Pennsylvania Asphalt Pavement Association

Pennsylvania Rides on Us.

2D or 3D Paving….What's the Difference Leveraging Lidar Technology for Real Results

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Sustainability

The typical departmental budget…

- Money matters – stretching the public's money as far as it can go.
- Average DOT Rehab and Resurfacing budget accounts for roughly 80% of the annual maintenance budget.
- This is for maintaining and resurfacing of existing roadways and structures.
- A smaller part of the budget allocated to new construction (widenings, turn lanes, expansion etc.)
- Sound investment of public funds is realized when durable and long-lasting pavements are built

Technology Improves Sustainability, Quality, and Safety

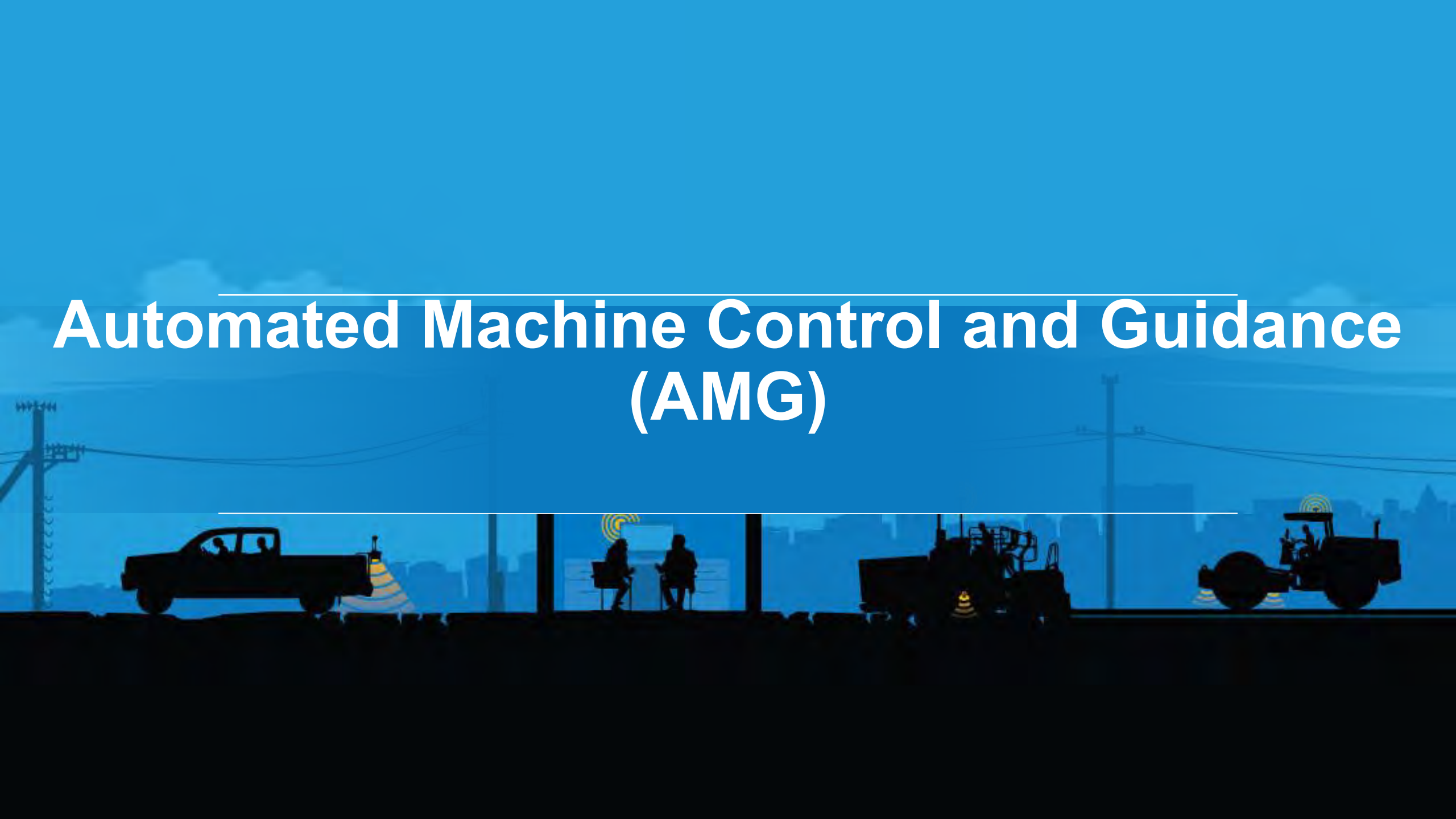
Sustainability and Durability

- Providing better workmanship in the field
  - 25% of roadway failures are generally caused by materials (Base, Surfaces)
  - 75% of failures are generally due to poor workmanship
- Generating real-time information in the field
  - Identify potential problems and future failure points that can be corrected before final inspection
  - Generate digital as-builts and progress and completion data for review during the project execution

Improving Worker Safety

- Exposure to dangerous conditions
- Reducing the time in precarious situations
- Work Zone visibility so the public knows what's ahead *(Distracted driving)*

Automated Machine Control and Guidance (AMG)



Roadway Construction – new and resurfacing

- Everything from a simple turn lane to a new mainline structure may require a multitude of technologies to produce good results
- A ground-up solution will be required, and specific tools will be used, from subgrade to finished surface
- Remove and Replace will be similar but may need a specific grading plan.

Basic Machine Control 2D

- 2D grade and slope control as been used for many years in the milling and paving environment
  - Initially beginning with ground contacting sensors and averaging beams that followed existing surfaces that could be reference to maintain a consistent cut or fill from that surface
  - later moving to sonic non-contacting sensors, and slope sensors,
  - 2D non-contacting grade and slope control has become a standard on most paving and milling projects

The Project

3D Machine Control (AMG)

- 3D machine control uses either a ground-based transmitter such as a survey transmitter, GPS, or a combination of both
  - 3D AMG provides a vertical, horizonal and slope information provided to a predefined design surface and compares the machine position to the design
  - 3D provides many advantages over 2D by
    - Knowing where on the project the machine is at any given moment
    - Having elevation and cross slope data at the current location

Control Options for Any Project Condition

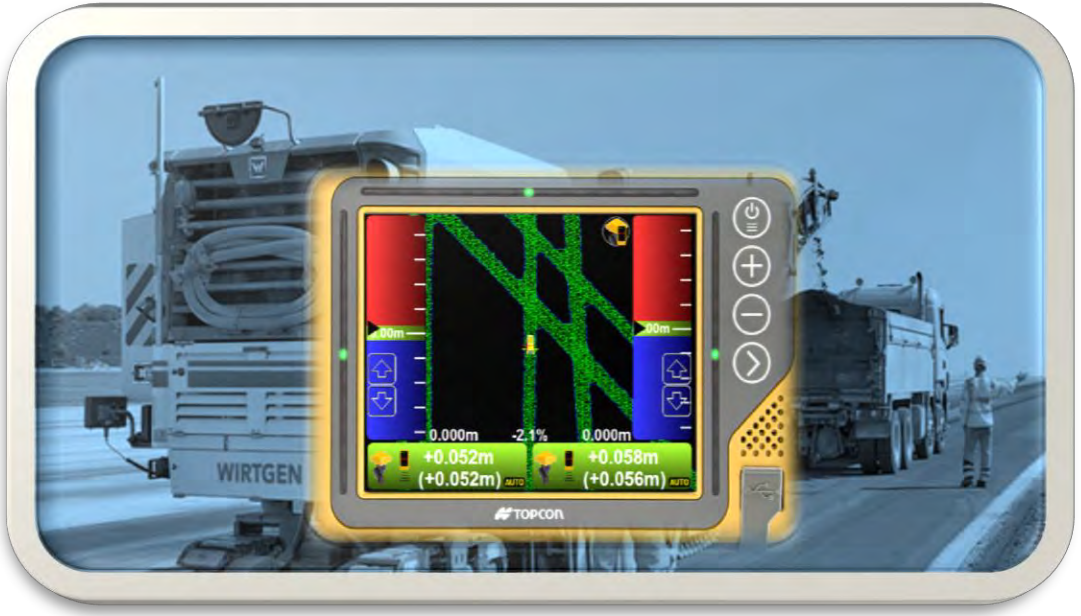
Robotic Total Stations

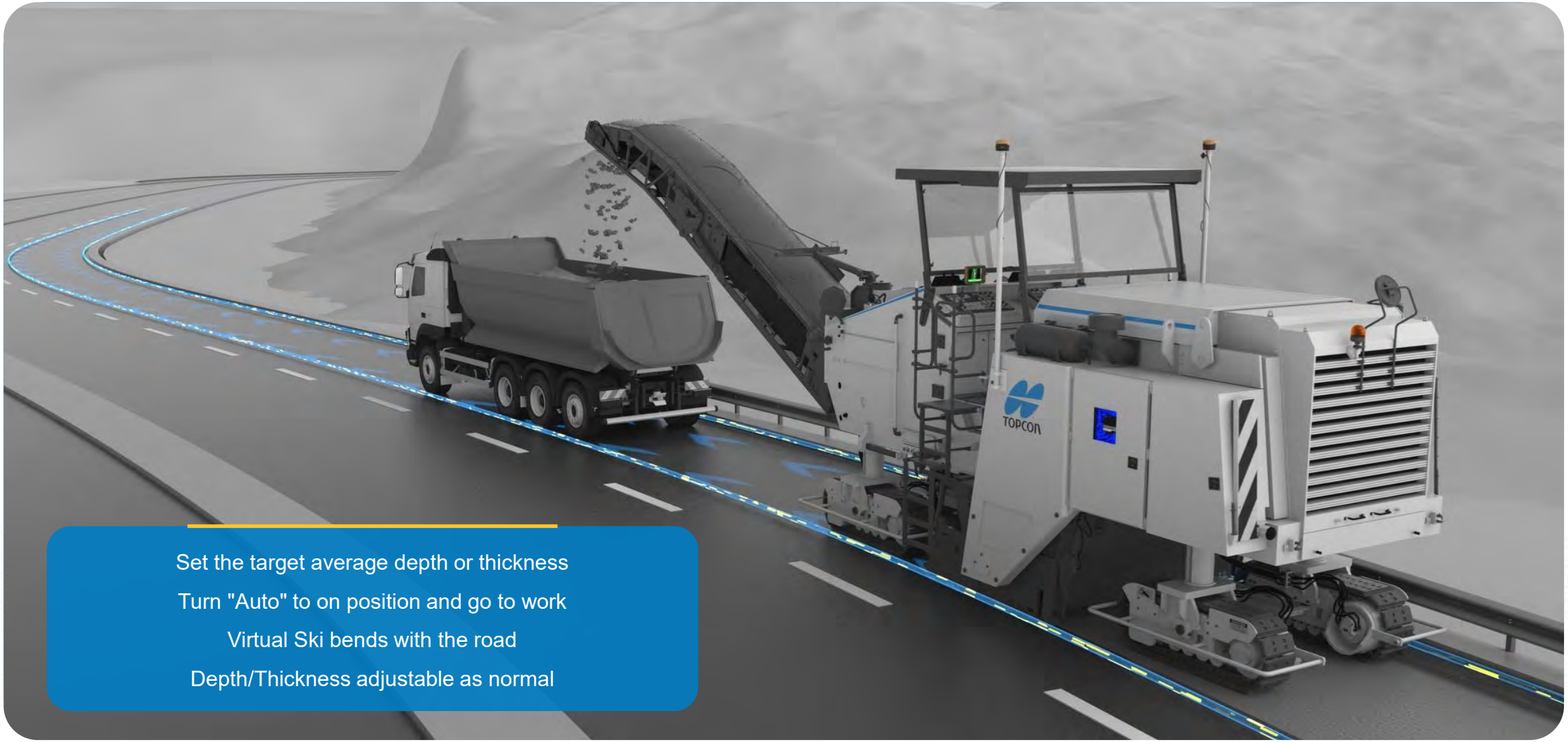
mmGPS

3D/2D Hybrid AMG solutions

Leading edge technological solution:

