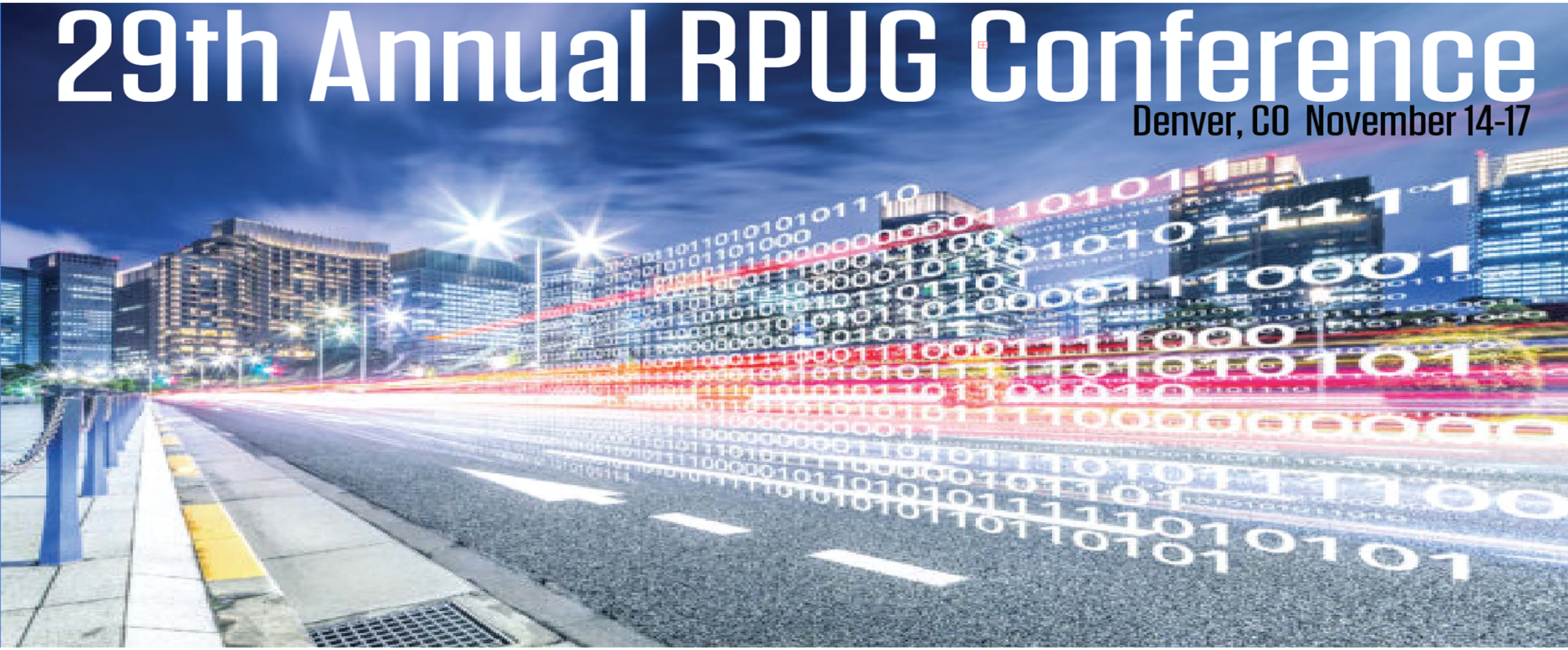


No Fogline, No Problem

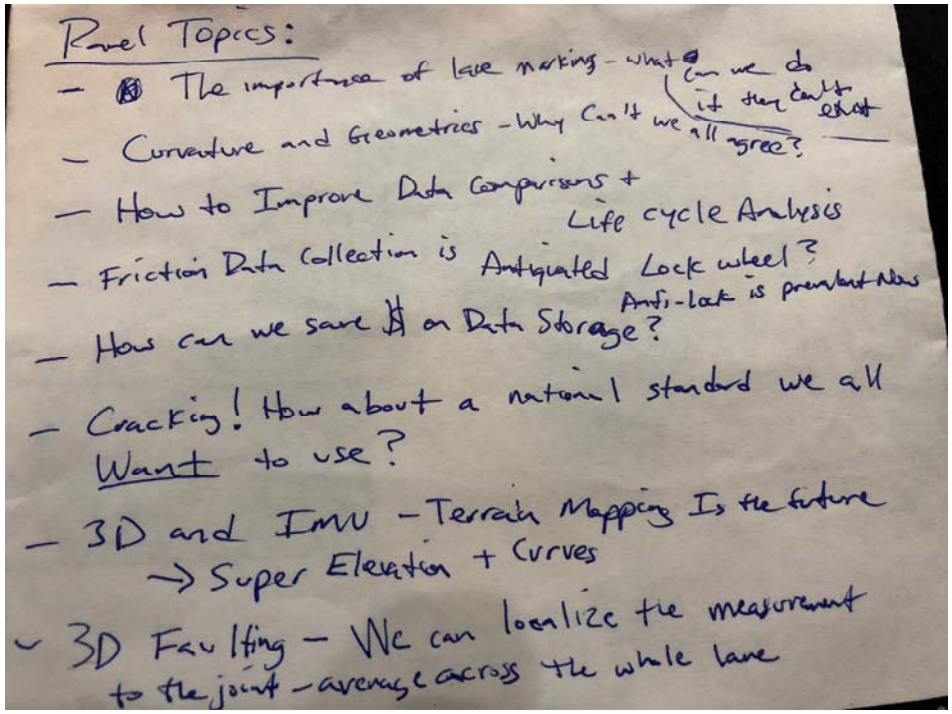
Scott Mathison
VP Operations, Pathway Services Inc.

RPUG
Road Profile Users' Group

Preface

- I don’t like speaking in front of groups
- I love RPUG (best week of the year for me and my fellow data nerds)
- Biggest Soapbox: Vendors should be the last people to present at events like this…and we should challenge ourselves to ADD TO THE TECHNICAL DISCUSSION and not give a sales pitch no one wants to hear
- Data presentations can be “sexy”

Wings Napkin



Potential Panel Topics:

1. The importance of lane markings—what can we do if they don't exist?
