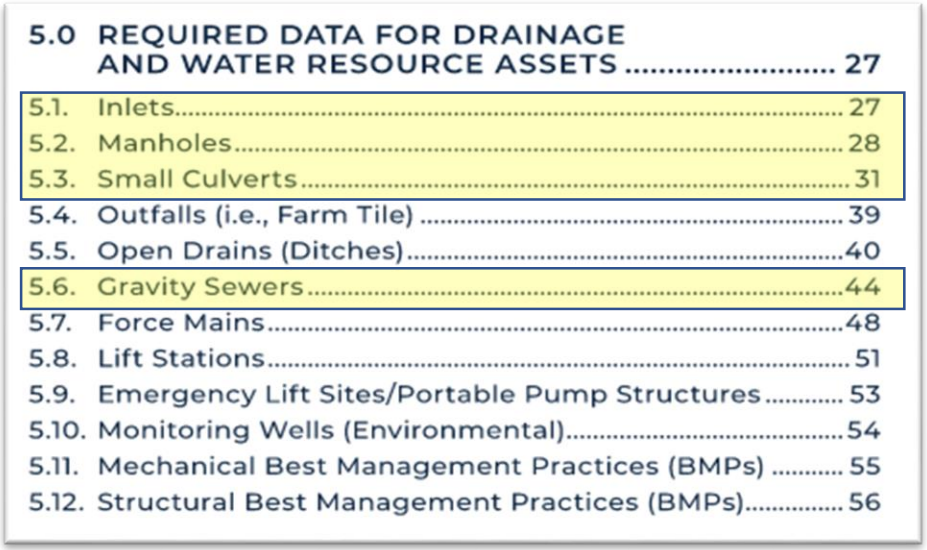
Case Study

- R-33493 I-69 Martinsville
- “As Designed” Dataset
  - DGN/DWG drawings (2D)
  - LandXML Surfaces and Alignments (3D)
  - InRoads Storm & Sanitary Database (3D)



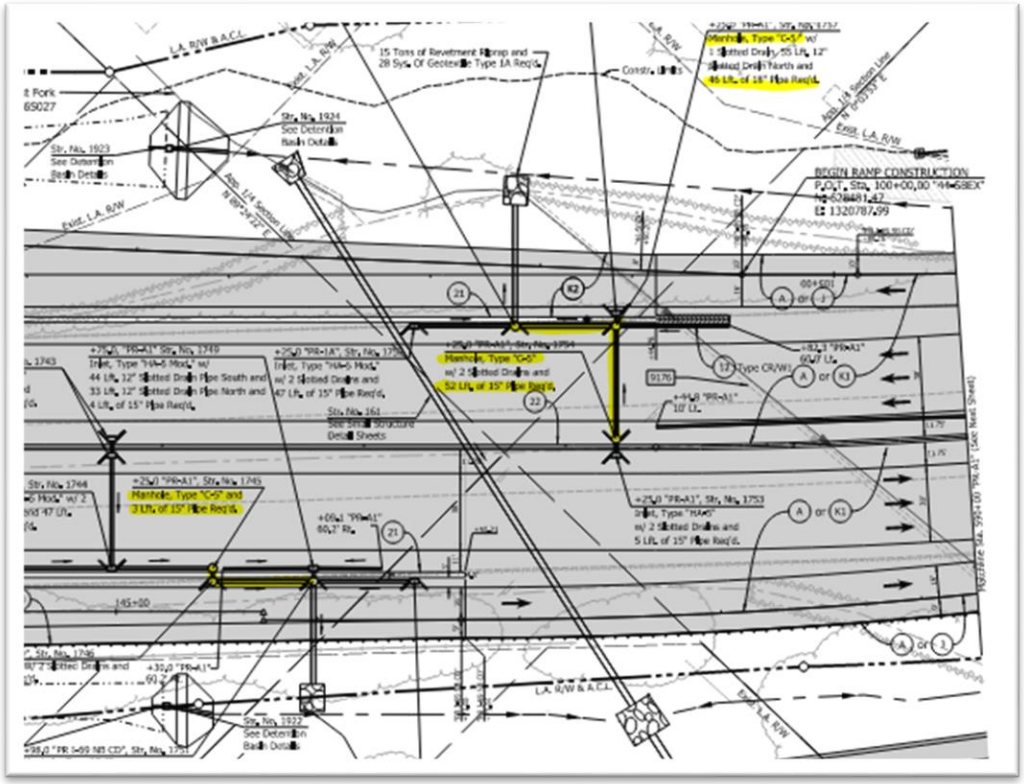
Data Requirements

- Point Feature Classes
  - Inlets
  - Manholes
- Linear Feature Classes
  - Small Culverts
  - Gravity Sewers