- A combination of both 3D and 2D can be used for 3D elevation and 3D cross slope.
- Using 2D or 3D for cross slope control, and 2D joint match
- 3D horizontal position and elevation with 2D slope control
- Using the benefits of accurate 2D sensors with a horizontal design position only





Set the target average depth or thickness

Turn "Auto" to on position and go to work

Virtual Ski bends with the road

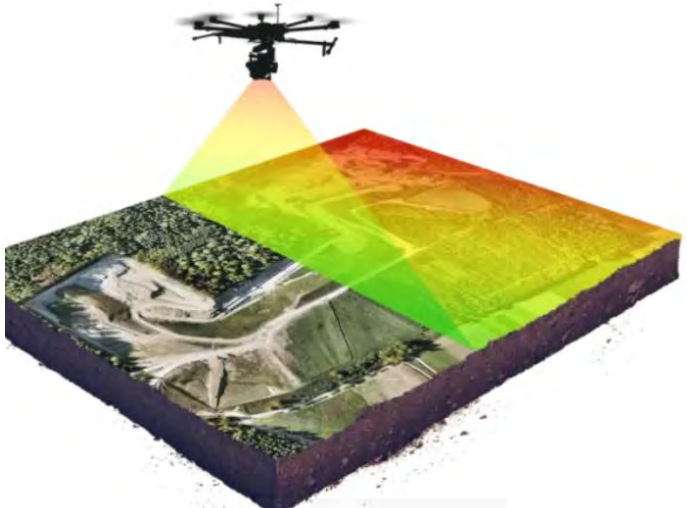
Depth/Thickness adjustable as normal

LiDAR and Scanning

LiDAR To Aid in the Construction Process

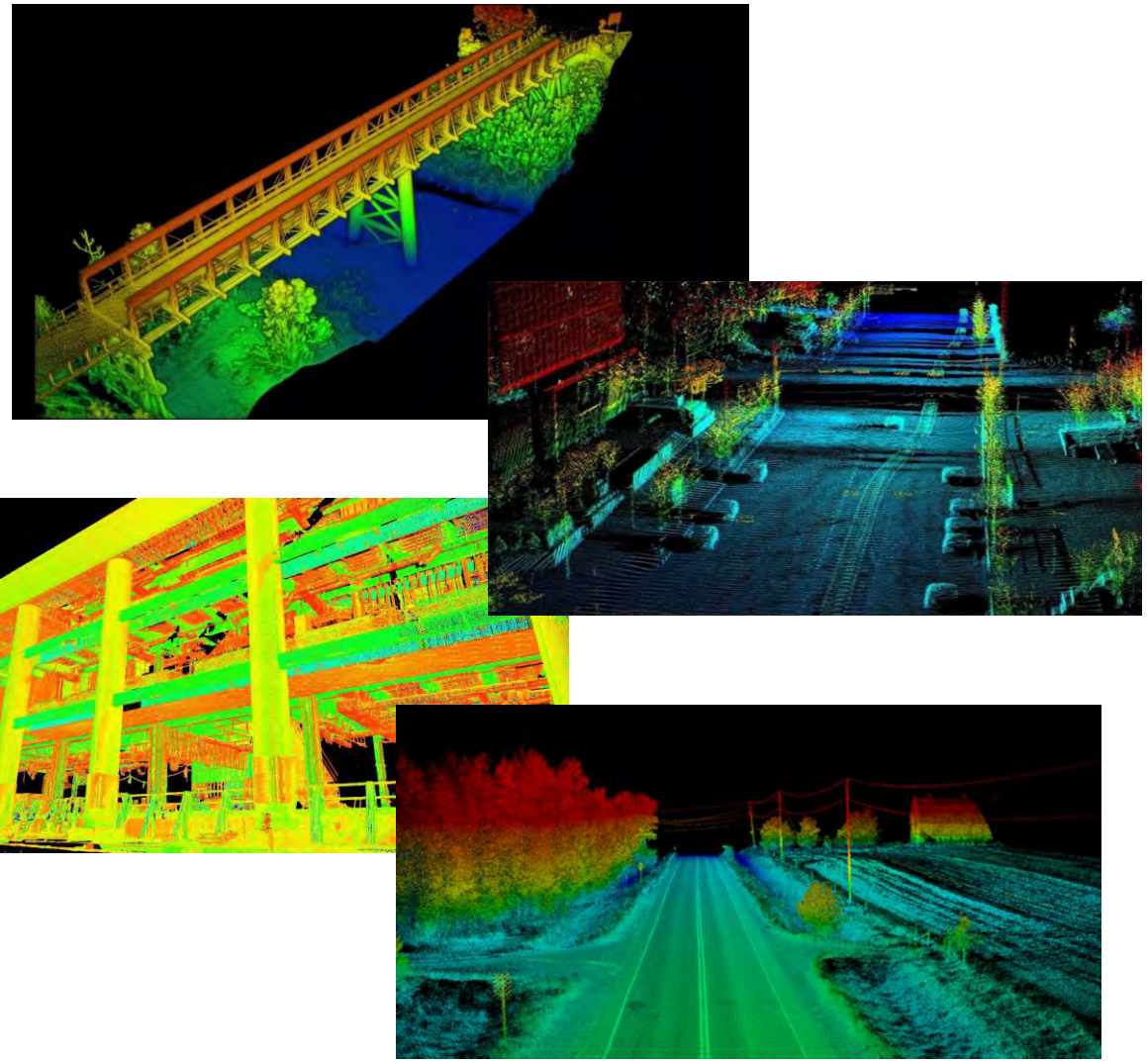
- Light Detection and Ranging

- Lidar is a powerful mapping method that uses light detection and ranging to collect construction assets like surface conditions accurately and cost-efficiently



LiDAR and Scanning

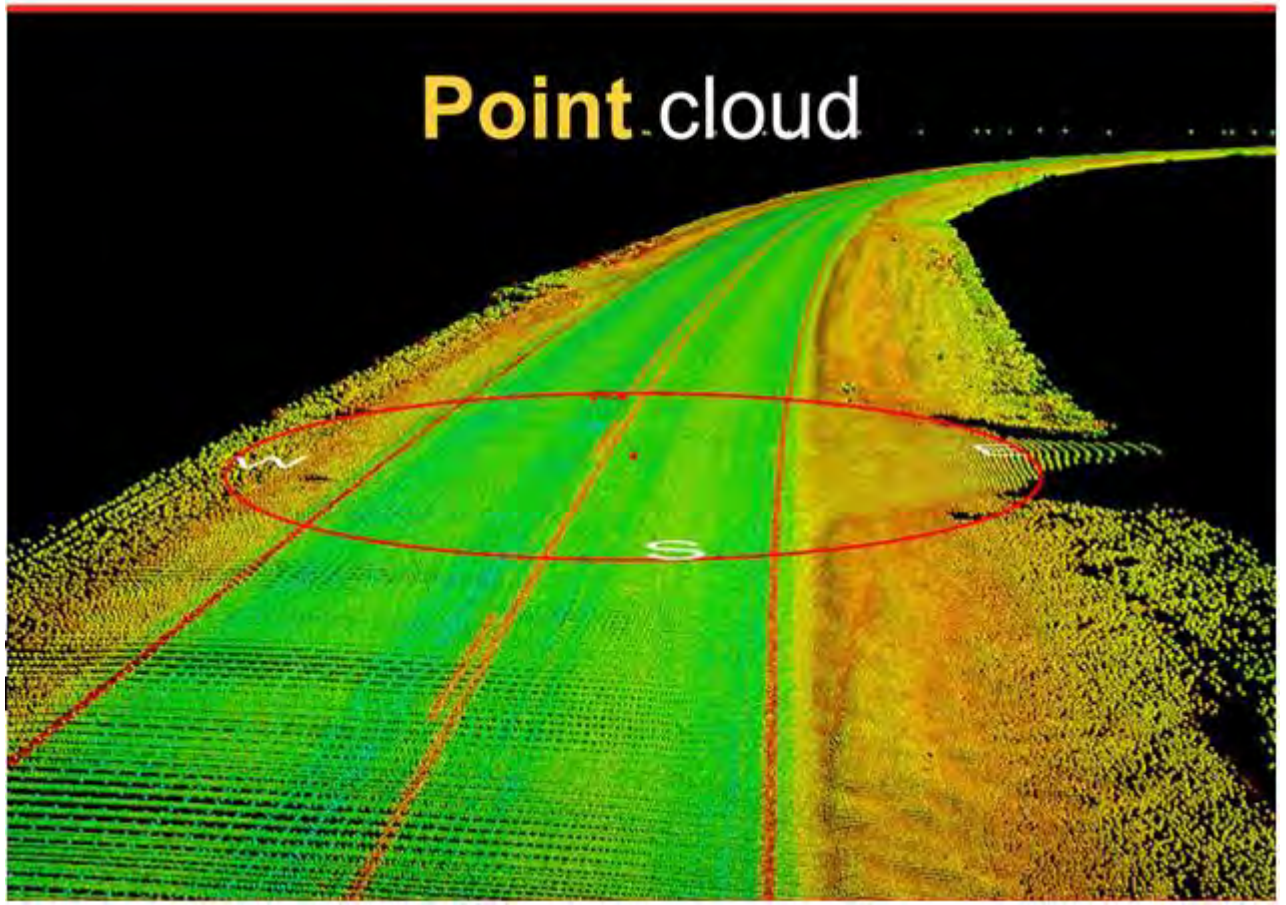
- Knowing the application allows you to choose the right tool for the job!
- Road construction may need different scanning tools than asset management or vertical construction.
- For example: A road assessment may not need the detail a bridge inspection may require.



