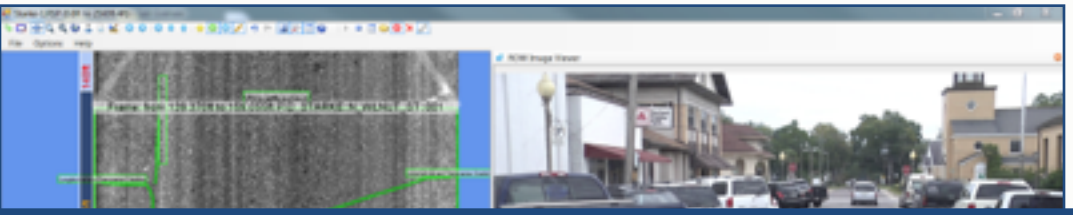
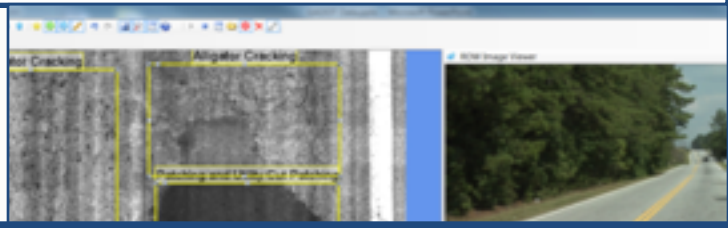

# Pre-Conference Workshop:
# Changing Methods in Pavement Data Collection





Dynatest[1]

Alvaro Ulloa-Calderon, PhD

Kurt Keifer, PhD, PE

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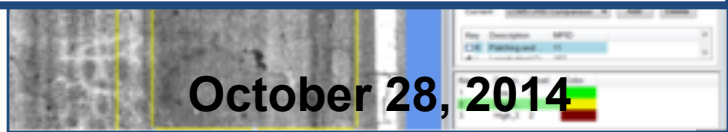

2014 NWPMA Conference – Seattle, WA

October 28, 2014

# Presentation Outline

- ✓ **Background**
- ✓ **Pavement Condition Index (PCI) Inspections**
- ✓ **Evolution of Pavement Imaging**
- ✓ **2D vs 3D Laser Imaging**
- ✓ **Distress Detection vs Classification**
- ✓ **Automated vs. Manual PCI Inspections**
- ✓ **Benefits and Limitations of Automated PCI Inspections**
- ✓ **Case Study: Cook County**
- ✓ **Questions and Answers**

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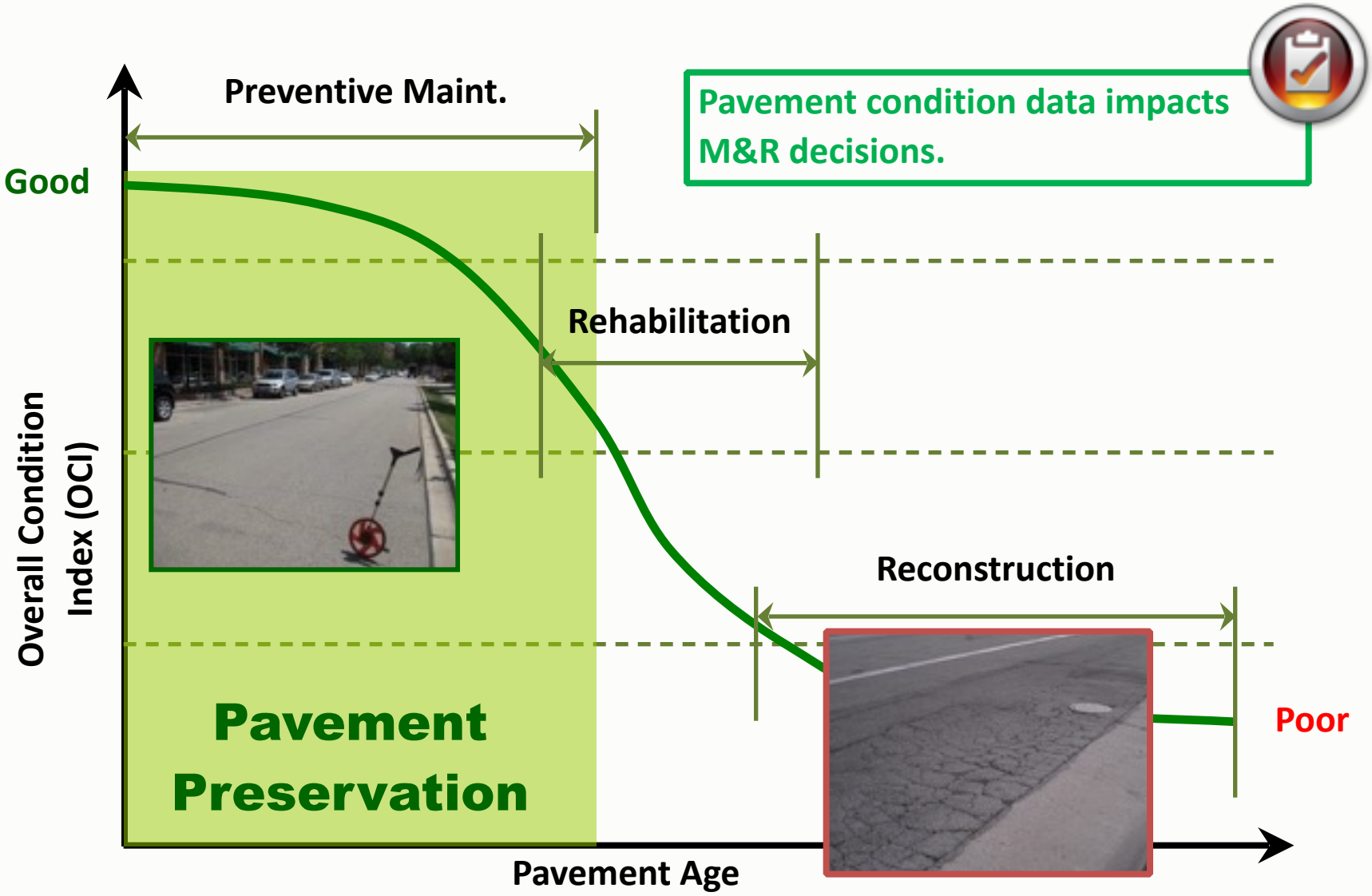
# Proactive Pavement Preservation

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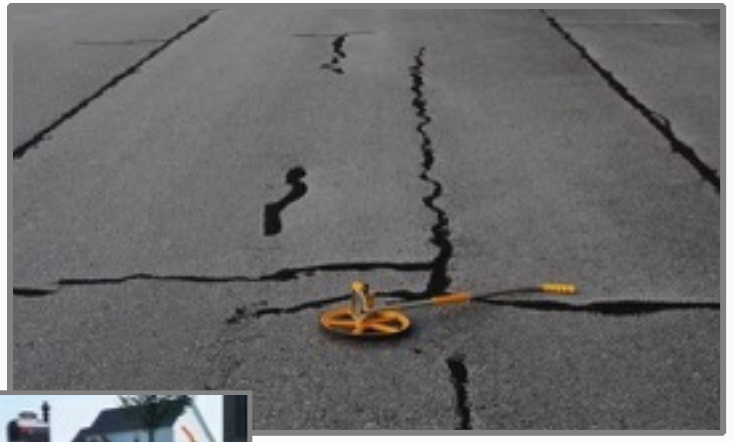
# Traditional Pavement Inspections



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# ASTM Pavement Condition Index (PCI)