2. Curvature and Geometrics—Why can't we all agree? States may not know they don't agree with each other.
3. How to improve data comparisons and life cycle analysis (as an industry)
4. Friction Data Collection is Sooooo Antiquated. Lock wheel? Most cars have ABS
5. How can we save $ on data storage? Pavement/Assets groups pay DOT IT overhead costs
6. Cracking! How can we create a national standard DOTs WANT to use?
7. 3D and IMU- Terrain Mapping is the future. Super Elevation/ Curves
8. 3D Faulting-We can localize the measurement to the joint, averaging across the entire lane

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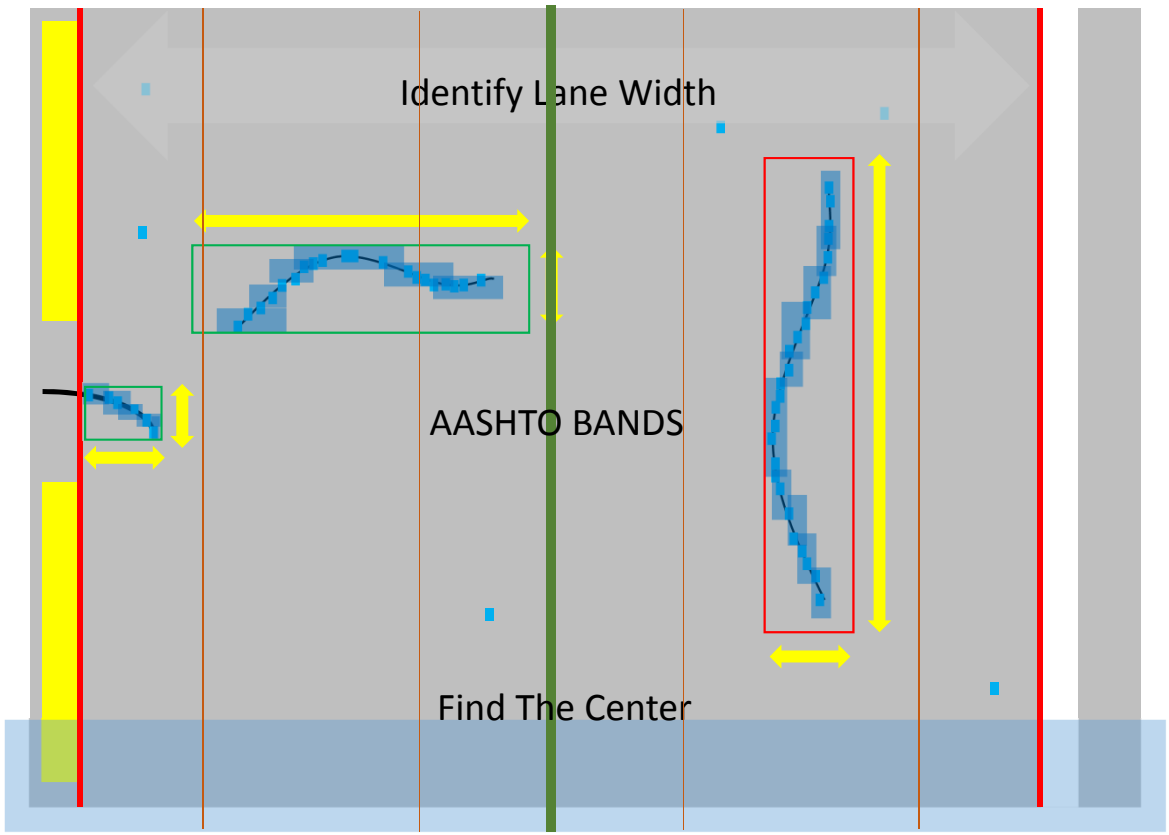
1. What Do We Do With Pavement Markings?