"There are different types of Lidar scanners… we're focusing on roadway. Some of the most common utilized in roadway surface construction are: 360 deg or a 180 deg downward facing scanner (which is much more cost efficient).

LiDAR and Scanning

- LiDAR (Light Distance and Ranging)
- Surveying with LiDAR provides large amounts of 3D survey points and more detail than conventional survey methods.
- LiDAR can be vehicle, tripod, or drone mounted depending on the application.
- LiDAR data collection can be much faster and safer than traditional surveying methods; collecting more data in less time while keeping workers safe and out of harms way.



Paving Opportunities

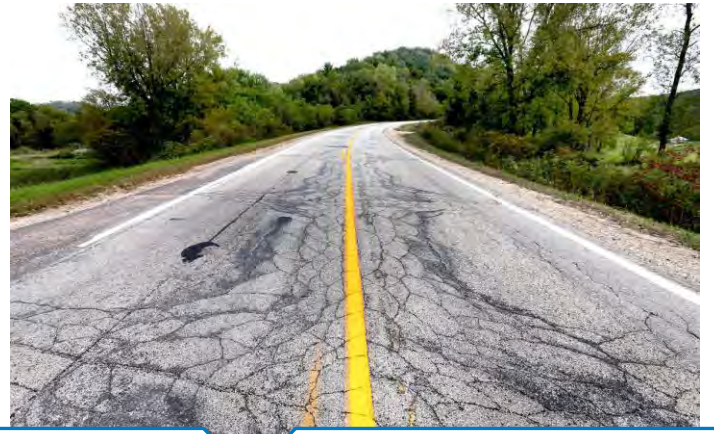
Project Dependent

Smoothness

Incentives and disincentives

Material Management

Quantity versus surface



Unknown Situation

Surface data and change orders

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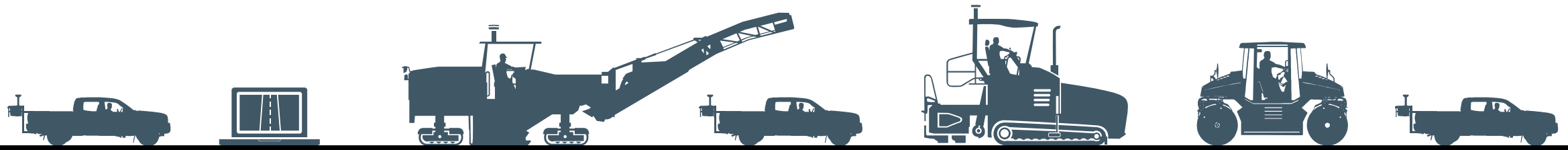
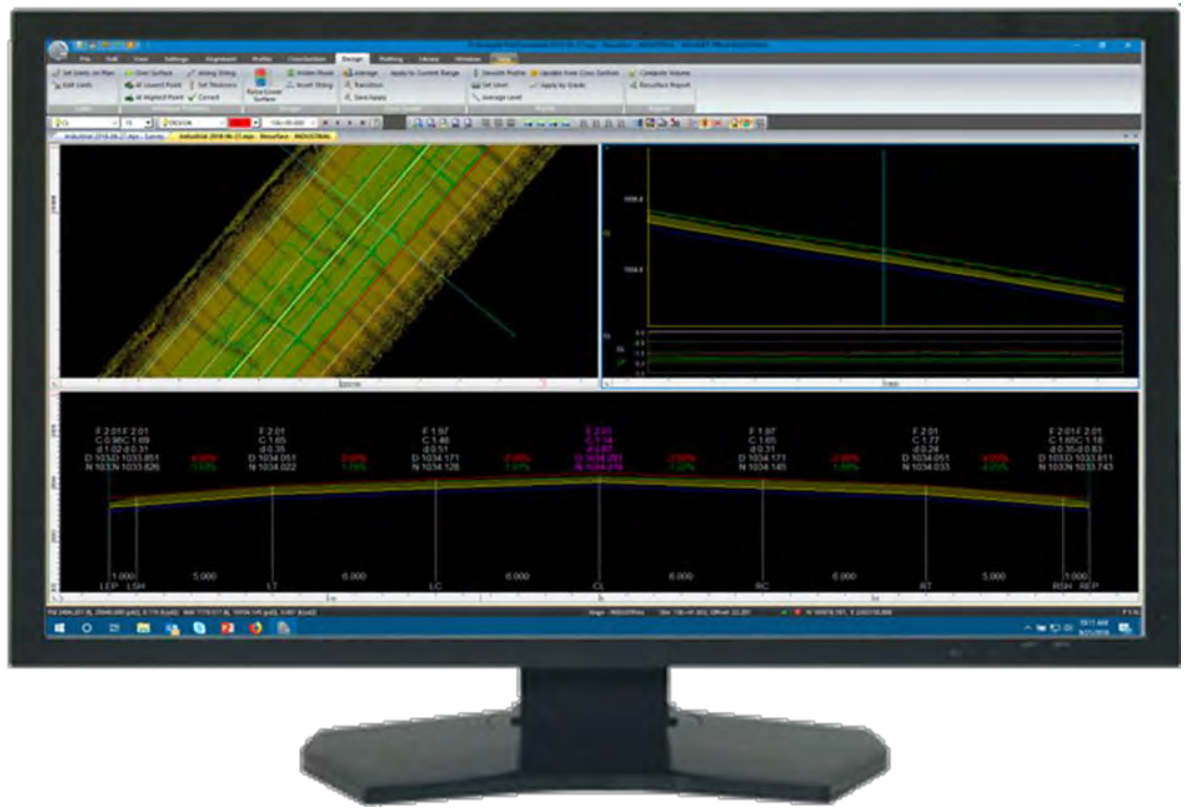
Time **Safety** **Quality** **Cost**



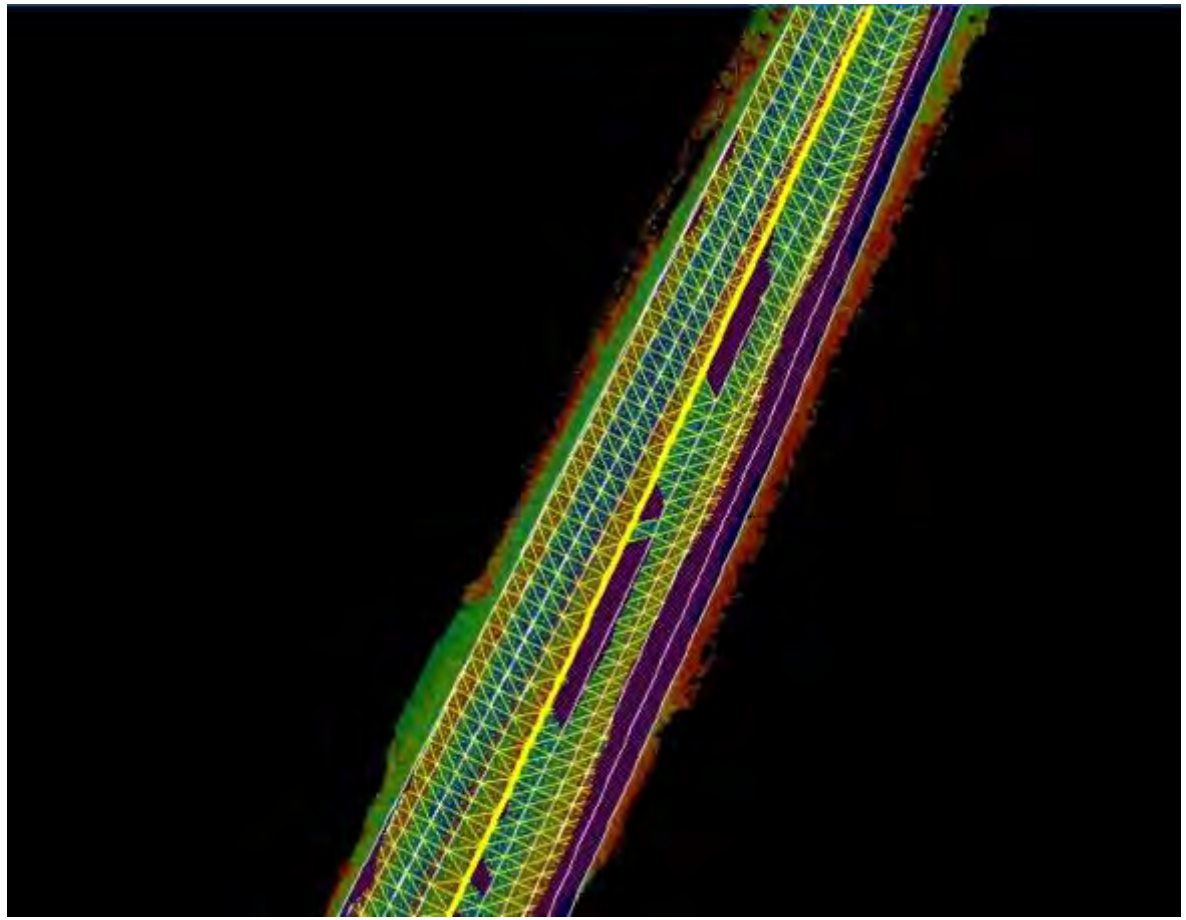
Surface Design

- Build a design to meet or exceed the project specifications
- Easy input of project parameters
- Variable depth MIN/MAX entry
- Smoothing Longitudinal wavelengths
- Cross slope correction
- Material management