**ASTM D5340-12:** *Standard Test Method for Airport Pavement Condition Index Surveys*

**ASTM D6433-11:** *Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*

***Manual* surveys only!**


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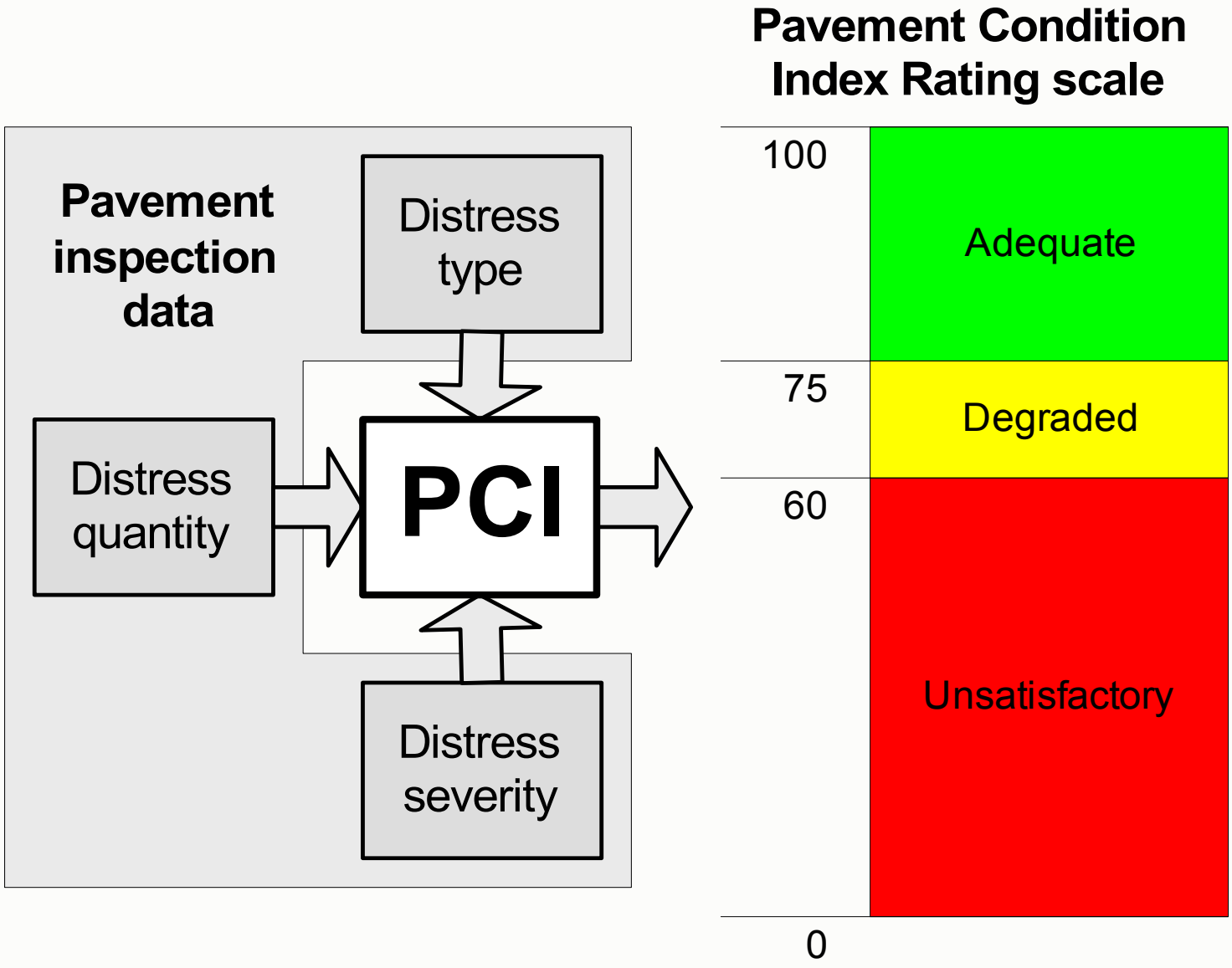
# Pavement Condition Index (PCI)

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# Evolution of Pavement Imaging


2D Laser Imaging

3D Laser Imaging

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Pavemetrics

Home | Our partnership with INO | Français

## Leader in vision systems for the automated inspection of transportation infrastructures.

Pavemetrics technology enables the automatic detection and evaluation of road features to optimize the use of road maintenance funds and to improve safety through better road surface maintenance. Our automated inspection technology is designed for both day and night time operation. It produces high resolution 2D images and 3D profiles of both asphalt and concrete road surfaces at speeds up to 100 km/h.

Contact Us

### Laser Crack Measurement System (LCMS)

- Automatic crack detection
- Detection of ravelling
- 4000 point rutting (rut depth, rut width)
- Macro-texture (MPD, digital sand patch) in all 5 AASHTO bands (wheel paths, center lane and lane edges)
- Day and night operation, immunity to shadows
- Low power consumption
- Data compression algorithms to minimize storage

### Laser Road Imaging System (LRIS)

- The most important feature of the system is that this opti configuration increases even the smallest cracl incident illumination an to cause the cracks to shadows.

### Laser Rut Measurement System (LRMS)

- 1 280 point 3D transverse profiles
- Low power consumption

**Current Developers**

Pavemetrics

Pathway Systems

Waylink Systems

…and others?

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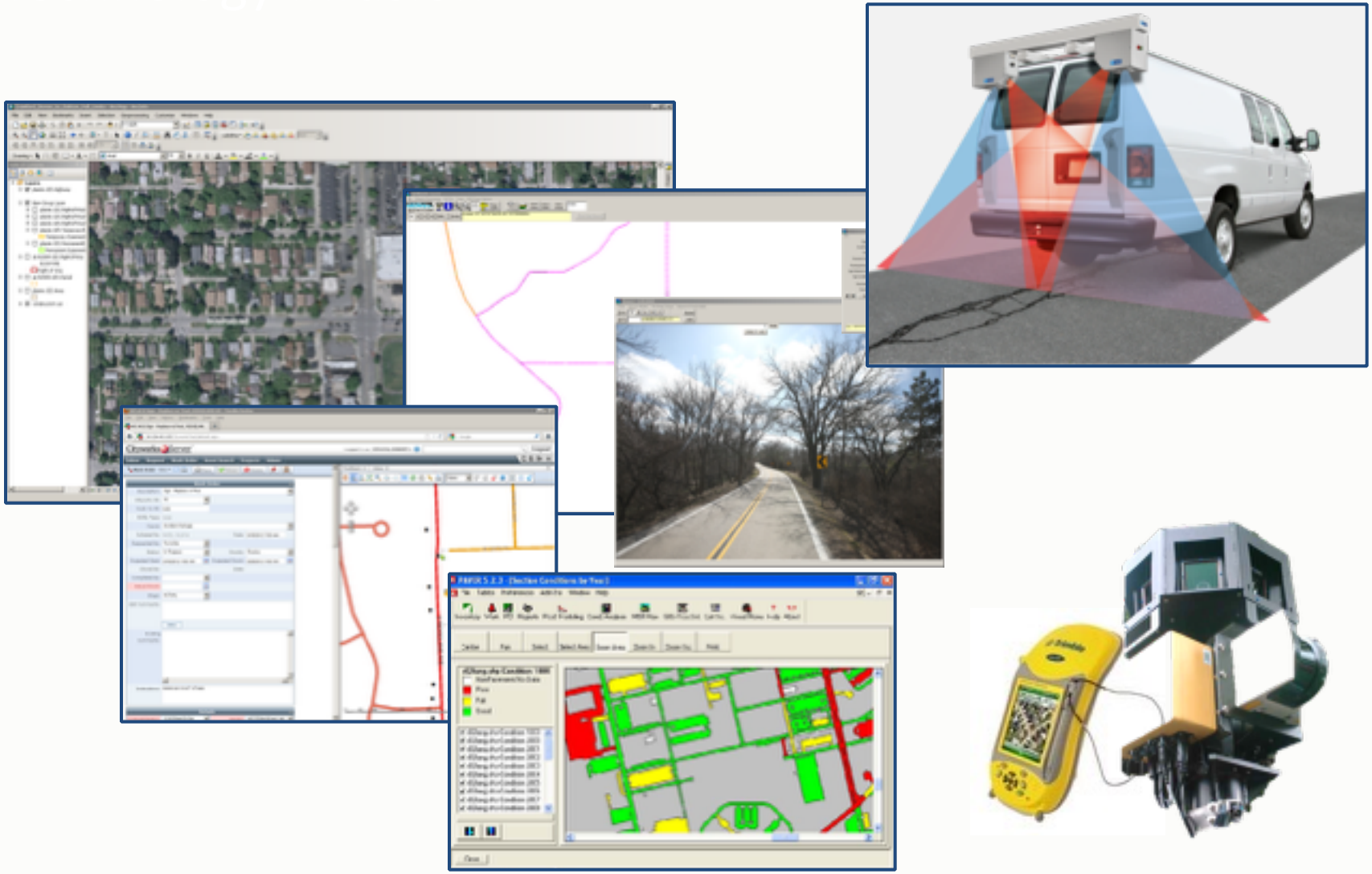
# Technology Infusion