Linear Feature Classes

- Gravity Sewers
  - Manhole to Manhole
- Small Culverts
  - All Others



Extract / Transform / Load

- InRoads V8i SS2 Storm & Sanitary (S & S)
  - Report Configuration
  - Export to space delimited (*.txt)
- Import to Excel (*.xlsx)
- Point Features
  - Import Excel Table
  - Table to Point Features
- Line Features
  - Generate Well-Known Text (WKT)
  - Import Excel Table as geopandas dataframe
  - Export to shape file (*.shp)
  - Import Features in ArcGIS Pro

```
in_file = "../../../data/raw/INDOT_IIM/Pipes H2S manual import.xlsx"
df = pd.read_excel(in_file, dtype={
    "ID": np.unicode_,
    "GeometryWKT": np.unicode_,
    "XBegin": np.float64,
    "YBegin": np.float64,
    "XEnd": np.float64,
    "YEnd": np.float64,
    "Span (in)": np.int32,
    "Height (in)": np.int32,
    "Pipe Shape": np.unicode_,
    "UpstreamInvert (ft)": np.float64,
    "DownstreamInvert (ft)": np.float64,
})
df.head()
```

[42]:

	ID	GeometryWKT	XBegin	YBegin	XEnd	YEnd	Span (in)	Height (in)
0	P-1100	LINESTRING (1300929.61 613043.06 590.70, 13008...	1.300930e+06	613043.0561	1.300855e+06	613112.4964	12	12
1	P-1101	LINESTRING (1301221.58 613353.30 590.80, 13011...	1.301222e+06	613353.2977	1.301143e+06	613426.3705	12	12
2	P-1103	LINESTRING (1301746.86 613924.88 593.94, 13017...	1.301747e+06	613924.8842	1.301779e+06	613960.0029	15	15
3	P-1104f	LINESTRING (1301813.27 613996.79 593.94, 13017...	1.301813e+06	613996.7877	1.301781e+06	613961.4721	15	15
4	P-1104	LINESTRING (1301777.42 613963.28 592.44, 13017...	1.301777e+06	613963.2819	1.301718e+06	614018.0795	18	18

```
df["GeometryWKT"] = df["GeometryWKT"].apply(shapely.wkt.loads)
gdf = gpd.GeoDataFrame(df, geometry="GeometryWKT")
gdf.head()
```

[43]:

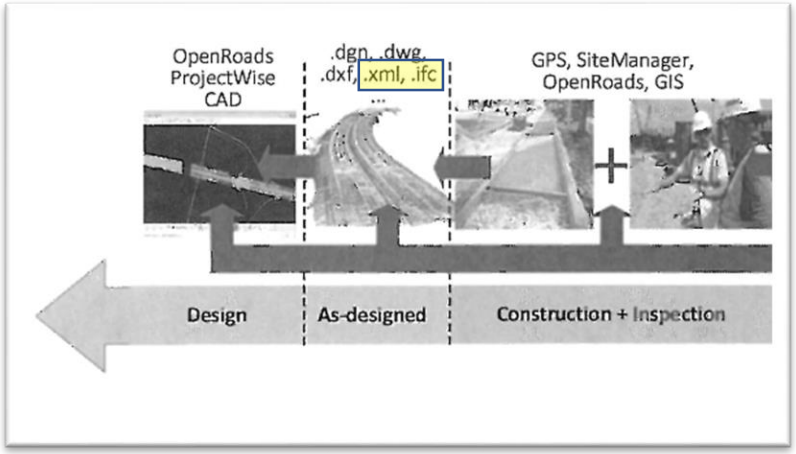
	ID	GeometryWKT	XBegin	YBegin	XEnd	YEnd	Span (in)	Height (in)
0	P-1100	LINESTRING Z (1300929.610 613043.060 590.700, ...	1.300930e+06	613043.0561	1.300855e+06	613112.4964	12	12
1	P-1101	LINESTRING Z (1301221.580 613353.300 590.800, ...	1.301222e+06	613353.2977	1.301143e+06	613426.3705	12	12
2	P-1103	LINESTRING Z (1301746.860 613924.880 593.940, ...	1.301747e+06	613924.8842	1.301779e+06	613960.0029	15	15
3	P-1104f	LINESTRING Z (1301813.270 613996.790 593.940, ...	1.301813e+06	613996.7877	1.301781e+06	613961.4721	15	15
4	P-1104	LINESTRING Z (1301777.420 613963.280 592.440, ...	1.301777e+06	613963.2819	1.301718e+06	614018.0795	18	18