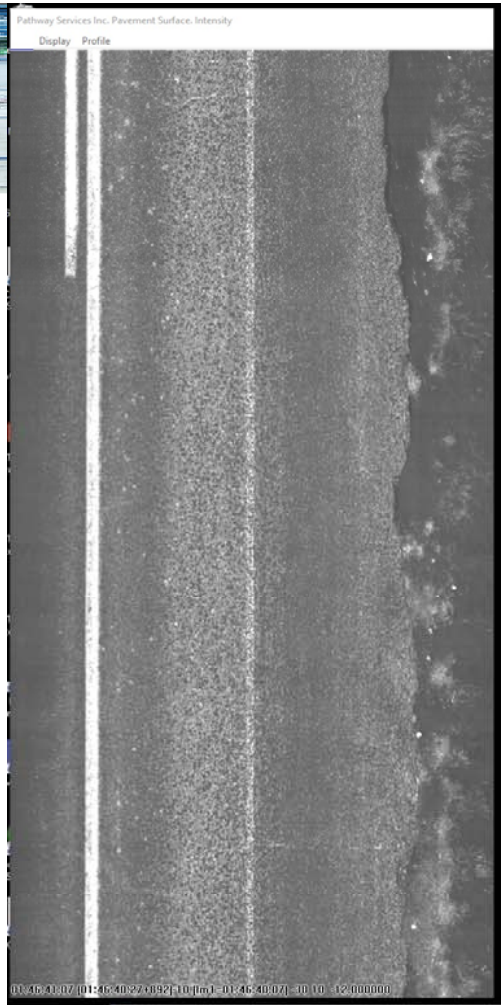
- Detect Them. How wide, long, thickness, material quantification, passing zones, rumble strips/stripes, etc.
- Use them to define the AASHTO Bands (Cracking, Zones)
- Sight Distance Comparisons (Dashed line vs. Vertical Curvature)
- Rutting calculations (localized to the lane)
- Pinpointing lane-to-edge dropoff locations
- In 3D, account for vehicle wander on IRI
- Better pinpoint the location of construction joints

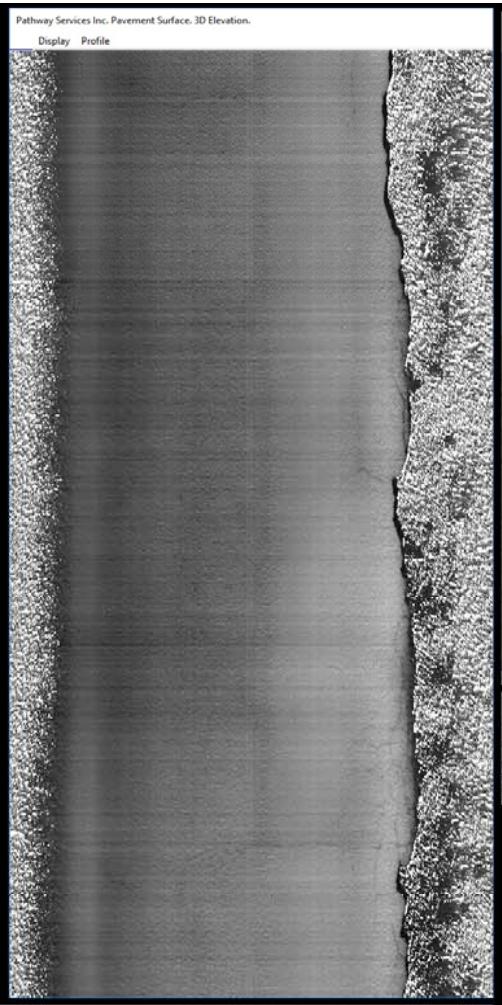
1. What Do We Do With Pavement Markings?