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# 2D Laser Imaging System (LRIS)


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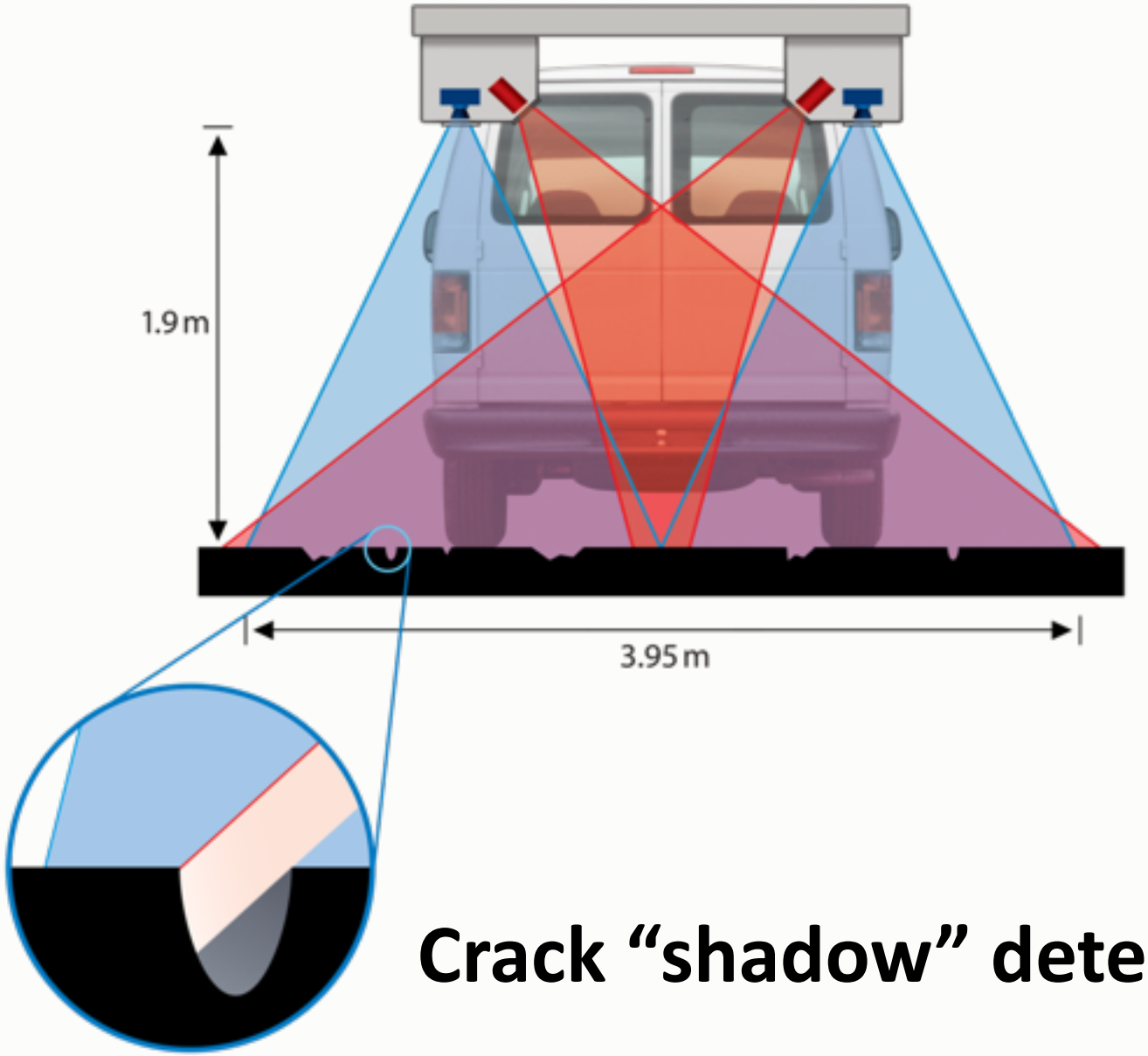
# 2D Laser Imaging System (LRIS)




**Crack “shadow” detection**

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# 3D Laser Crack Measurement System (LCMS)