Findings

- Overall alignment with production schema
- Some attribution required beyond “as-designed”
  - Asset ownership
  - Pipe materials
- Additional vendor status “As Designed”

Looking Forward

- Repeatable Processes
- Vendor-Neutral, Open Data Formats
  - LandXML
  - Industry Foundation Classes (IFC)
- Value for Construction Inspection



Questions?

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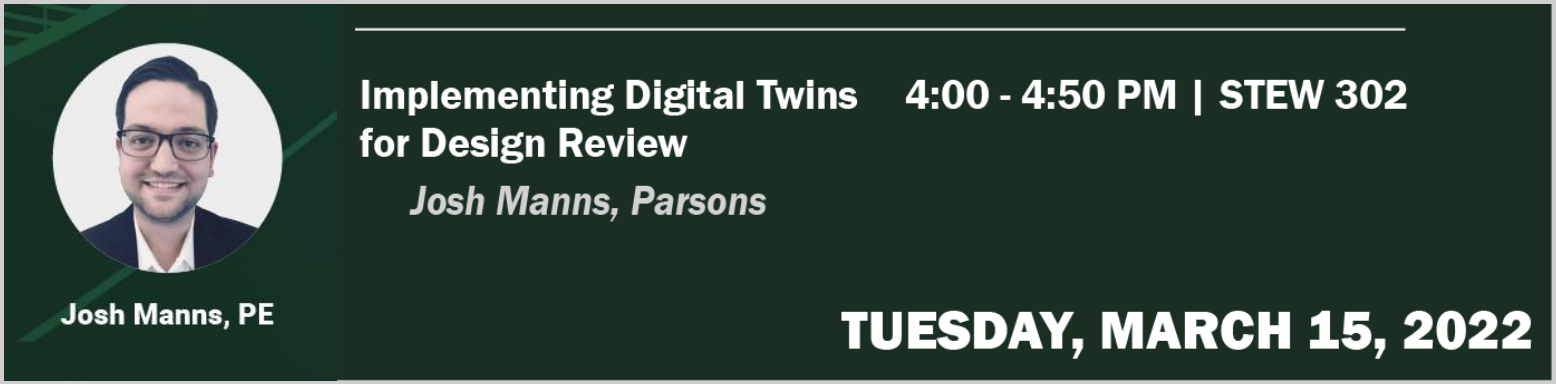
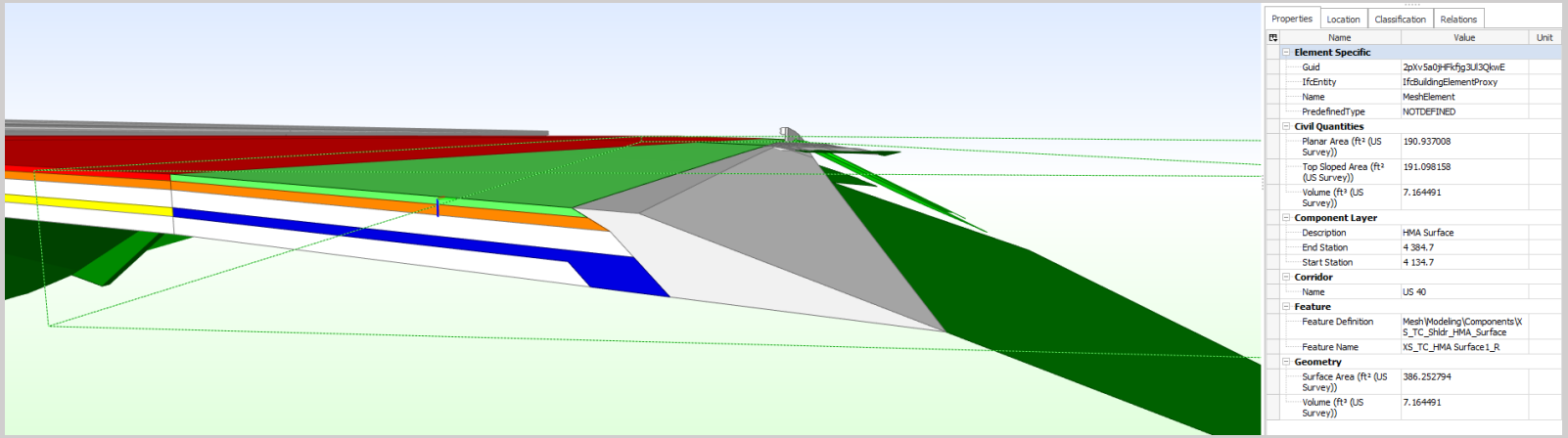
Scott Lecher, HNTB – slecher@hntb.com