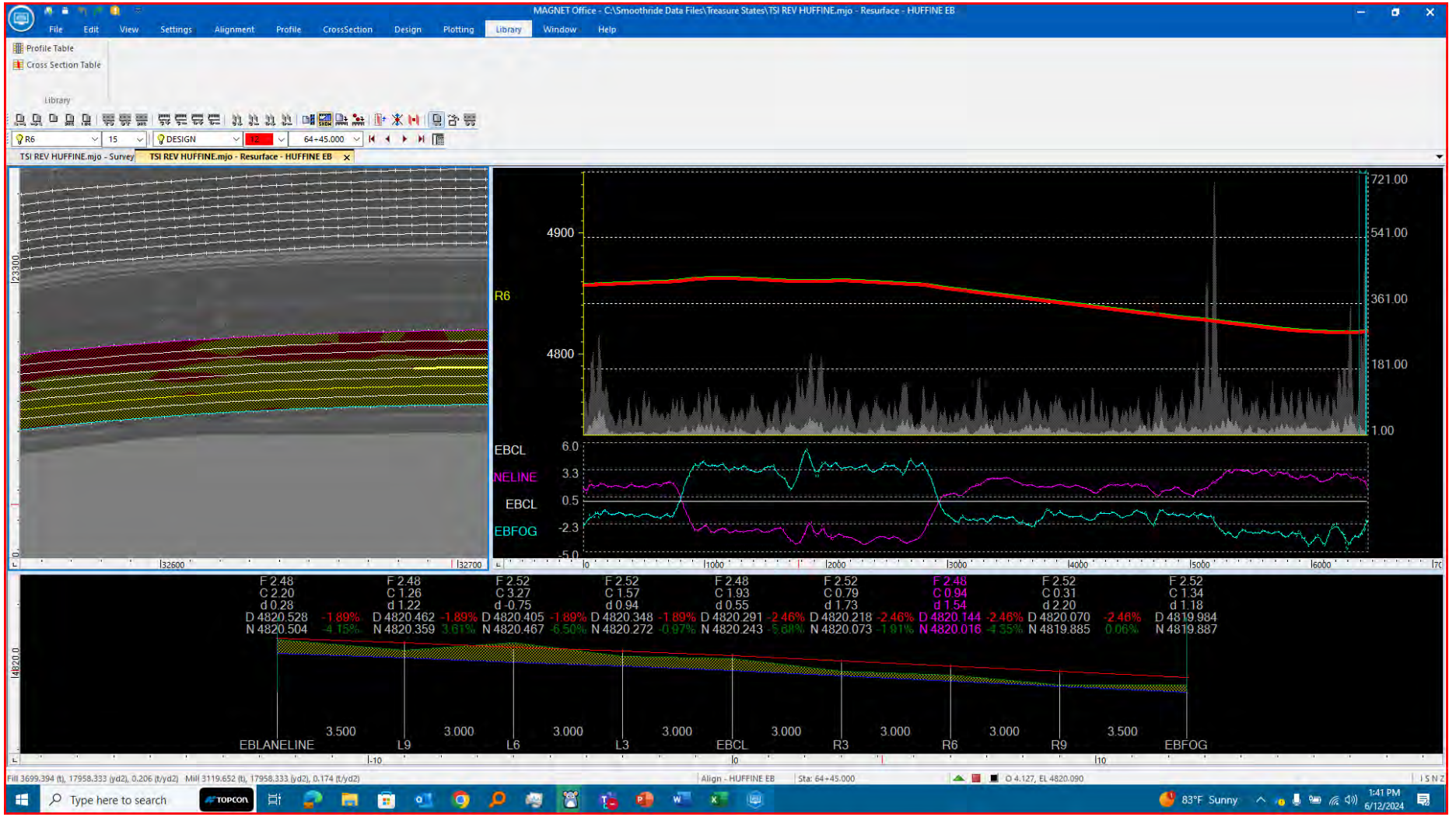


Scan & Design

- Visual indicators and representation of the existing road
- Identify where and why you can or cannot meet design criteria



Scan & Design


MAGNET Office - C:\Smoothride Data Files\Treasure States\TSI REV HUFFINE.mjo - Resurface - HUFFINE EB
File Edit View Settings Alignment Profile CrossSection Design Plotting Library Window Help
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R6
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EBCL
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EBFOG
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Type here to search
83°F Sunny
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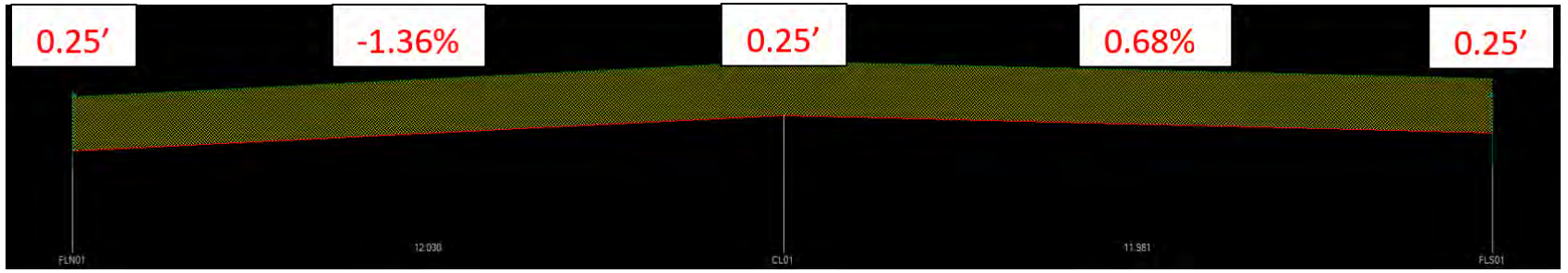
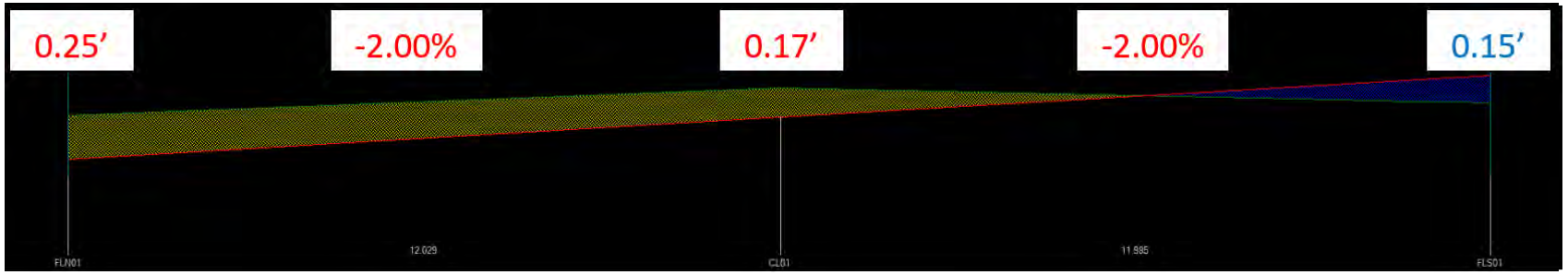
Design Examples

- Make significant smoothness improvements
- Design to specific grade requirements
- Meet elevation constraints
- Identify the need for leveling courses

Existing



Design



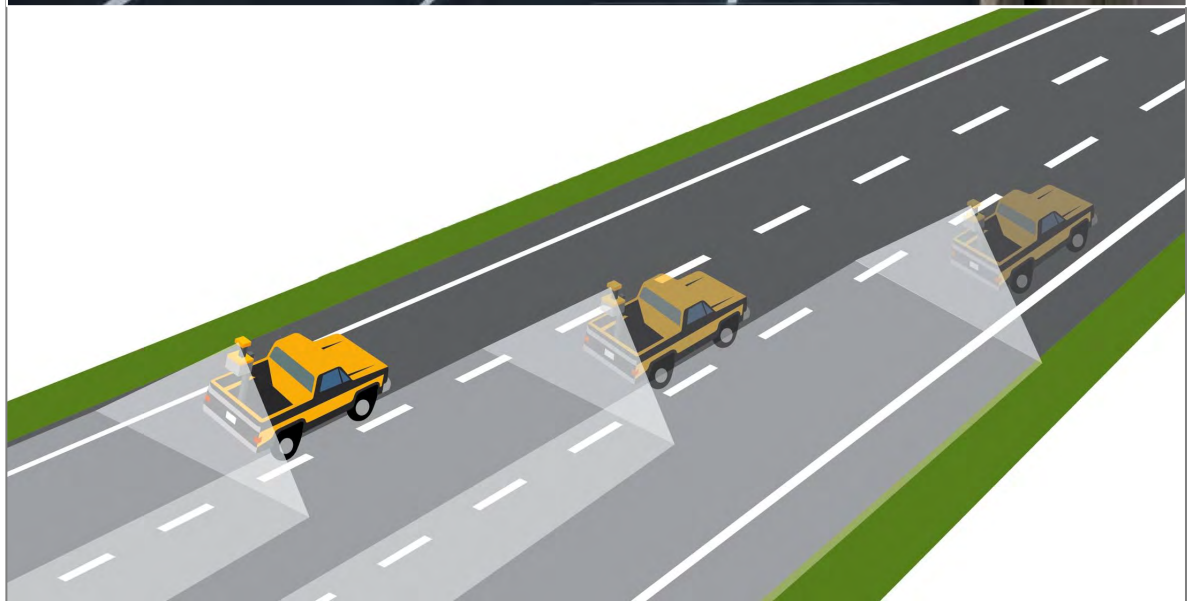

DANGER

Scanning the Milled Surface

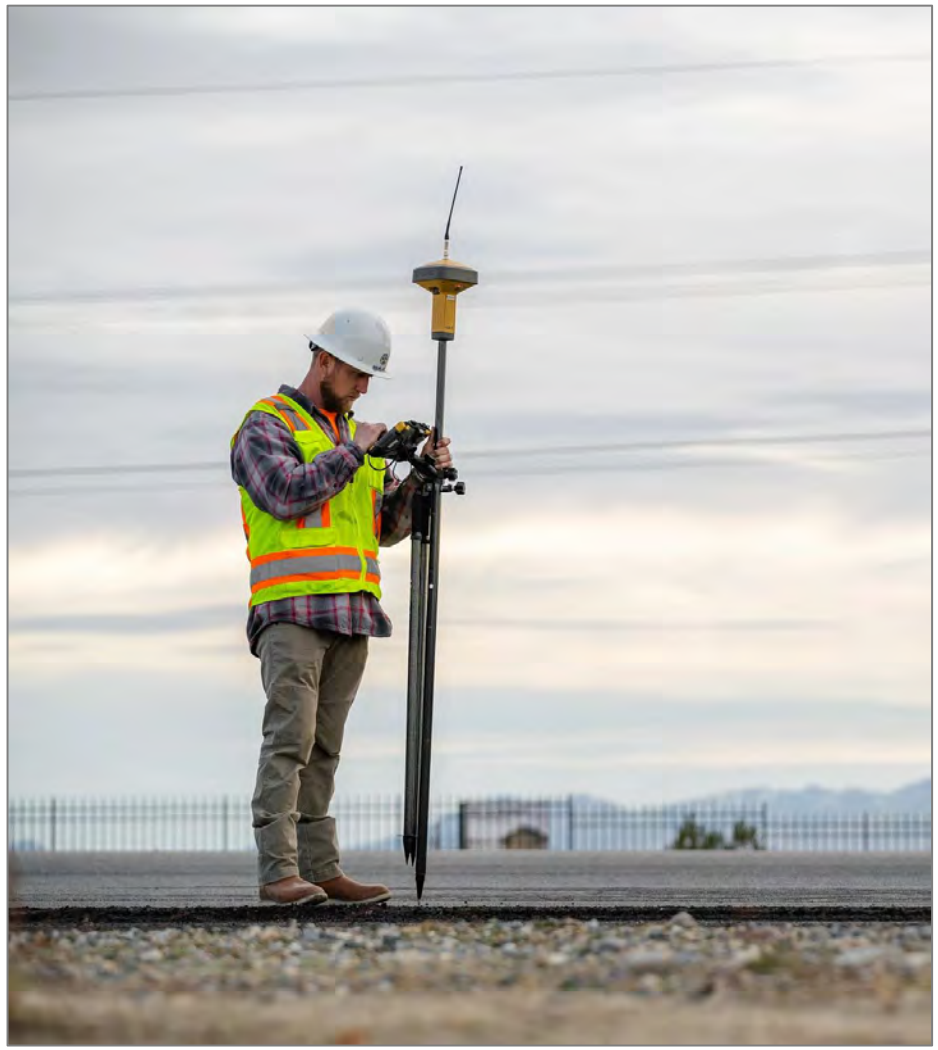
- Verify milled surface to design
- Confirm paving quantities before paving
- Make any corrections if needed