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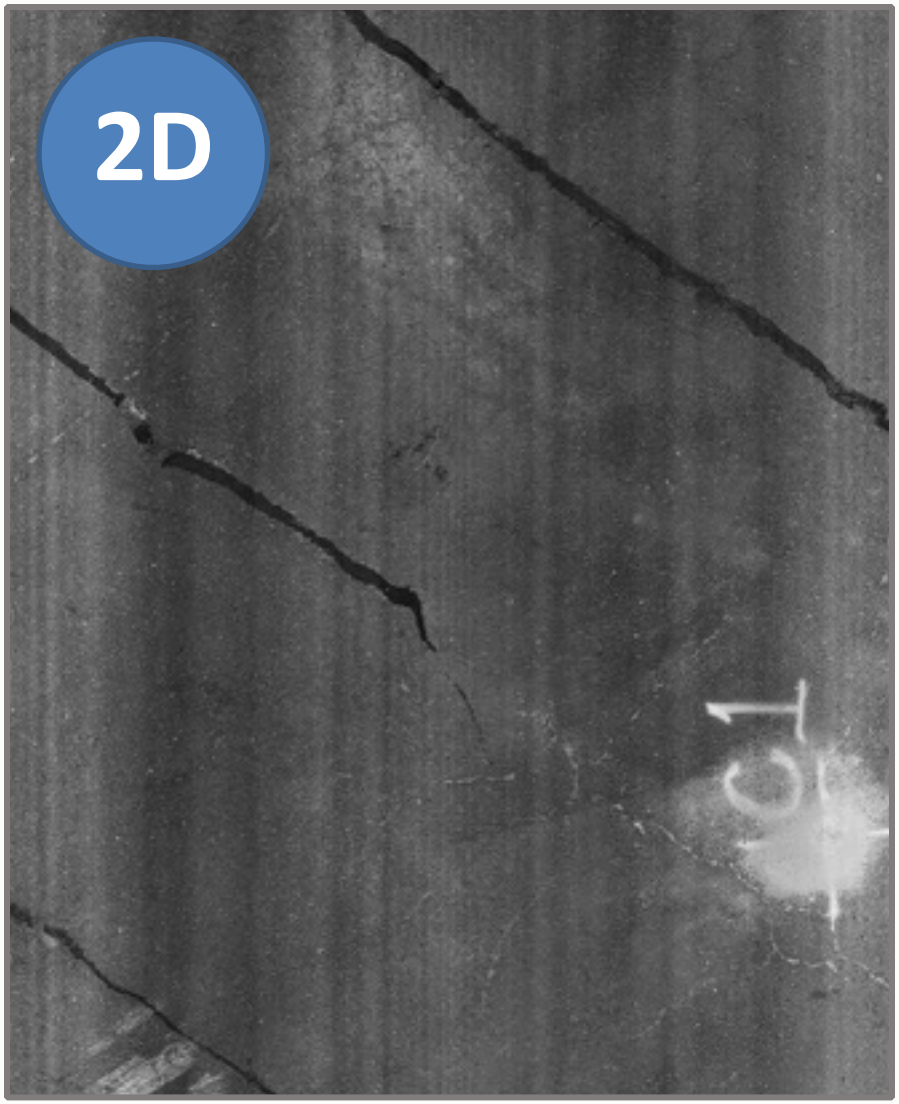
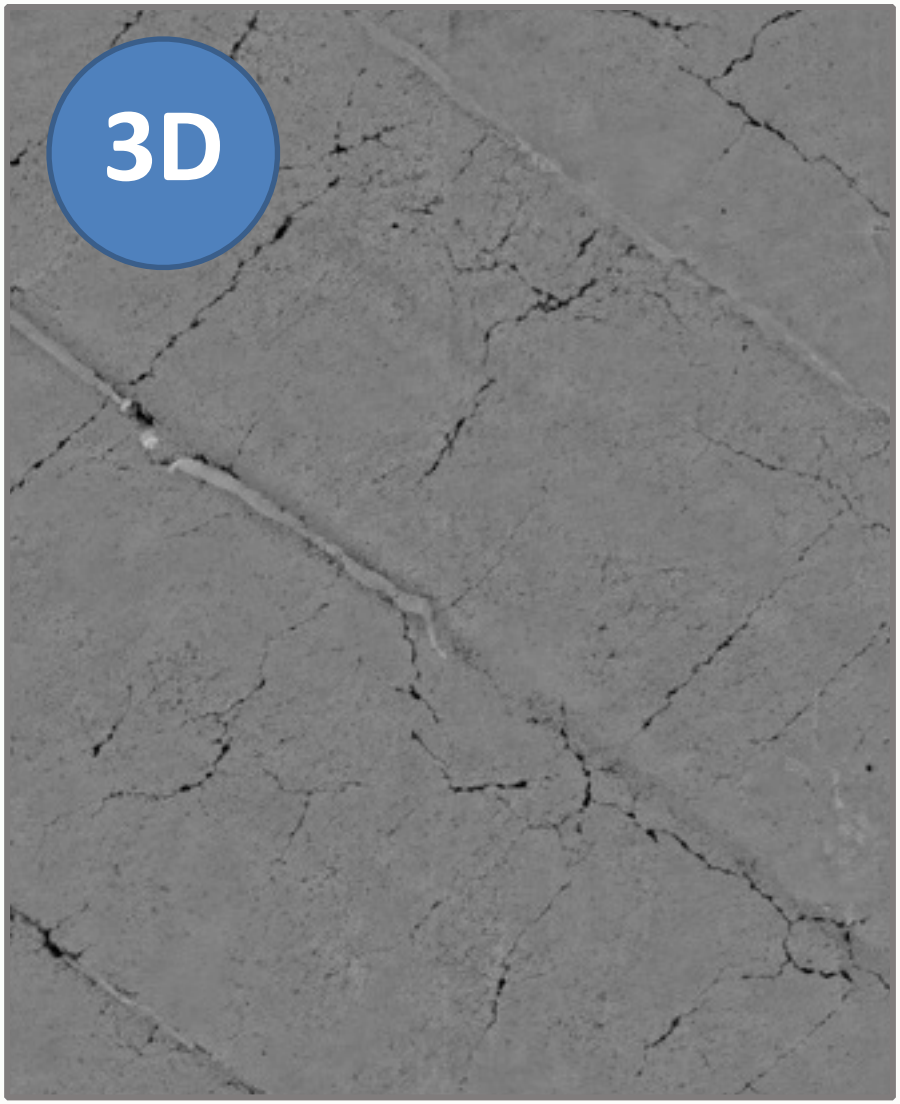
# 3D Laser Crack Measurement System (LCMS)

# Asphalt Pavement




2D Laser “Intensity” Image




3D Laser “Range” Image

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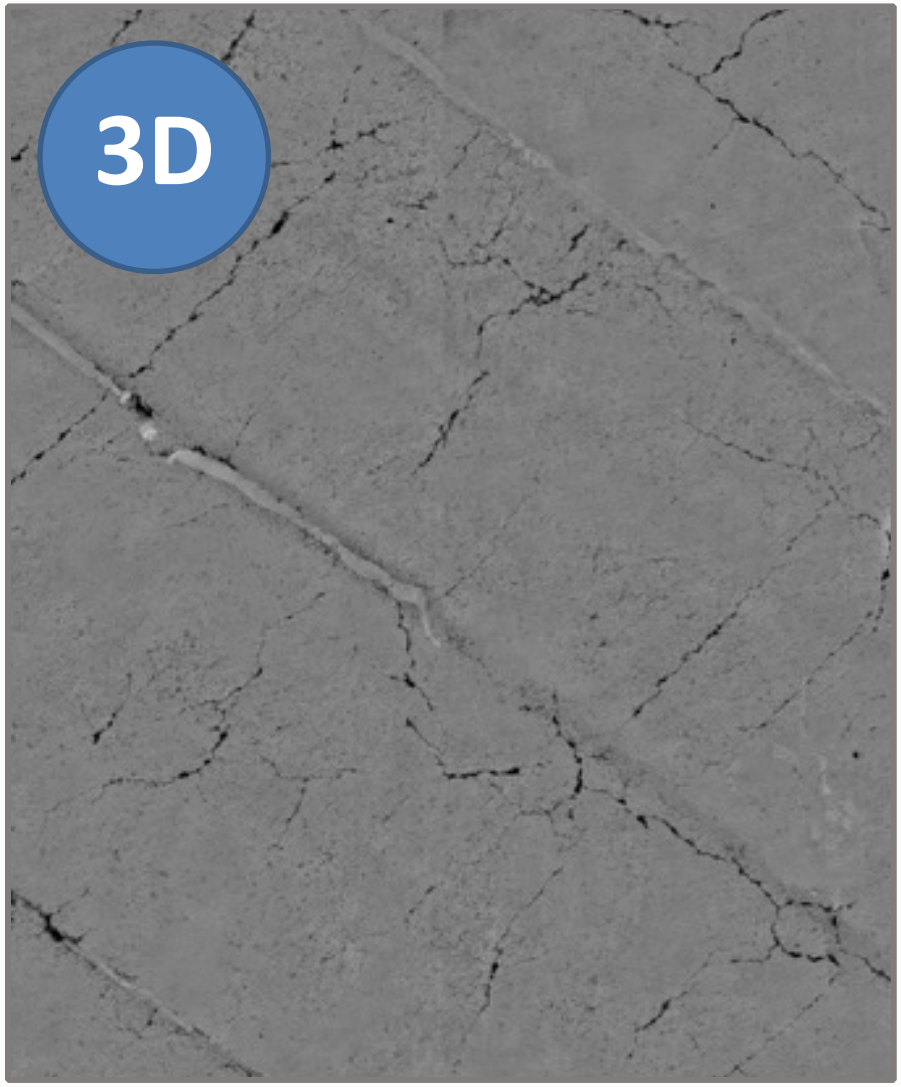
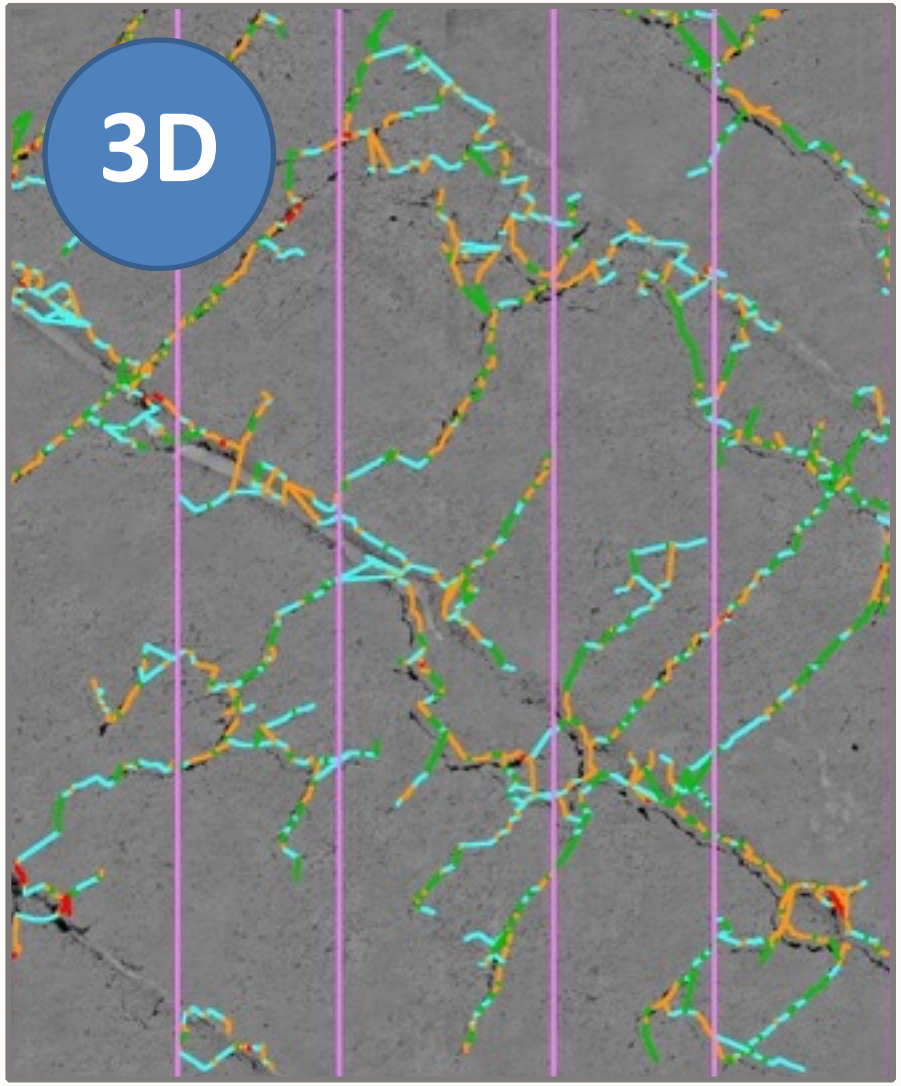
# Asphalt Pavement