Digital Twins and IFC

Digital Twins Road School Session:



IFC Review Example:



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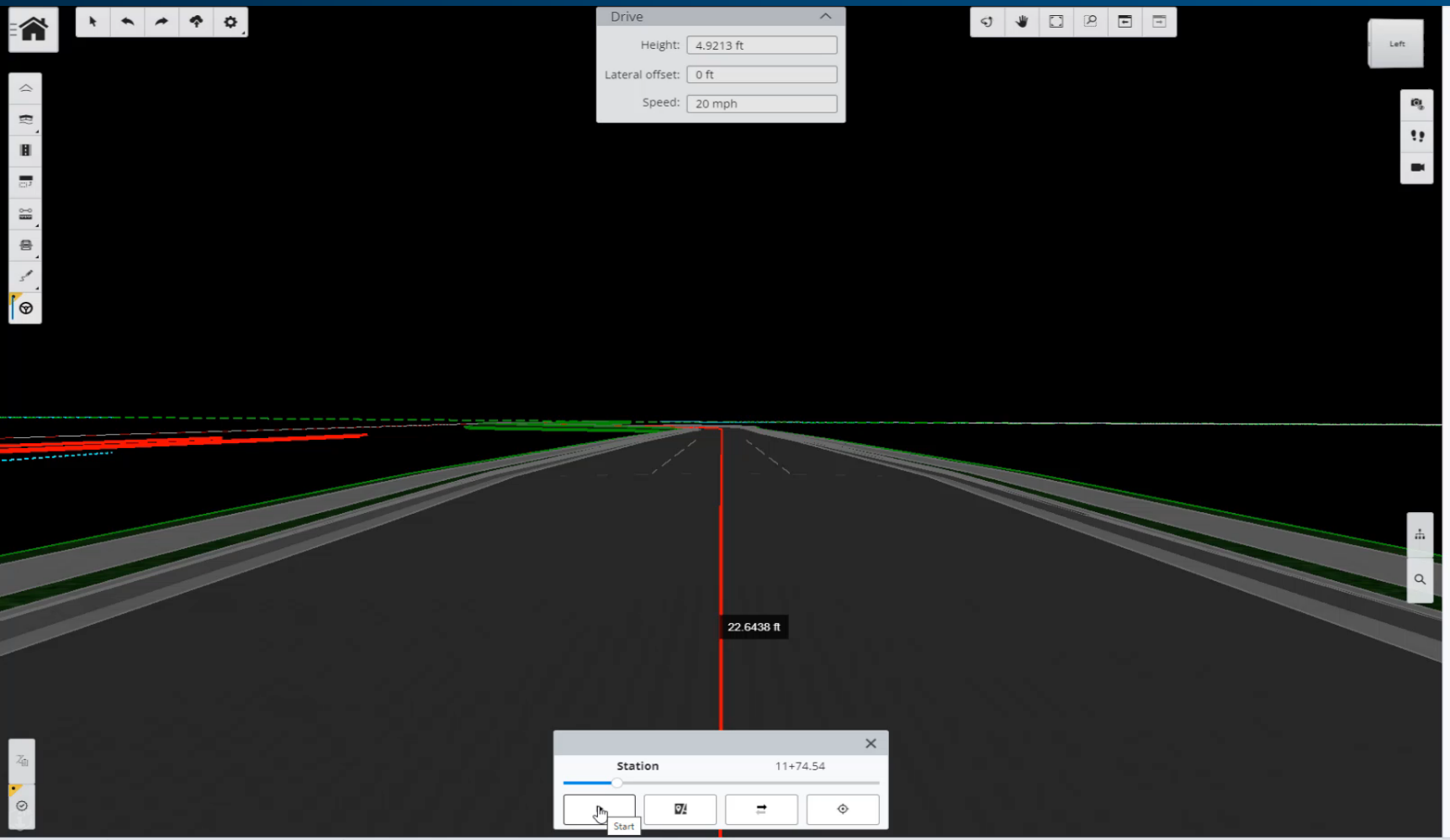