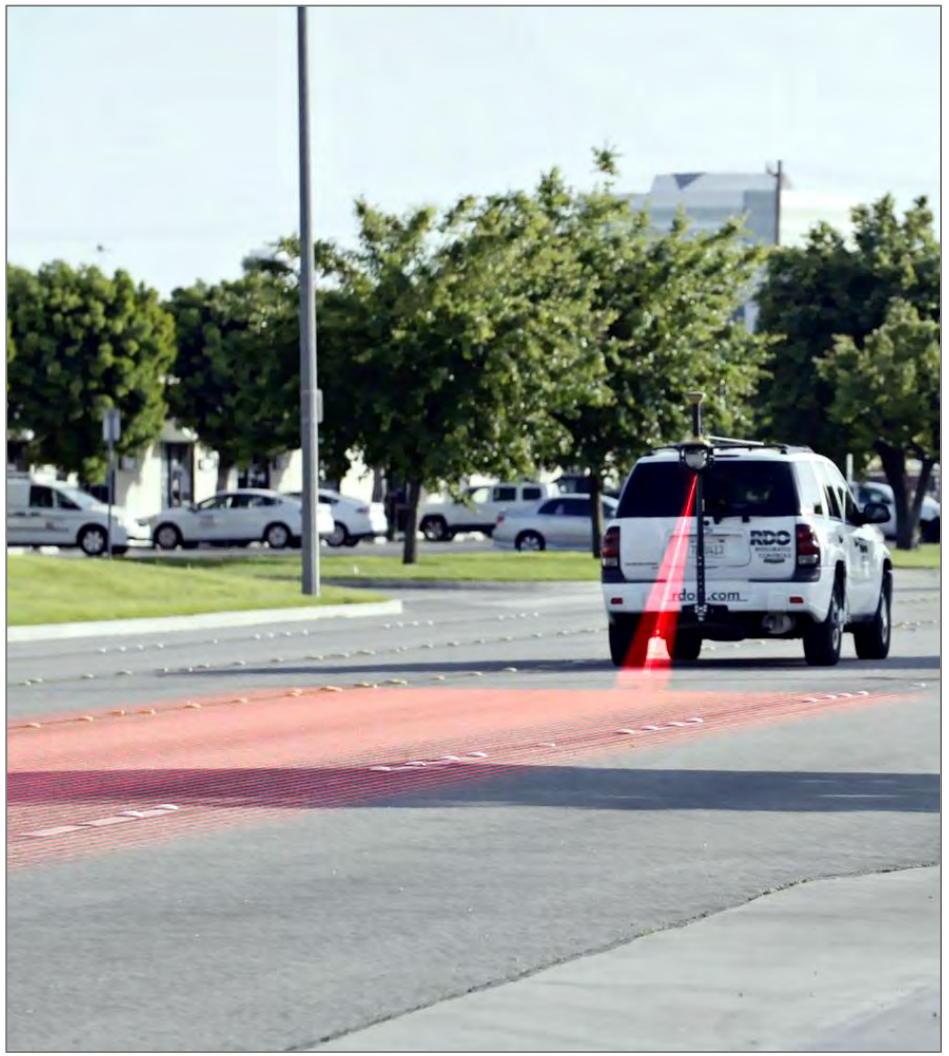
Scanning the Final Surface

- Verify lane lines, and roadway slope, confirm thicknesses, and confirm pavement accuracy to the design
- Digital records of roadway

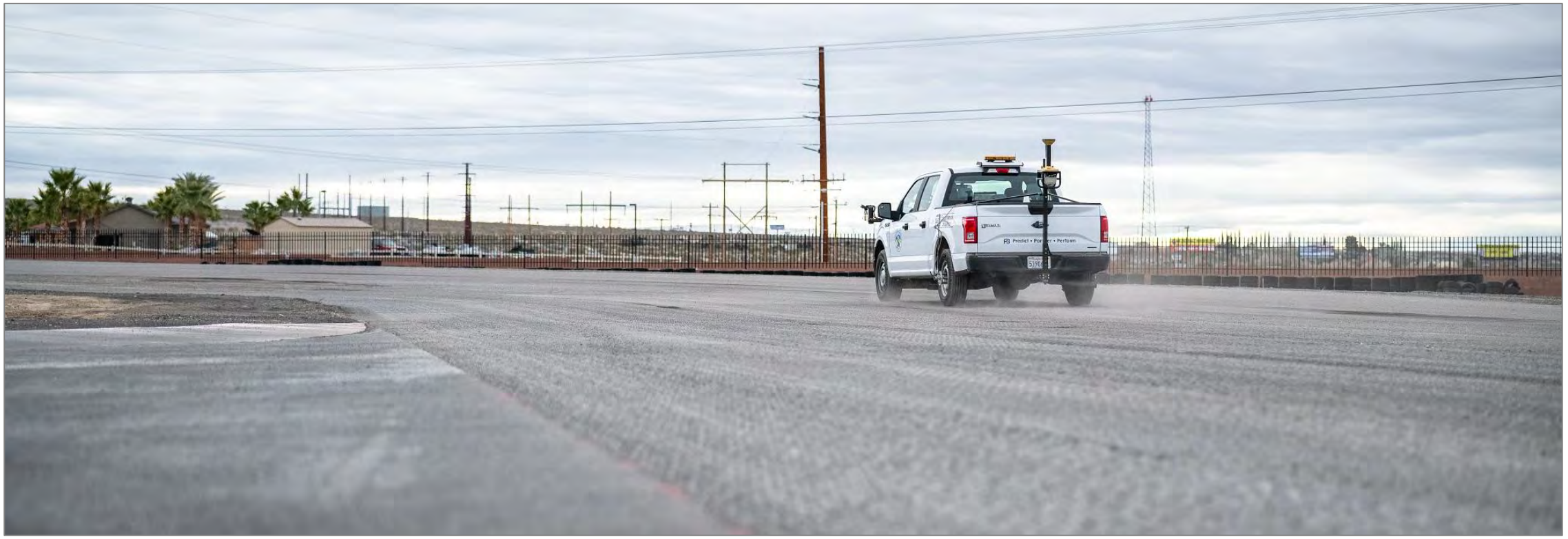


Safety




RDO

Safety

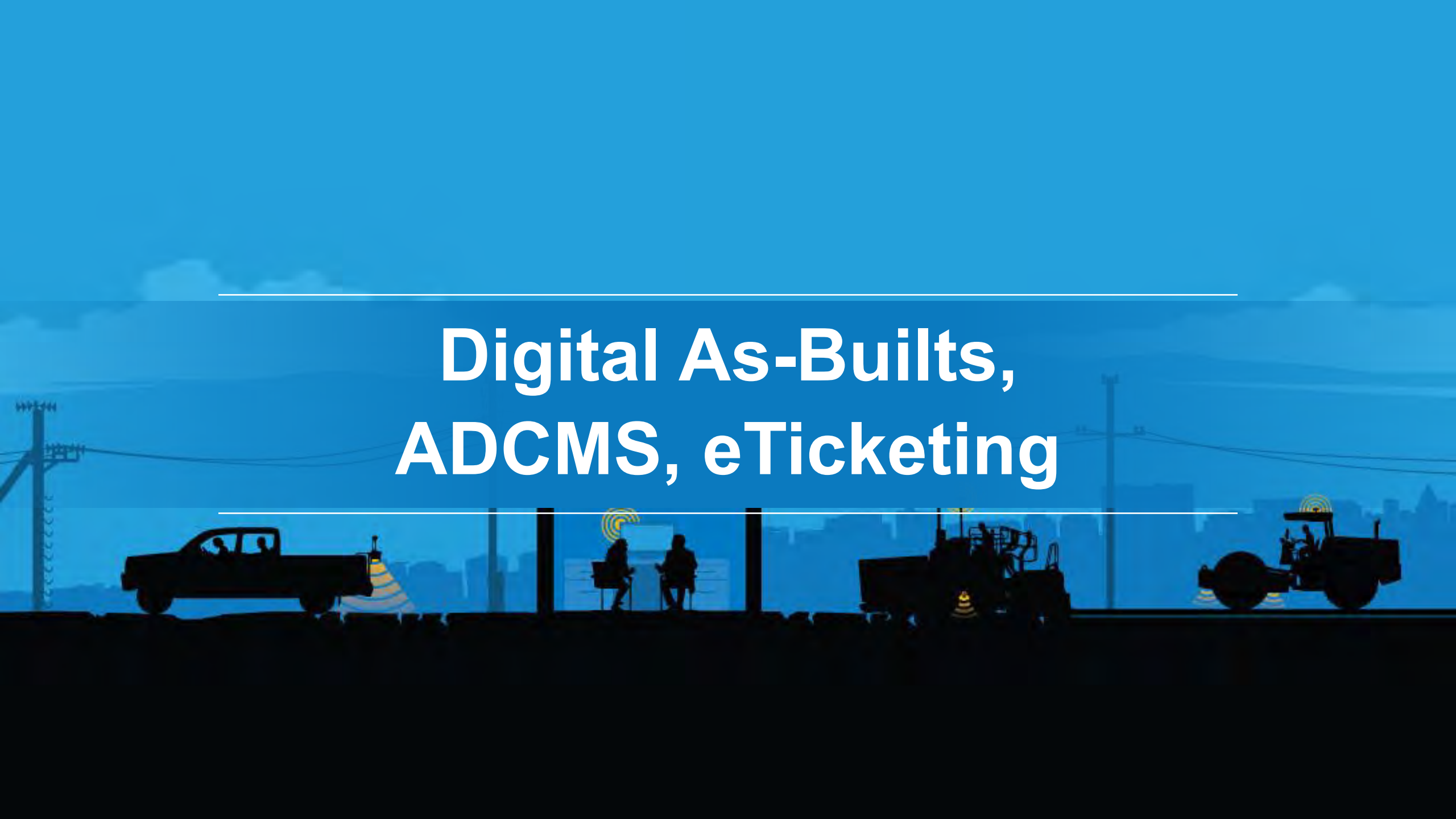


Eliminates the need for tedious point collection

Eliminates lane closures, crash trucks, etc.