3D Laser “Range” Image




Automated Crack “Detection”

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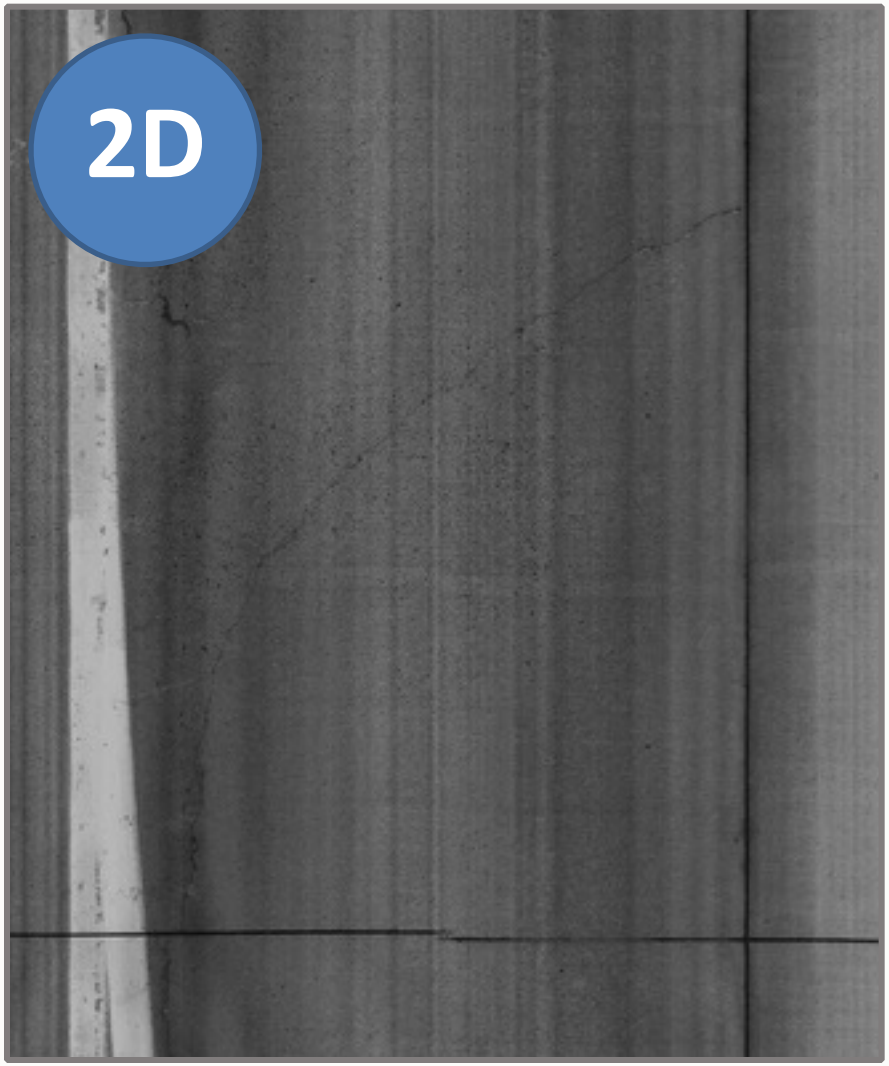
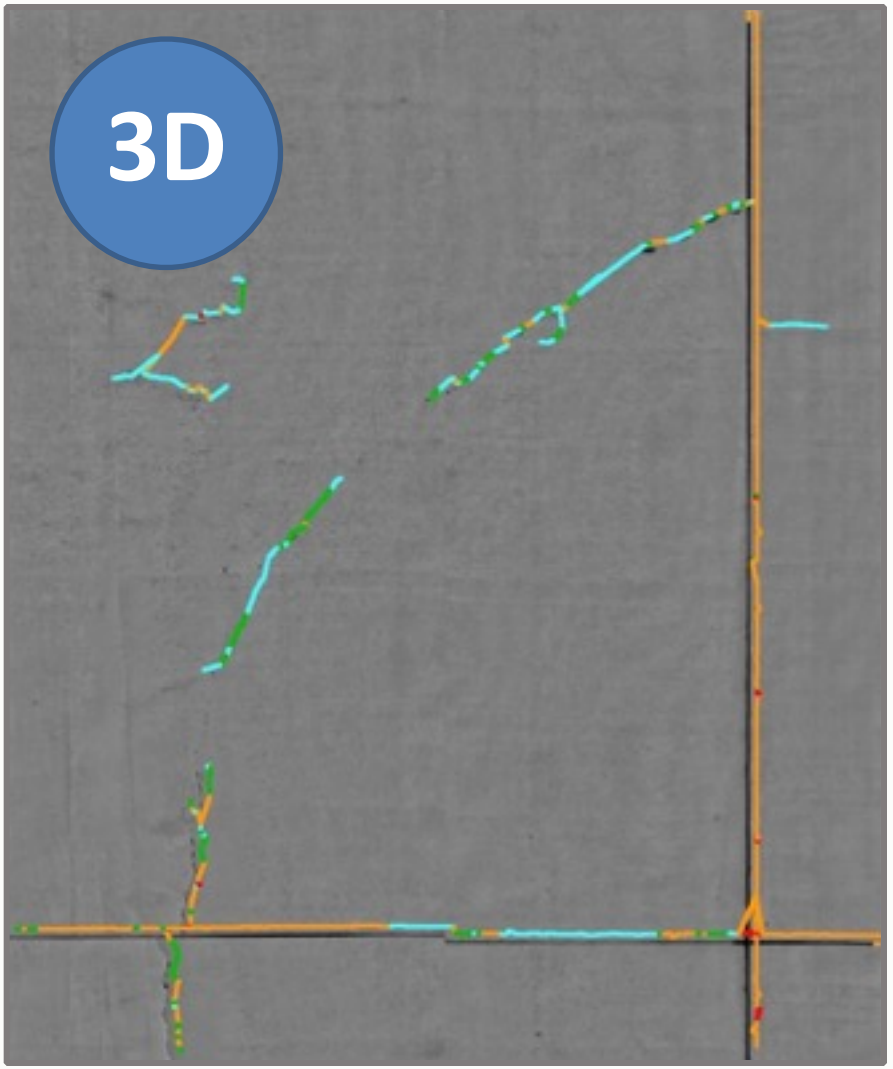
# Concrete Pavement