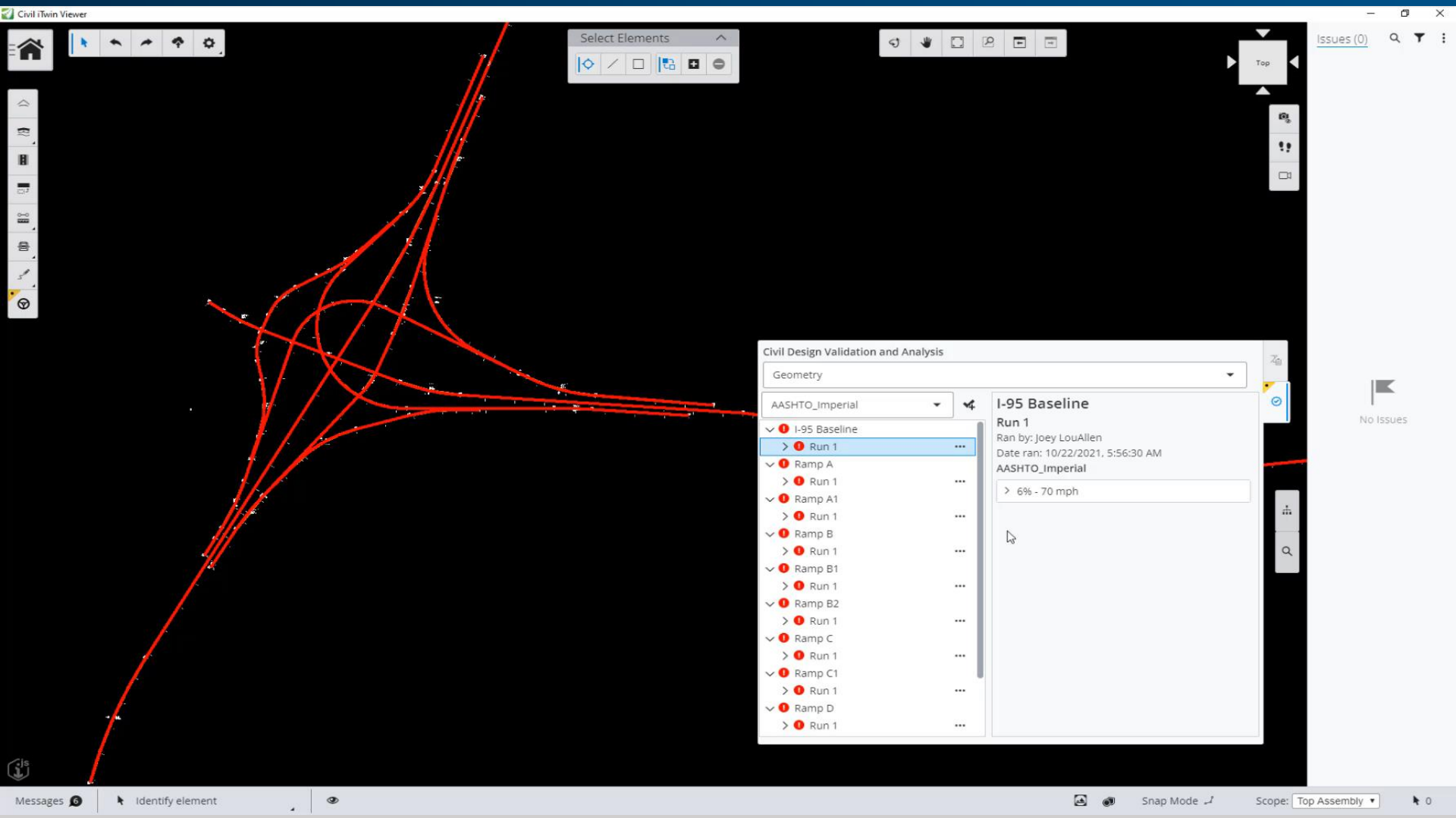
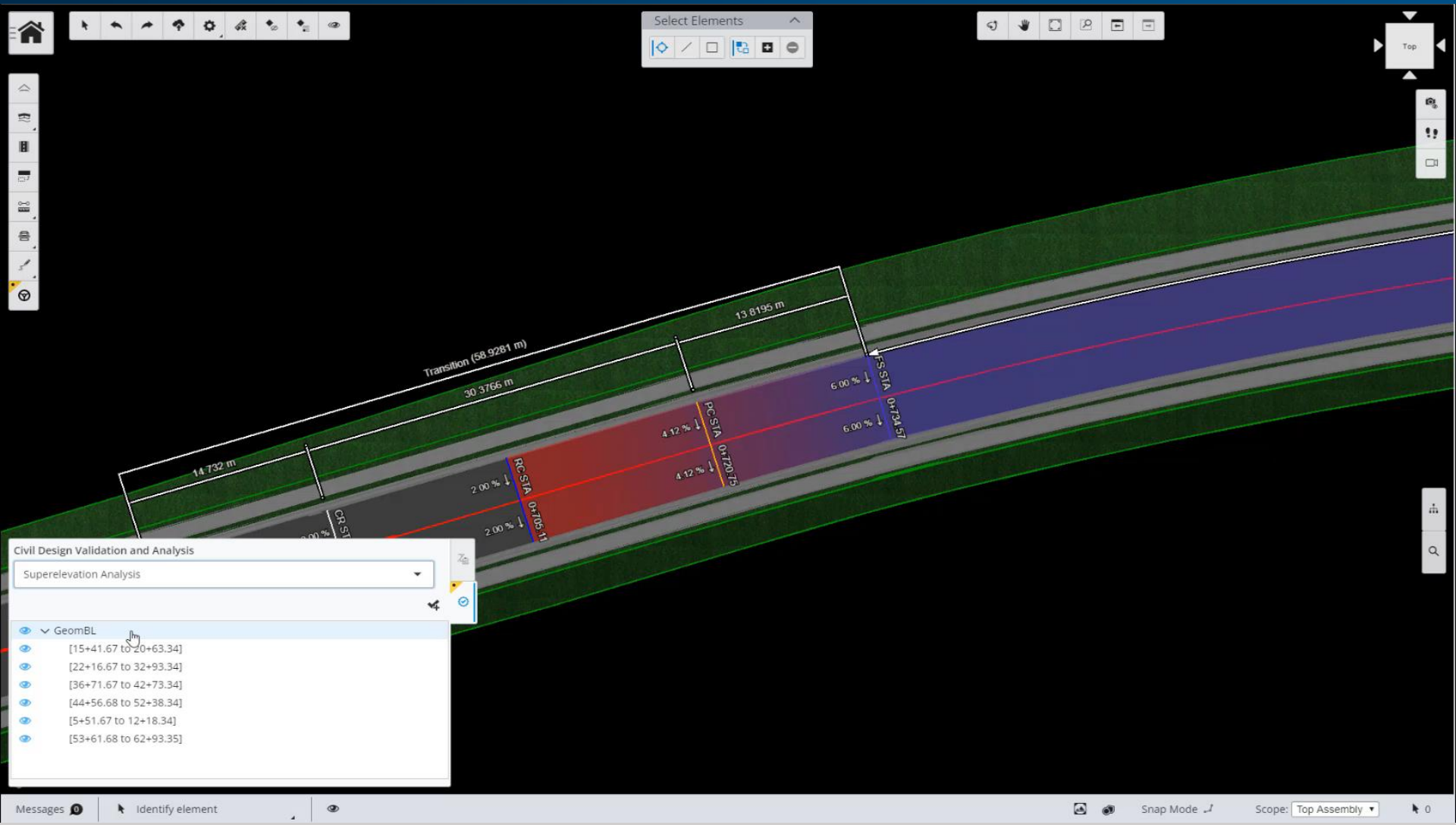
Video - Drive