What Do We Do When There Are No Pavement Markings?

- ”Nearest Neighbor” Approach
- Assumed values based on road surface image dimensions (not ideal)
- Extreme Cases require manual Intervention


Pathway Services Inc. Pavement Surface. Intensity
Display Profile


Pathway Services Inc. Pavement Surface. 3D Elevation.
Display Profile


Pathway Services Inc. Digital Images
Image Help


Image / Location Data
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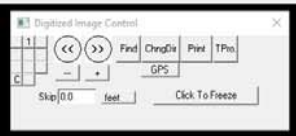
Set 378
61.8 m/h
Dist 3024.5 ft
16.413 mi
5+11.381
Lat +35.6339902
Lon-100.3591766
Heading 269.9° Grade-0.8% CS+1.3°
Date 01/23/2017 Time 12:01
Road FM1268 K


Digitized Image Control
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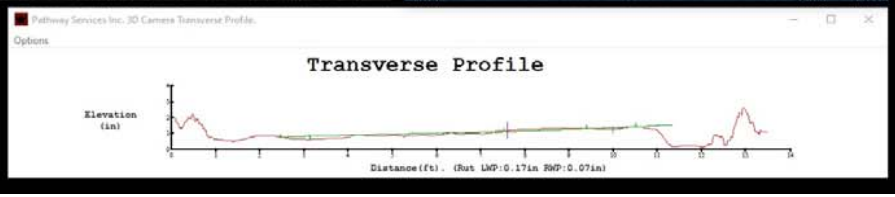
ChngDir
Print
TPro
GPS
Skip 0.0
feet
Click To Freeze


Pathway Services Inc. 3D Camera Transverse Profile.
Options
Transverse Profile
Elevation (in)
Distance(ft). (Rut LWP:0.17in RWP:0.07in)

Extreme Examples Study (About 1000 Miles)

- 30% Difference in Automated Rutting data
- Wrong wheel path locations caused crack type and severity classifications
- Cracks were often rezoned, which affected indexes that differentiate between Structural vs. Functional Indices
- Had to build automated tools to mitigate the amount of manual labor (detection of extreme examples)
- Do states know this? Do hardware owners account for this?

2. Curvature/Geometrics (it's more complex than it sounds)

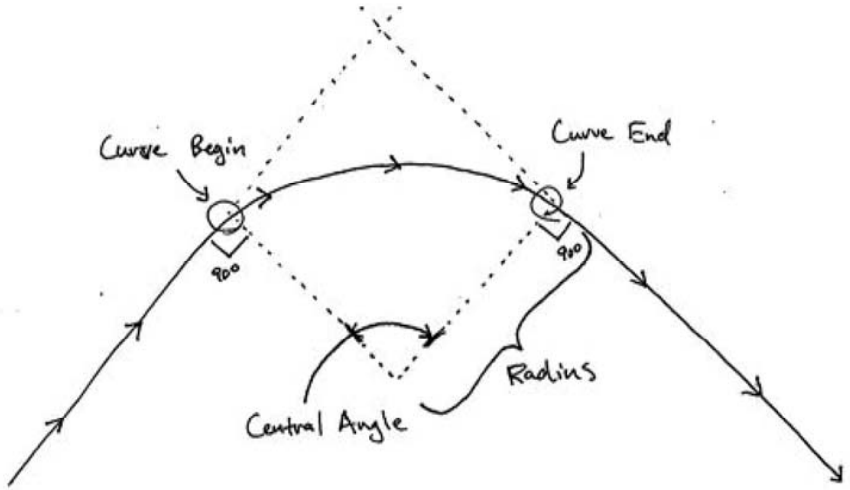
- Grade, Cross Slope, Horizontal/Vertical Curve data is collected as part of many (most) network-level collections
- Many groups within the DOT want/benefit from quality geometric data (Design, Safety, Pavement, Bridge, etc.)
- Virtually every DOT has an idea of how they want this data reported. HPMS field manual even has it own reporting paradigm (Curves A-F, Grade A-F)
- Even Basic Calculations for Curvature are interpreted differently from state to state