2D Laser “Intensity” Image




3D Laser “Range” Image

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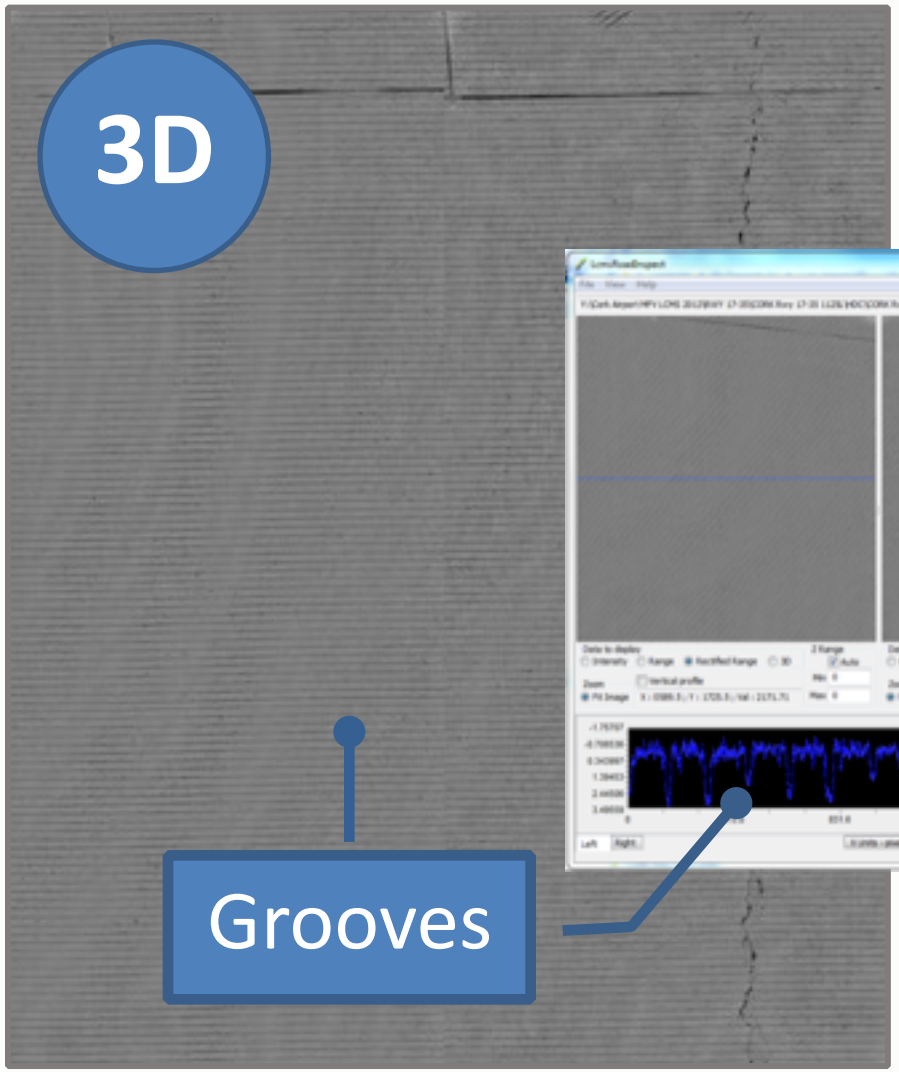
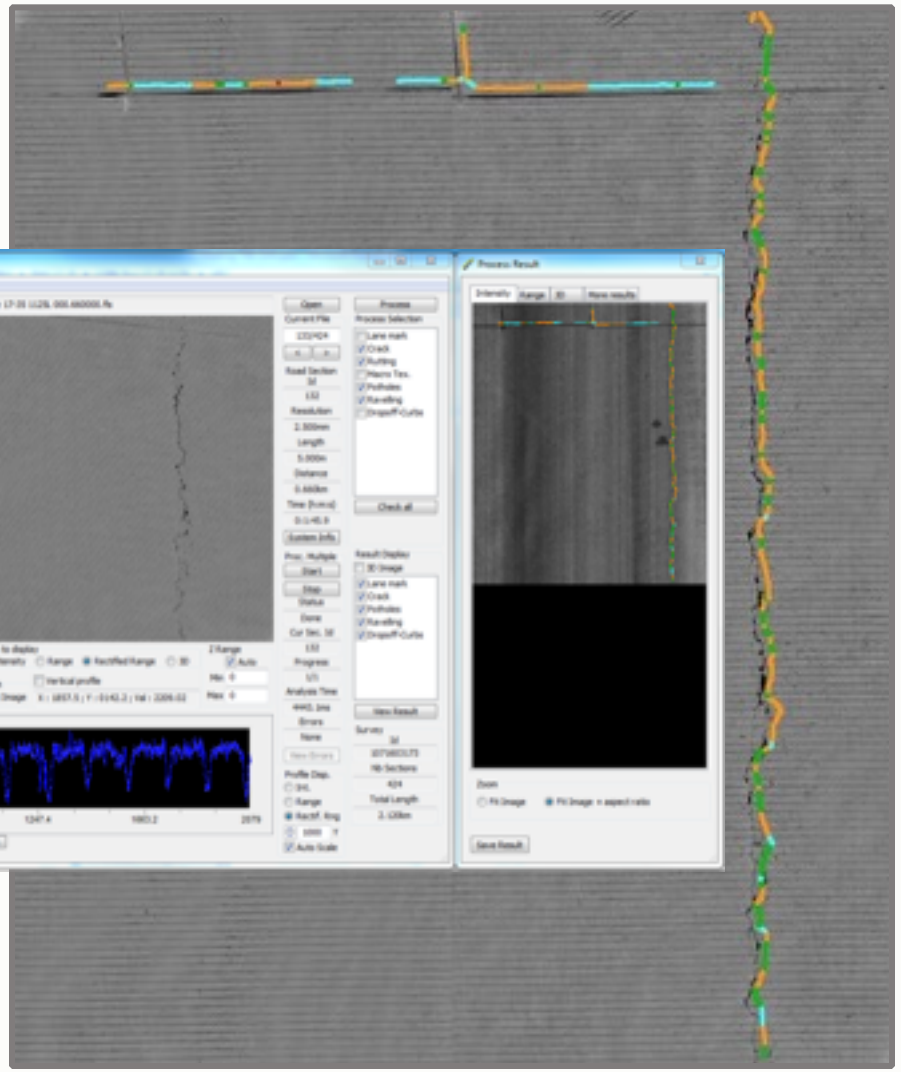
# Concrete Pavement– Grooving