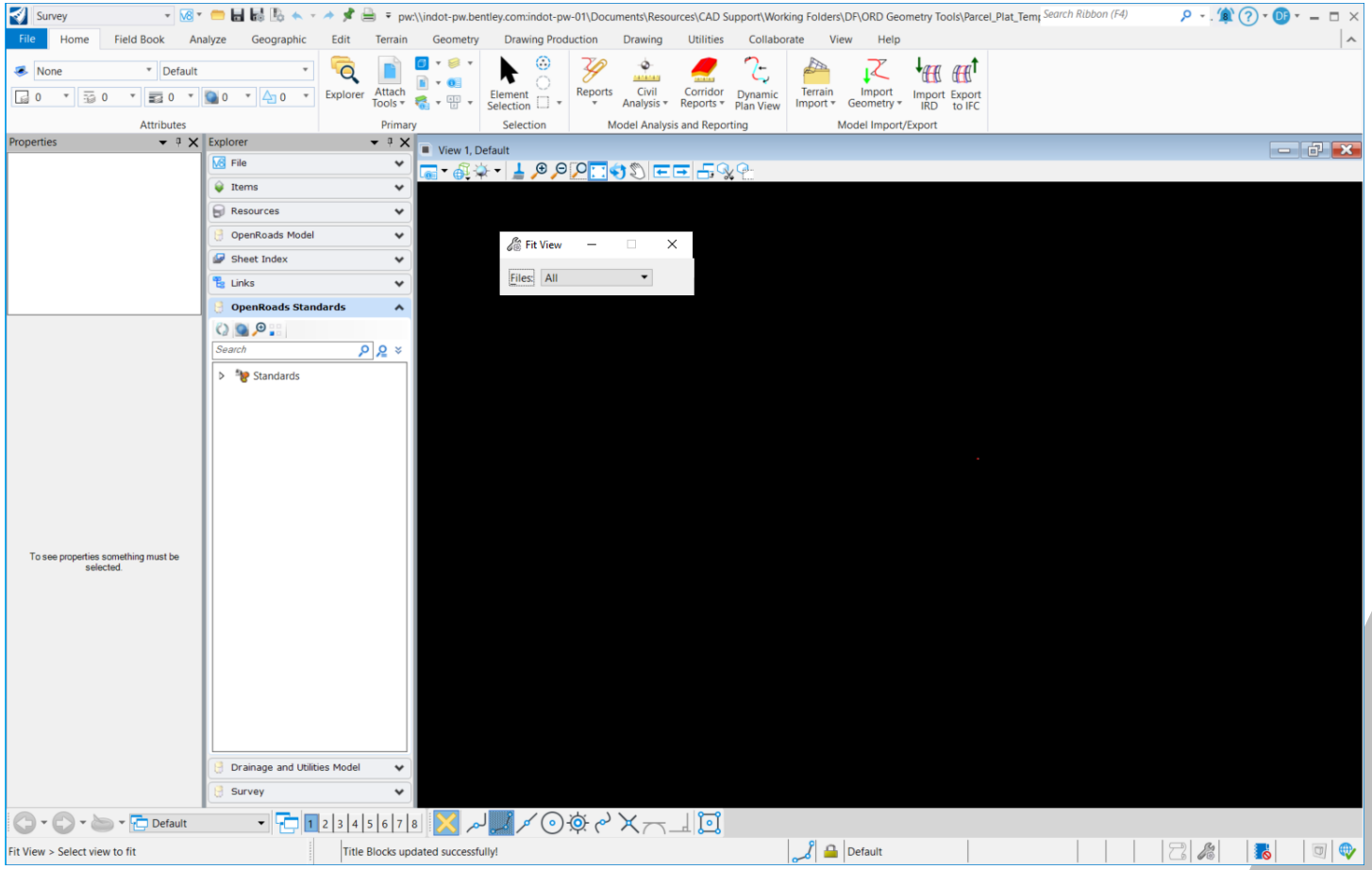
Video - Geometry Validation



Video – Superelevation Analysis



ORD Tool Layout



ORD Tool Layout

- Upper Left Pulldown contains Workflows
  - Survey Workflow contains Geometry tools
  - Reality Modeling Workflow for UAS imagery, LiDAR Data, etc.
  - Drawing Workflow for typical MicroStation tools (Place Line, Copy, Move, etc.)
- Search Ribbon
  - Located near the upper right
  - Helpful when trying to find a particular tool

Exporting to GIS

- Add exported shapefiles to GIS