Identifies possible problem areas ahead of milling / paving

Creates a very dense model of the surface



Digital As-Builts, ADCMS, eTicketing

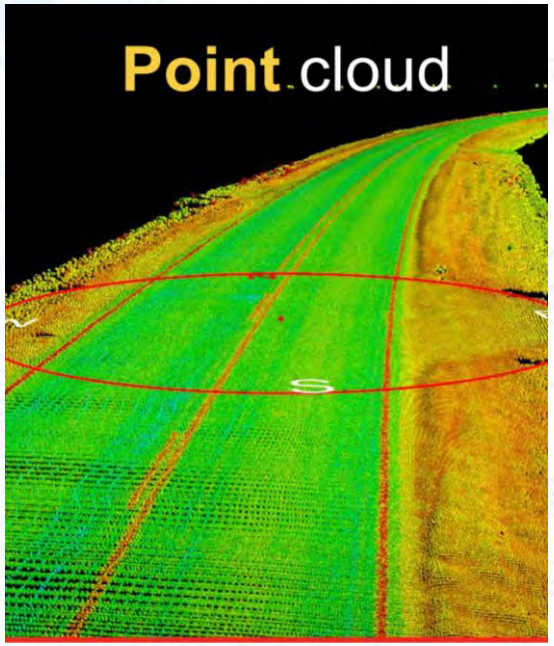
As-Builts

Digital as-builts can be defined in many ways.

Pre and Post construction for design and asset management are the most common.

From other perspectives, an as-built might include material placement and information including:

- Temperature
- Elevation
- Segregation properties
- Material depth and width
- Densities
- Smoothness



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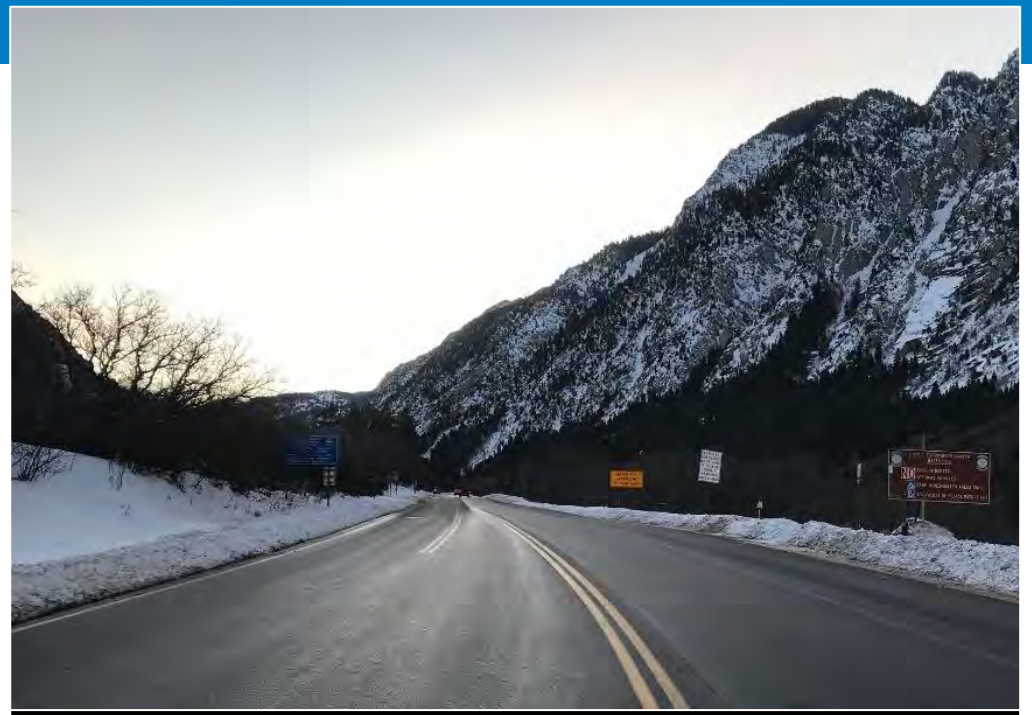
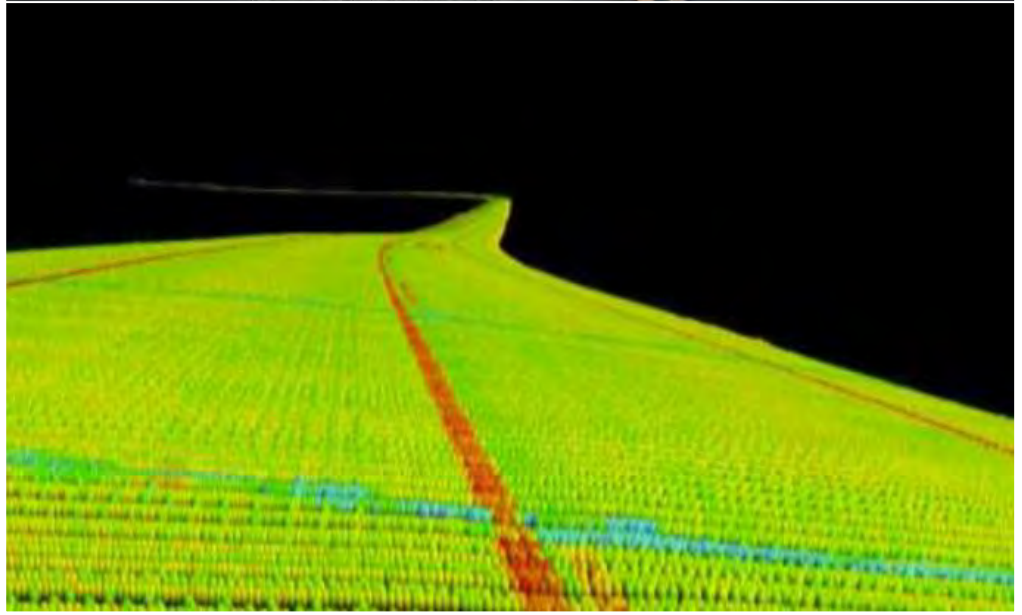
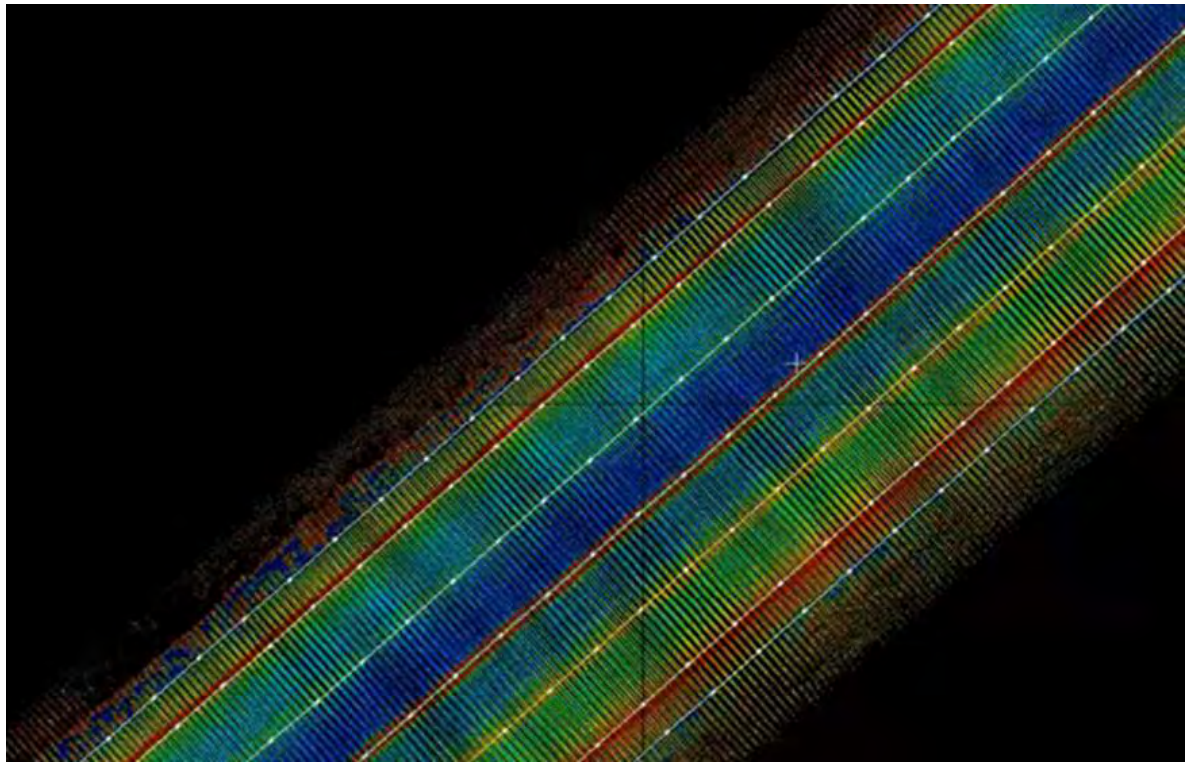
Roaday Data

- Provides an accurate surface of the existing conditions like lane widths, elevations, slopes, and causes of roughness like cracking as well as utilities.
- The existing surface generated from the lidar scan can be used as a true accurate as-built deliverable.