3D Laser “Range” Image



3D Laser “Range” Image

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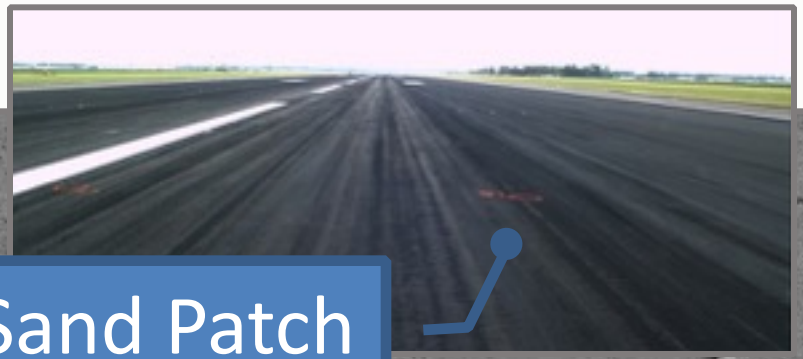
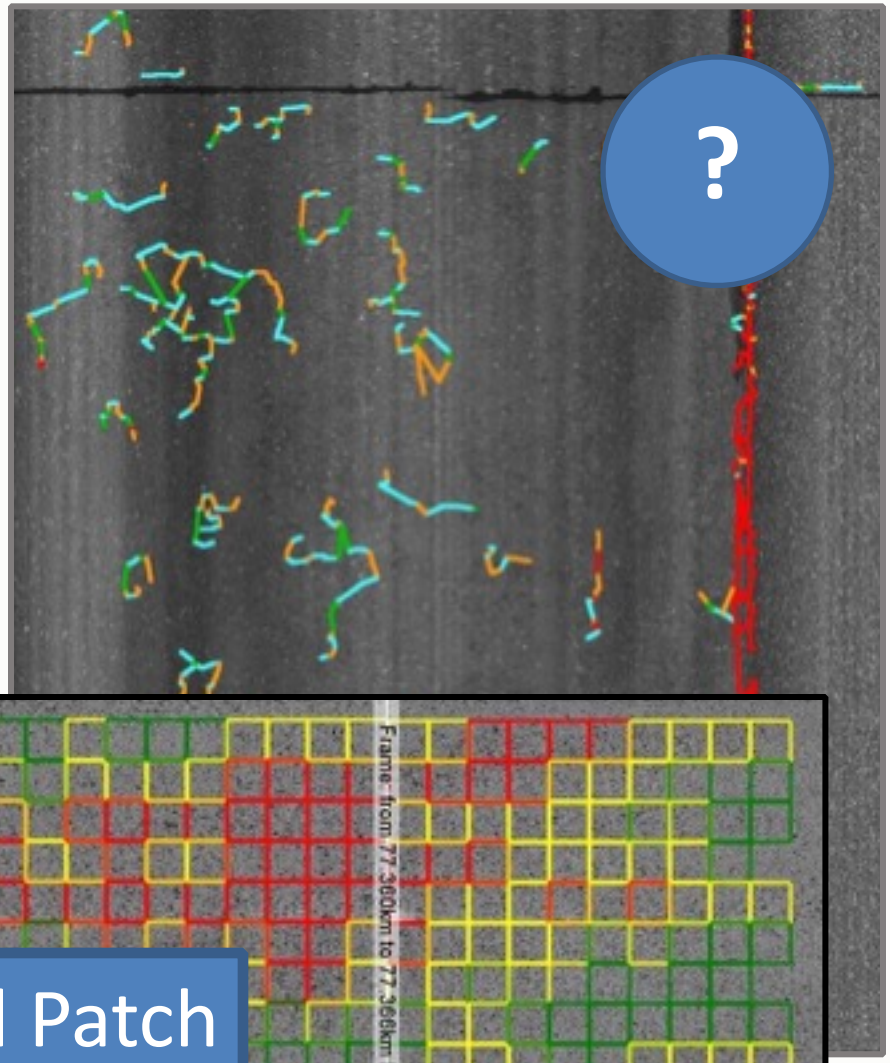
# Asphalt Pavement – Raveling



Sand Patch



?

3D




“Digital” Sand Patch

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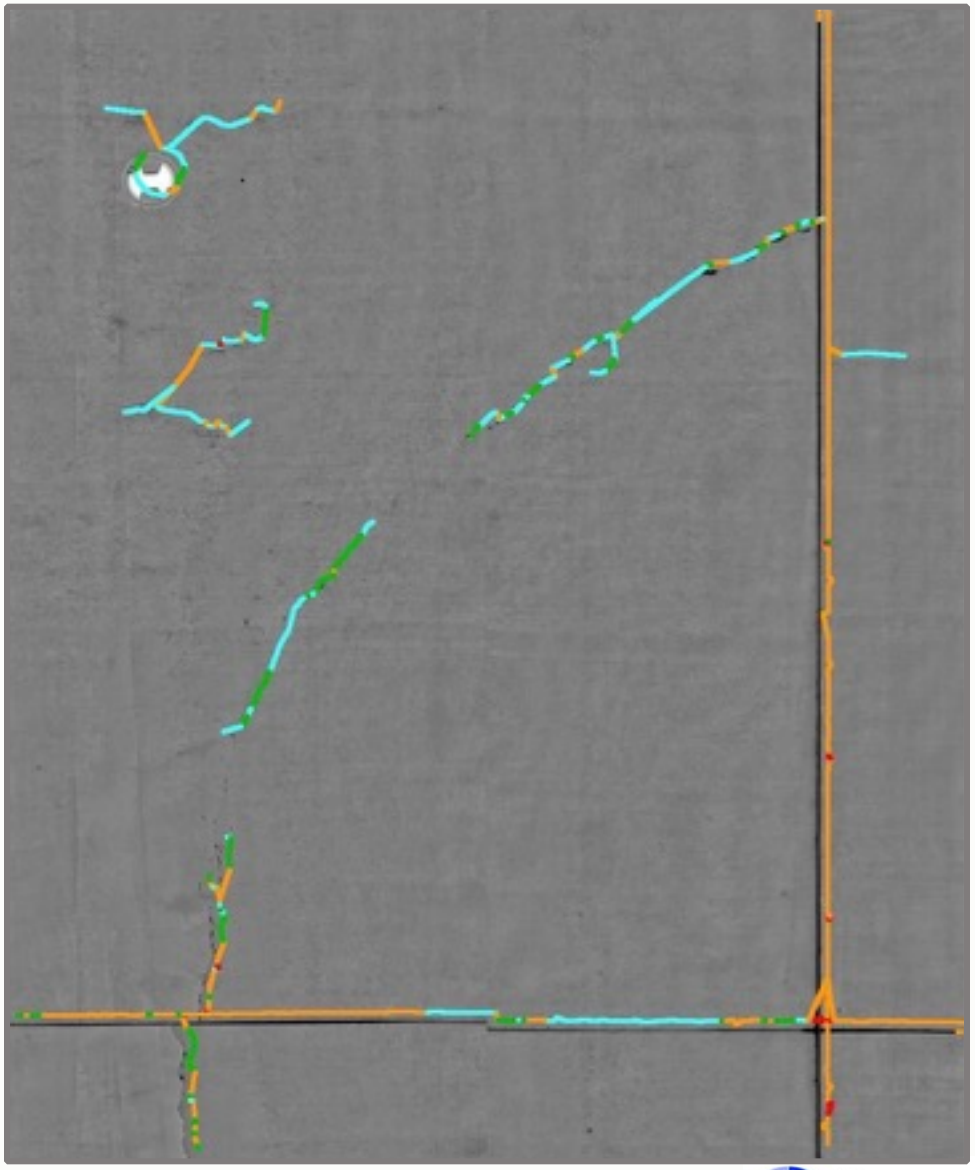
# Distress Detection vs. Classification