Terms That Mean Different Things To Different People

- Point of Curvature (Where a tangent changes to curve)
- Central Angle (total change in heading from the beginning of the curve to the end)
- Degree of Curvature (how quickly the curve is turning)
- How small a curve needs to be in order to be considered a “curve” (determines aggregation 1 vs 2 curves)
- Length of Curve, Radius, K Value, etc. are dependent on the interpretation of the above terms

Horizontal Curvature

When calculating horizontal curvature, you need to know a few terms. The following illustration may help:

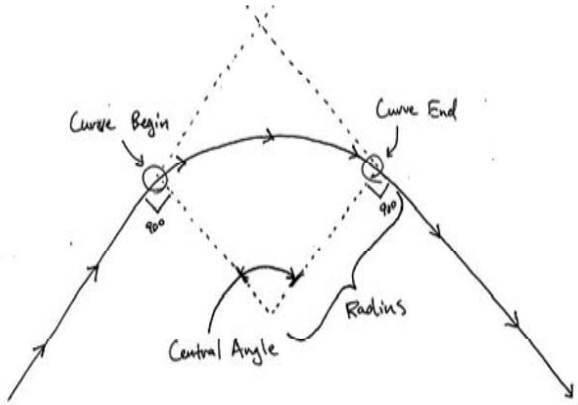


It's helpful to think of a curve in a road as an arc, or a segment on a circle.

- Central Angle: This could be thought of in two ways: (a) The angle between the curve's starting point and ending point, as measured from the center of the circle; or (b) the difference in heading at the beginning of the curve versus the heading at the end of the curve. Either way you define it, they are equivalent.
- Curve Length / Arc Length: The arc distance from the beginning of the curve to the end of the curve. *Not* a straight line, but the actual path taken on the curve.
- Radius: The distance from the center of the circle to the arc.
- Degree of Curvature: The rate of change in heading, measured in degrees per unit of distance (such as degrees per foot).

Central Angle Vs. Degree of Curvature

- The Central Angle tells us the total change in heading from the beginning of the curve to the end.
- The Degree of Curvature tells us how quickly the curve is turning.



For example, if you have a curve that starts going North (0 degree heading) and ends going East (90 degree heading), your Central Angle is 90 degrees.

If that 90 degree curve is 20 feet long, you have an extremely high Degree of Curvature because your heading is changing very quickly (4.5 degrees per foot).

If that 90 degree curve is 20 miles long, you have an extremely low Degree of Curvature because the heading is changing very slowly (0.00085 degrees per foot).

Why is this important?

- I am the proud owner of more than a dozen DOT-specific curvature calculation documents---none of them are the same in the definition/interpretation of these terms
- HPMS requirements include curve and grade and these "represent" our roads…but each state interprets even the HPMS field manual differently (samples vs. interval, degree of curvature vs. central angle, etc)
- I think we all would prefer to be on the same page on this

3. How To Improve Data Comparisons/Life Cycle Analysis

- State DOTs often struggle internally to match data collected at different times or by different people
- Multiple LRS are used by different departments
- Some LRS are referential and not distance-based
- LRS are constantly being updated and data had to be reconciled annually
- Roads can get realigned / new roads don’t always fit into existing systems

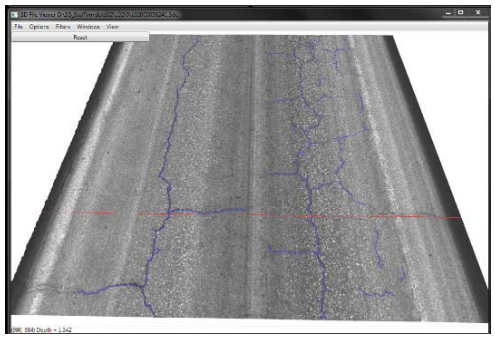
How To Improve Data Comparisons/Life Cycle Analysis

- In reporting/Analysis, we're not always comparing "Apples to Apples" in tabular (flat) data sets. Different Roads/locations, etc.
- Construction complicates multi-year comparisons
- Different LRS may get different results
- Concurrent routes can complicate integration
- GPS checks were typically only done at the beginning and at the end of a route—no shape checks in between
- QC process is quite lengthy to verify all discovered differences & anomalies