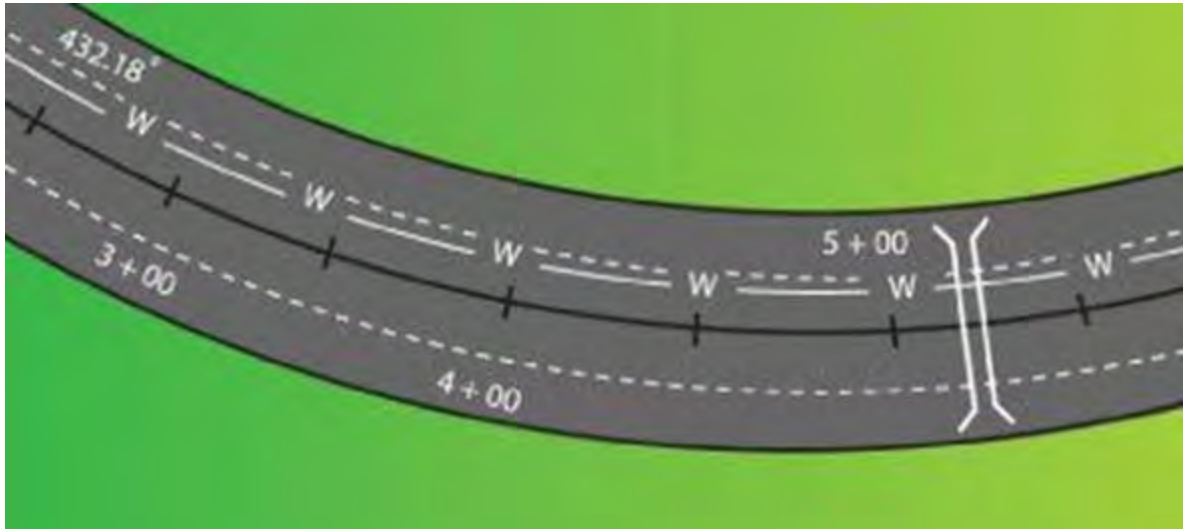


Asset As-Built



Lane line Extraction

Roadway INSPECTION



Alignment Creation

Milling As-Built

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	datetime_utc	station(ft)	horizontal_	design_xsl	actual_xslo	north_l(ft)	east_l(ft)	auto_l	mode_l	ground_eleva	design_elevat	sensor_de	design_de	depth_offs	target_dep	estimated_	error_l(ft)
2	5/16/2023 13:32	18335.75	-2.8435	-2.6685	-2.6506	7023935.381	1655991.433	1	Thickness	5818.0091	5817.8884	-1.0375	0.1207	0	0.1207	0.1225	-0.0018
3	5/16/2023 13:32	18334.09	-2.8444	-2.6676	-2.7007	7023933.744	1655991.43	1	Thickness	5818.0091	5817.8904	-1.04	0.1187	0	0.1187	0.12	-0.0013
4	5/16/2023 13:32	18332.45	-2.8484	-2.6676	-2.5756	7023932.098	1655991.425	1	Thickness	5818.0091	5817.8918	-1.0375	0.1172	0	0.1172	0.1225	-0.0053
5	5/16/2023 13:32	18330.68	-2.8004	-2.6675	-2.9509	7023930.338	1655991.47	1	Thickness	5818.0132	5817.8925	-1.035	0.1208	0	0.1208	0.125	-0.0042
6	5/16/2023 13:32	18328.9	-2.8659	-2.667	-2.4255	7023928.561	1655991.403	1	Thickness	5818.017	5817.8949	-1.04	0.1222	0	0.1222	0.12	0.0022
7	5/16/2023 13:32	18327.11	-2.8109	-2.667	-2.5756	7023926.785	1655991.456	1	Thickness	5818.0199	5817.8947	-1.0375	0.1253	0	0.1253	0.1225	0.0028
8	5/16/2023 13:32	18325.47	-2.835	-2.6669	-2.4255	7023925.151	1655991.43	1	Thickness	5818.0199	5817.8959	-1.04	0.124	0	0.124	0.12	0.004
9	5/16/2023 13:32	18323.83	-2.8069	-2.6667	-2.6756	7023923.512	1655991.456	1	Thickness	5818.0199	5817.8956	-1.0425	0.1244	0	0.1244	0.1175	0.0069
10	5/16/2023 13:32	18322.18	-2.8057	-2.6667	-2.5506	7023921.867	1655991.456	1	Thickness	5818.0199	5817.8957	-1.04	0.1242	0	0.1242	0.12	0.0042
11	5/16/2023 13:32	18320.39	-2.7881	-2.6667	-2.5255	7023920.075	1655991.472	1	Thickness	5818.02	5817.8956	-1.0375	0.1244	0	0.1244	0.1225	0.0019
12	5/16/2023 13:32	18318.71	-2.8151	-2.6676	-2.2504	7023918.404	1655991.443	1	Thickness	5818.0199	5817.8954	-1.0375	0.1245	0	0.1245	0.1225	0.002

- During Milling using Log
- As-built data showing design depths and estimated depths constructed
- Error Column (Far Right)

ADCMS and eTicketing

- Digital as-builts may also include information from an Advanced Digital Construction Management Systems (ADCMS) and eticketing platforms.
- An ADCMS provides material details over 800 data fields including mix types, product location and a multitude of additional details.
- E-Ticketing can provide quantities, mixtures, delivery times and location.
- THE GAP… Bringing the actual construction as-built data in from the field.

See All Photos

18 Ticket Types

AMOUNT	MATERIAL NAME	NUMBER OF TICKETS	TICKET TYPE
16,380.96	19MM 160GYR PG 70-22	769	Asphalt
10,004.64	25MM 160GYR PG 64-22	480	Asphalt
5,970.13	25MM 160GYR PG 64-22	270	Asphalt
5,398.16	19MM 160GYR PG 64-22	253	Asphalt
3,538.79	9.5MM 160GYR PG 64-22	166	Asphalt

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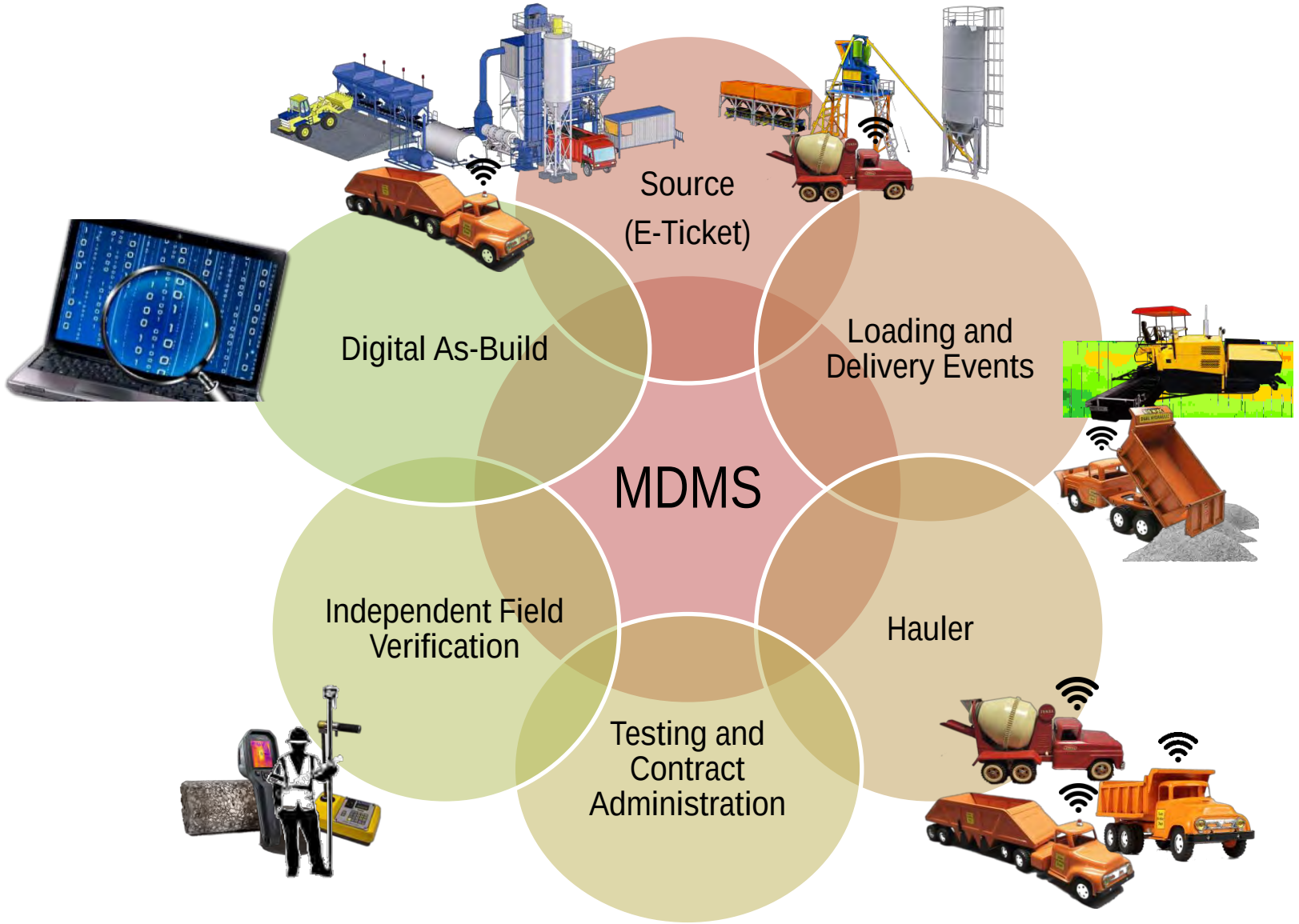
Material Delivery Management System (MDMS)



System that manages source, Hauler, loading and delivery events, testing and contract administration, and independent field verification *data associated with delivery of material to a contract.*

Courtesy: Rebecca Embacher, MnDOT

MDMS “As Built” Data – What's Needed??

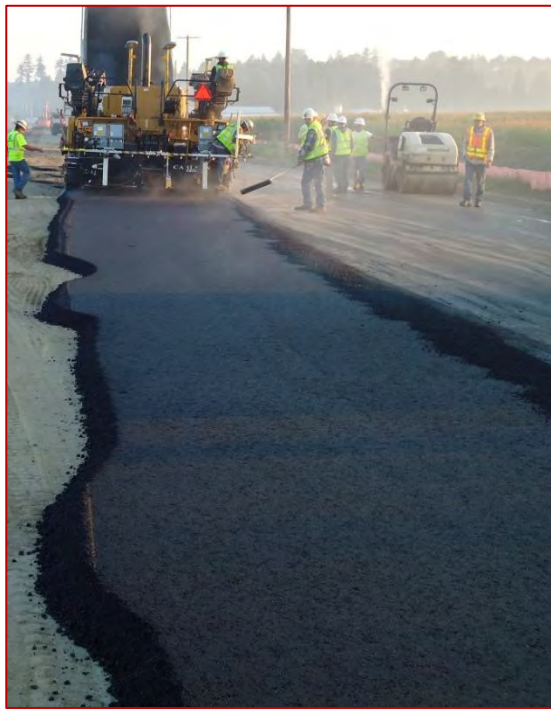
What’s Needed

1. Data Transmitters & Servers
2. GPS Receivers
3. Software Packages
4. Licenses
5. 3D Packages
6. Distance Measuring Devises
7. Temperature Measuring Devise
8. Ambient Conditions Measuring Devise
9. Harnesses, Hardware & Mountain Brackets

What’s Needed??? Packaged in ICT Below

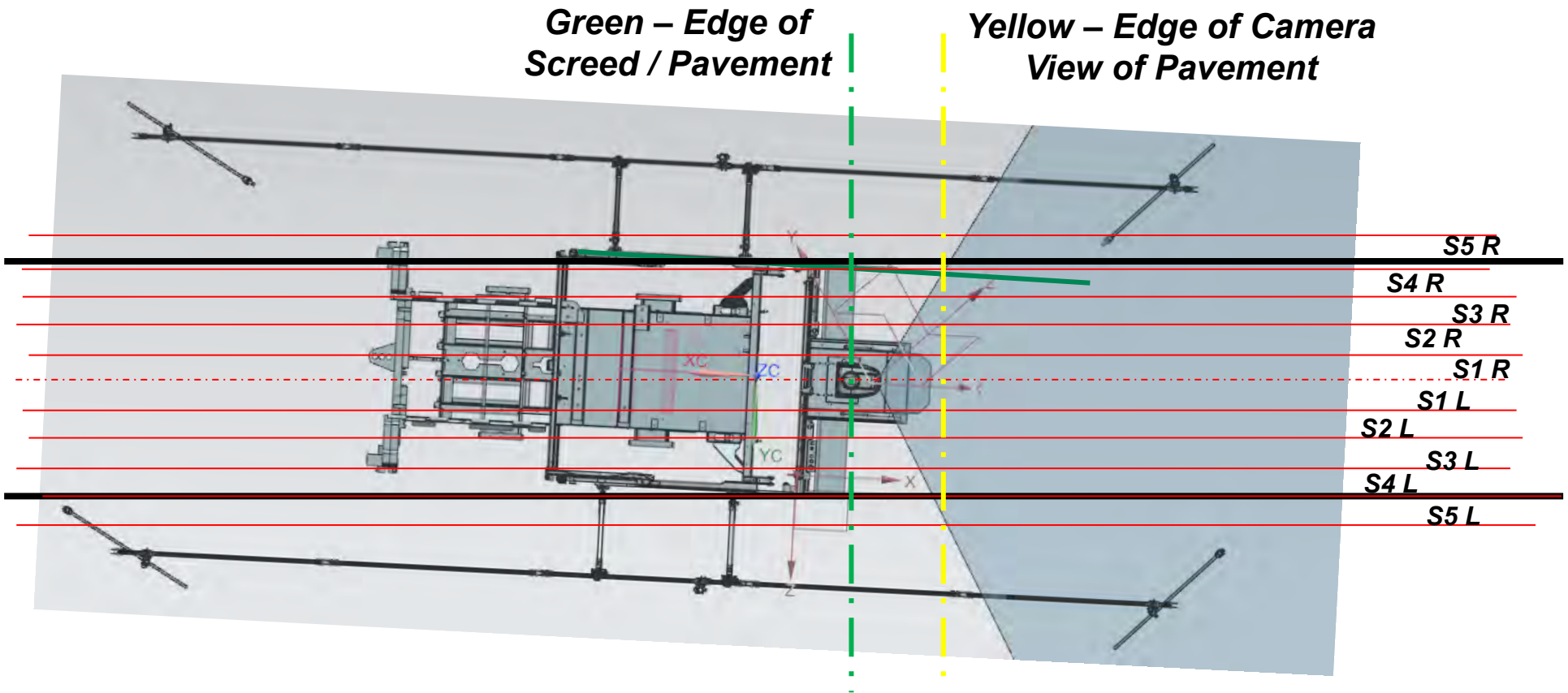
1. PMTP – Paver Mounted Thermal Profiler
2. IC - Intelligent Compaction??
3. DPS - Dielectric Profile System
4. MDMS - Material Delivery Management System
5. 3D Milling & Paving

PMTP “As Built” Data Challenges



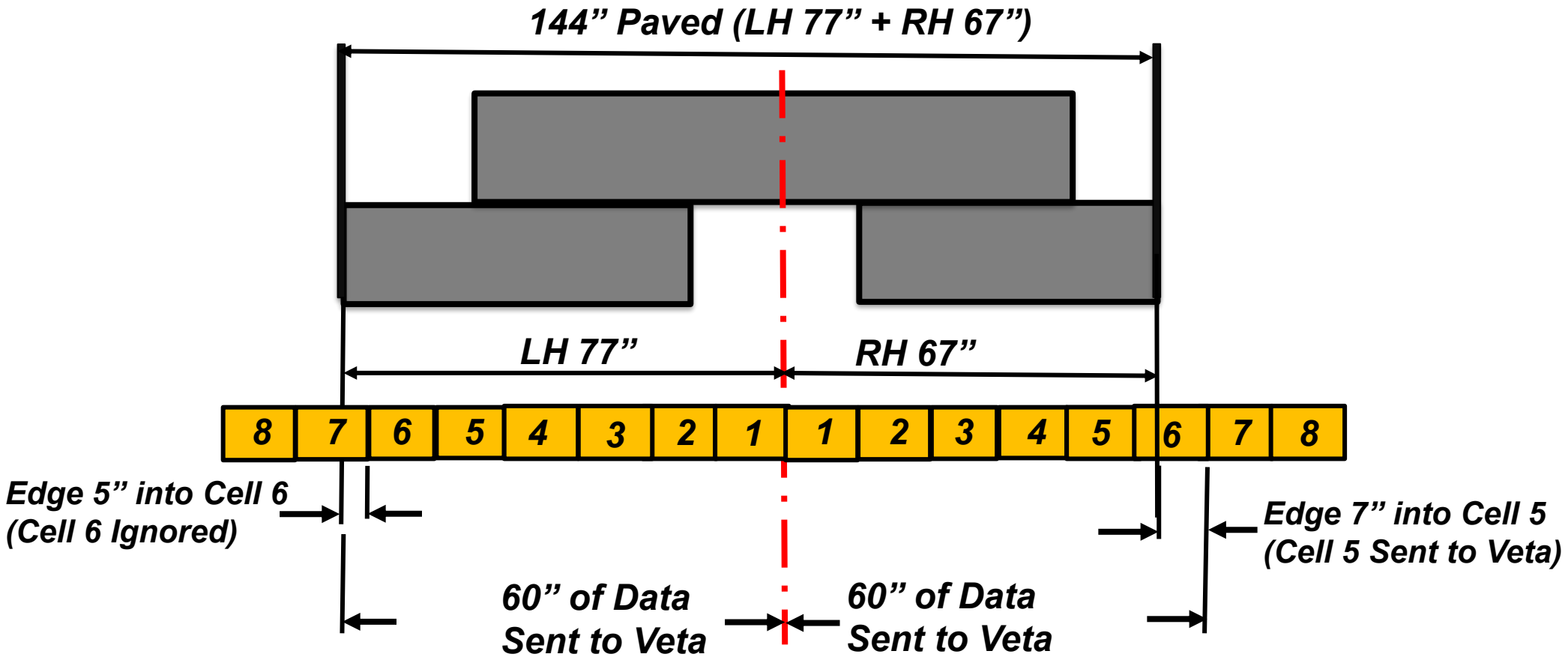
Veta Ride Brackets / Ability to Turn Sensors Off

- Operators don’t always Steer Straight
- Slight Turns could put the Ski in more that 2 cells



Screed Width Sensors Set Paving Width & Trim Obstructions

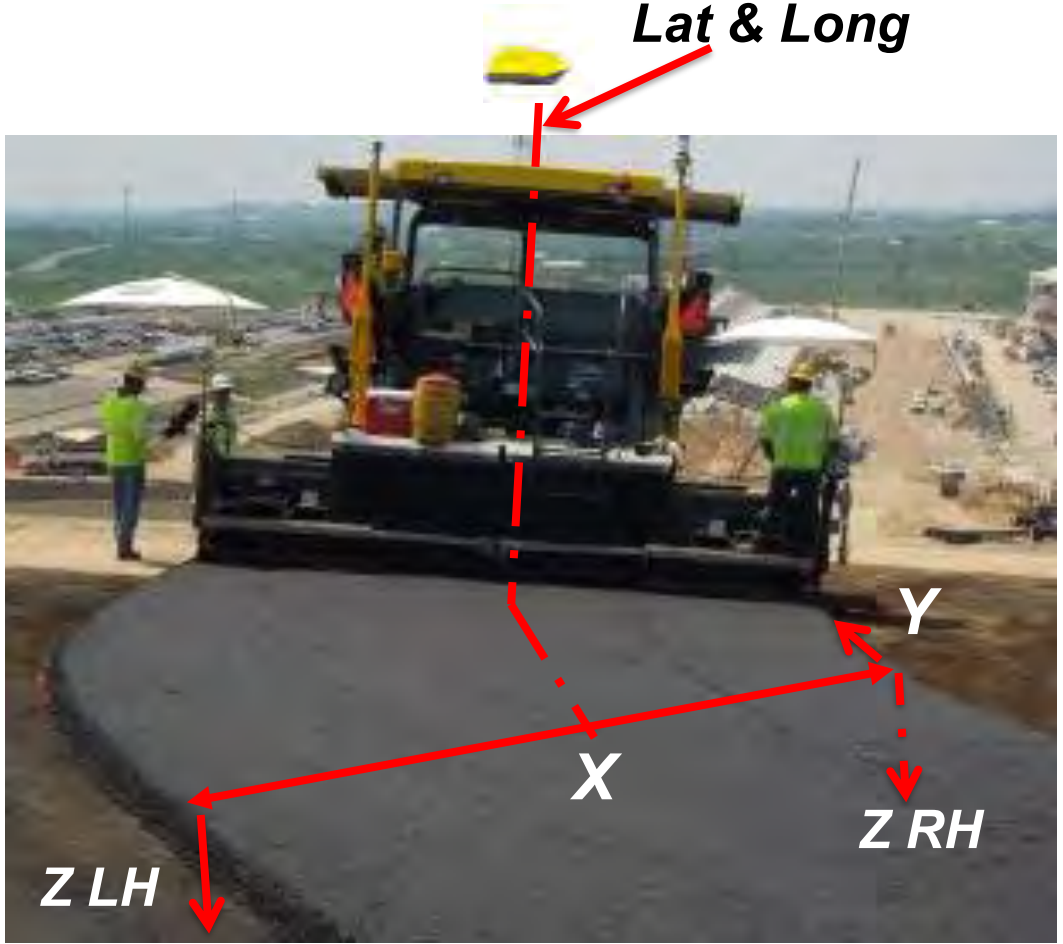
- Centerline Positioned by PMTP Camera GPS Receiver
- Per AASHTO R110 Each reading represent 12” Max (at what Threshold)
- Veta Received Data per Cell (Width)



MDMS "As Built" Data

- Lat & Long Can be Paver Center Captured from Thermal Camera
  - Must have GPS Receiver or used PMTP System
- Z have several options
  1. Could be Manually Entered – But Not "As Built"
  2. Measured by Some OEM – "Average As Built"
  3. "As Built" Z from 3D - when Available

- Must Answer the following Questions ???
  - Why we need "As Built"???
  - For Who – How Many DOT?? FHWA??
  - What Level of Accuracy???
  - Paving Crew Qualification Needed??
  - At What Cost



Integrations

- Integration is becoming a big part of the digital delivery programs
- Staring with planning and design and moving into project changes and updates in a 3D digital world
- Providing data not only from the designers and consultants, but also from data collected from the field
- Information is being processed in formats that is easier for all parties involved to use and update
- Interaction amongst all parties is necessary to provide positive project delivery and reduce confusion.


Any questions?
Thank You
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