How To Improve Data Comparisons/Life Cycle Analysis

- Huge Advances in recent years of Precision/Data Density (LiDAR, 3D Road Surfaces Systems, etc.)
- Better integration of IMU and GPS subsystems to produce a rich, spatial data set

Automated Crack Detection



Advanced GPS/IMU Data

Asset Management Toolkit

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Advantages of Spatial-Based Data Reporting

- In data collection, only focus on getting 100% network coverage with no gaps/overlaps
- Data is not only tabular, but graphical
- Reporting is independent of Road name, mile points
- Location checks/joins at more than just the beginning and ending points (we use the whole polyline!)
- Drastically reduced QC effort
- Data joins / Accuracy down to 3-5 feet in many cases

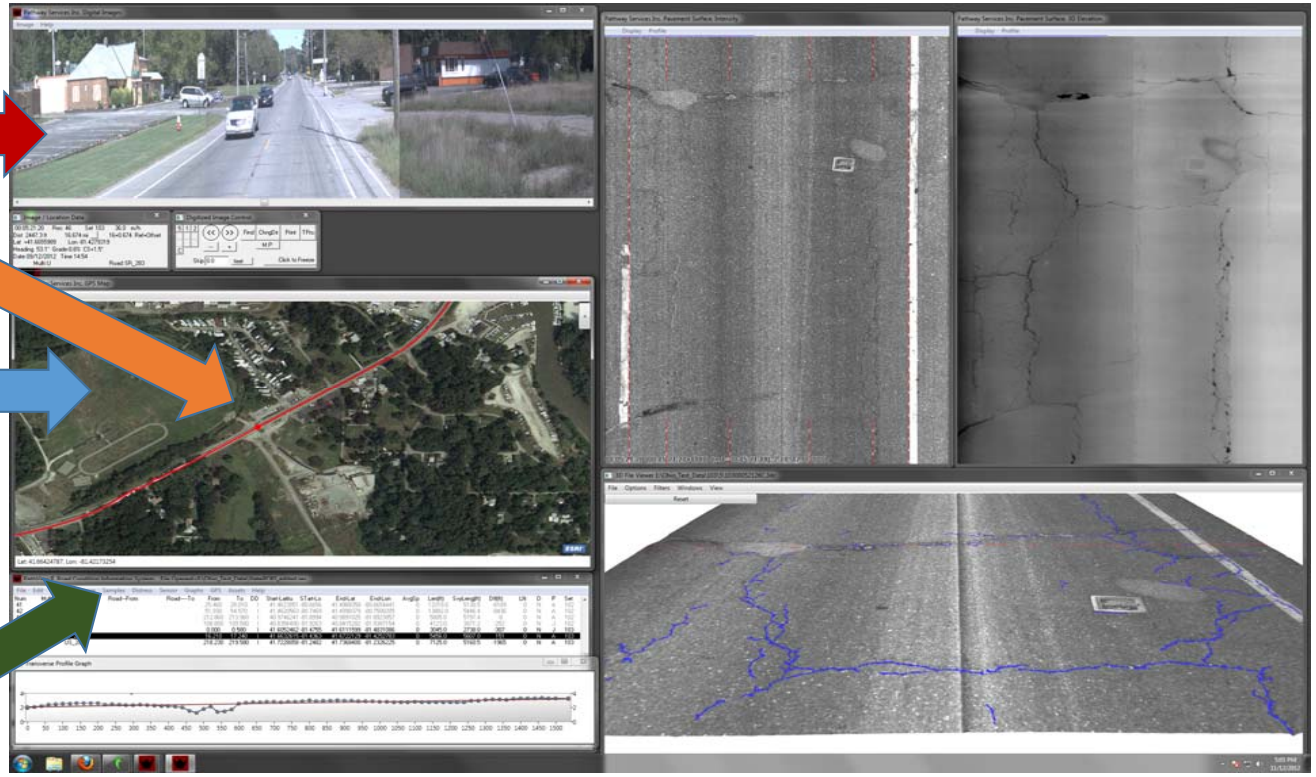
Advantages of Spatial-Based Data Reporting

Spatially-plotted data can be used as navigation to view imaging and extracted roadway assets such as signs, guardrails, ramps, etc.

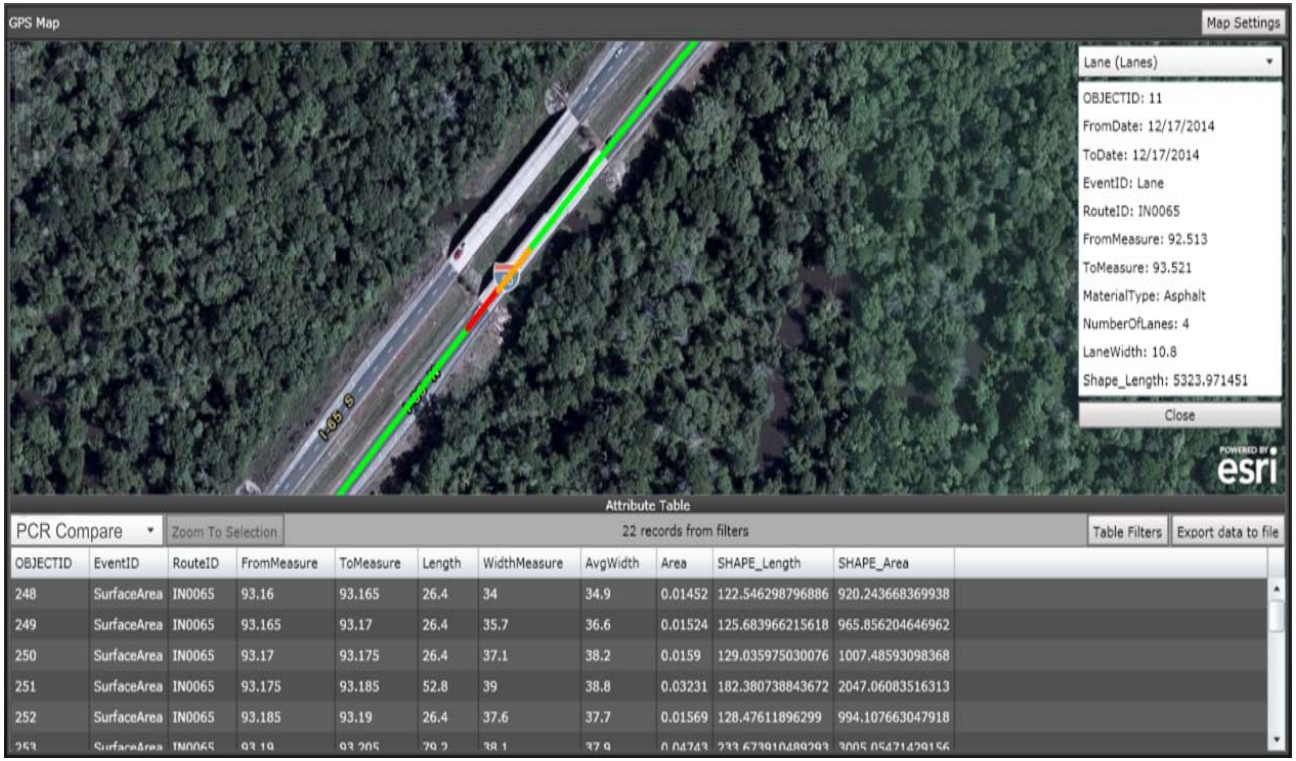
Data Falls on your network where it should, not dependent on matching route name/LRS

Line work can be color coded by index. Multiple years plotted simultaneously. Multiple LRS can be viewed as layers too!

Every Asset is stored in a spatial database for plotting and navigation. Including cracking!



Cracking Year-Over-Year



OBJECTID	EventID	RouteID	FromMeasure	ToMeasure	Length	WidthMeasure	AvgWidth	Area	SHAPE_Length	SHAPE_Area
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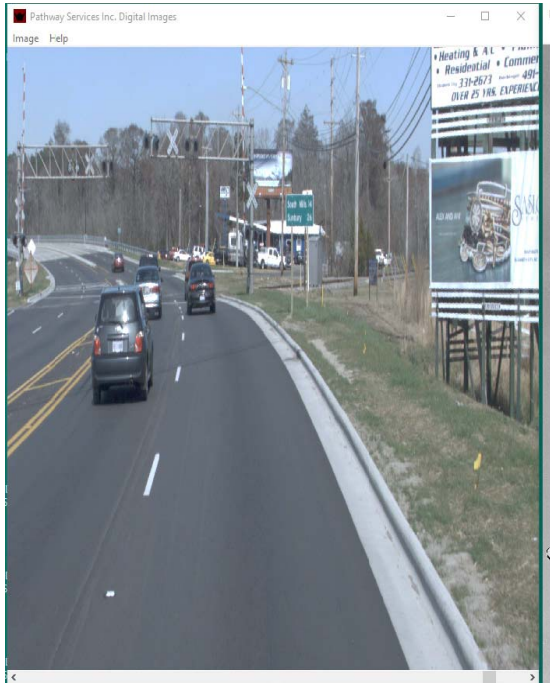
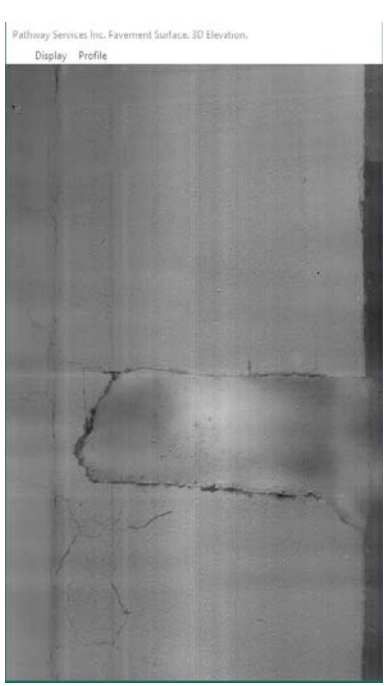
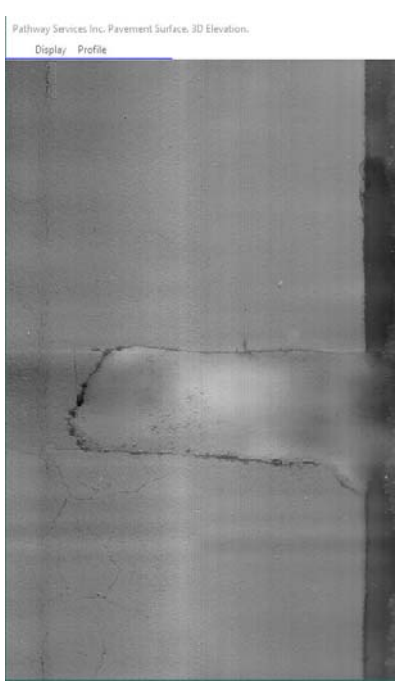
249	SurfaceArea	IN0065	93.165	93.17	26.4	35.7	36.6	0.01524	125.683966215618	965.856204646962
250	SurfaceArea	IN0065	93.17	93.175	26.4	37.1	38.2	0.0159	129.035975030076	1007.48593098368
251	SurfaceArea	IN0065	93.175	93.185	52.8	39	38.8	0.03231	182.380738843672	2047.06083516313
252	SurfaceArea	IN0065	93.185	93.19	26.4	37.6	37.7	0.01569	128.47611896299	994.107663047918
253	SurfaceArea	IN0065	93.19	93.205	79.2	38.1	37.9	0.04743	233.673910489293	3005.05471429156

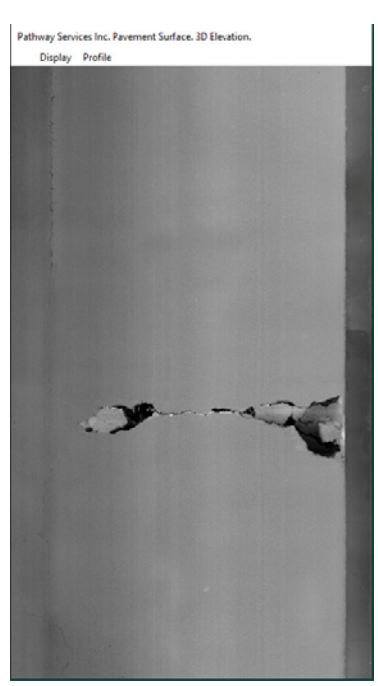
- We are comparing Apples to Apples—only what can be joined is compared.
- Data Layers are Graphical (YOY PCR shown)
- Differences can be color-coded

Cracking Year-Over-Year









Conclusions

- I don't have any. Just wanted to throw out some ideas/patterns that I've noticed relating to the current state of our industry
- We all have similar issues, concerns and tools to accomplish the same tasks. There may be some key areas where we (collectively) could/should work together to ensure we're all on the same page
- Panels at events like this, where subject matter experts are plentiful could be immensely productive to share ideas and discuss opportunities for technological/methodological improvements.

Questions?

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