**<u>Step 1</u> Distress Detection**
***We have detected something!***

**<u>Step 2</u> Distress Classification**
***Now what have we detected?***

- Corner Break
- Cracks (Longitudinal, Transverse, and Diagonal)
- Durability ("D") Cracking
- Joint Seal Damage
- Patching, Small
- Patching, Large and Utility Cuts
- Scaling, Map Cracking, Crazing
- Shattered Slab/Intersecting Cracks
- Shrinkage Cracks
- Alkali-Silica Reaction (ASR)



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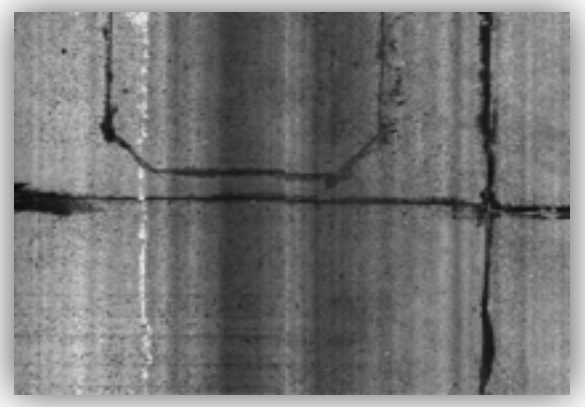
# ASTM D6433 Pavement Distresses

Automated

Manual + Automated

Manual



## ASPHALT PAVEMENT

- Alligator Cracking
- Bleeding
- Block Cracking
- Corrugation
- Depression
- Edge Cracking
- Joint Reflection Cracking
- Longitudinal and Transverse Cracking
- Patching and Utility Cut Patching
- Potholes
- Lane-to-Shoulder Dropoff
- Pumping
- Polished Aggregate
- Raveling
- Rutting
- Shoving
- Slippage cracking
- Swell
- Weathering

## CONCRETE PAVEMENT

- Alkali Silica Reaction (ASR)
- Blowup/Buckling
- Corner Break
- Cracks (Longitudinal, Transverse, and Diagonal)
- Durability ("D") Cracking
- Joint Seal Damage
- Patching, Small
- Patching, Large and Utility Cuts
- Popouts
- Lane-to-Shoulder Dropoff
- Polished Aggregate
- Pumping
- Scaling
- Settlement or Faulting
- Shattered Slab/Intersecting Cracks
- Shrinkage Cracking
- Spalling, Longitudinal and Transverse Joint
- Spalling, Corner

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# Dynatest Pavement Condition Survey System (PCSS)

**High resolution downward images**

**High resolution right-of-way (ROW) images**

**Rutting in both wheelpaths**

**Longitudinal profile in both wheelpaths**

- **International Roughness Index (IRI)**

**Applanix DGPS receiver and DMI**



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1. **Rutting (wheelpath)**
2. **International Roughness Index (IRI)**
3. **Ride Number (RN)**


**A PCI survey is not just crack counting.**
**Inertial profiling is needed as well.**

# Benefits

**Advantages**

1. **Fast** – *minimize impact to operations, collect several lane miles of pavement data in a day*
2. **Comprehensive** – *capture the entire pavement surface and profile!*
3. **Safer** – *fewer bodies on the road, and pavement inspectors not exposed to traffic hazards.*
4. **Day or night survey**
5. **Automated distress detection may aid manual interpretation**
6. **Easier to QC/QA**

**7. Permanent record of pavement condition** – *witness 3D time-series pavement deterioration!*

**8. Geo-referenced Data** – *High accuracy GPS coordinates provide an exact location for each data unit captured*

**9. Quality of Data** – *ROW pictures (daytime)*

**10. Pavement Characteristics** – *Pavement ride quality (IRI) and continuous rutting measurements (Vehicle based system)*

**11. Pavement Geometry** – *Cross slope, radius of curvature and grade.*

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# Limitations

**Limitations**

1. **Require manual interpretation of imagery**
2. **Sensitive to weather conditions (rain)**
3. **No forward facing images during night surveys** – ***only downward!***
4. **Difficult in narrow lanes**
5. **May require nominal investment in server space to warehouse imagery**
6. **May require redefinition of inspection protocol**


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# Case Study: Cook County

- **Pavement Network Definition and Sectioning via GIS**
- **Pavement Work History Development**
- ***PAVER Training – Level 1***
- **PAVER Database Creation, Customization and GIS linkage**
- **Automated Pavement Condition Index (PCI) Survey**
- **Falling Weight Deflectometer (FWD) Testing**
- **Collaborative QC/QA Program**
- ***PAVER Training – Level 2***
- ***ELMOD Training***
- **PAVER Analysis and Reporting**
- ***PAVER Training – Refresher***

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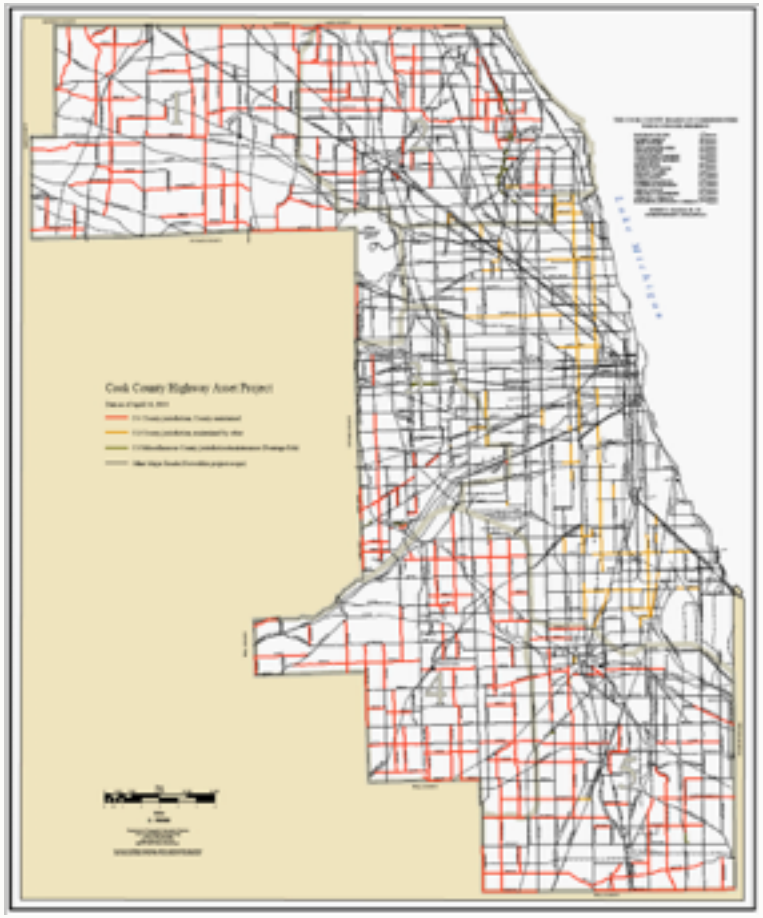
# 1. Pavement Network Definition



**PAVER Hierarchy**

- **Network**
- **Branch**
  - Roadway
  - Parking lot
  - Alley
- **Section**
  - "Uniform" lengths/areas of a branch

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- **Major Rehabilitation and Reconstruction (MR&R)**
- **Global Maintenance**
- **Localized Maintenance**

***A somewhat painful but ultimately beneficial process!***

# Training

## 3. PAVER and ELMOD Training

**Level 1 – Pavement management with PAVER**

- PAVER capabilities
- PAVER customization
- Pavement Condition Index (PCI)

**Level 2 – Real-world PAVER**

- County's database
- Analysis and reporting

**PAVER refresher training**

**ELMOD Training**



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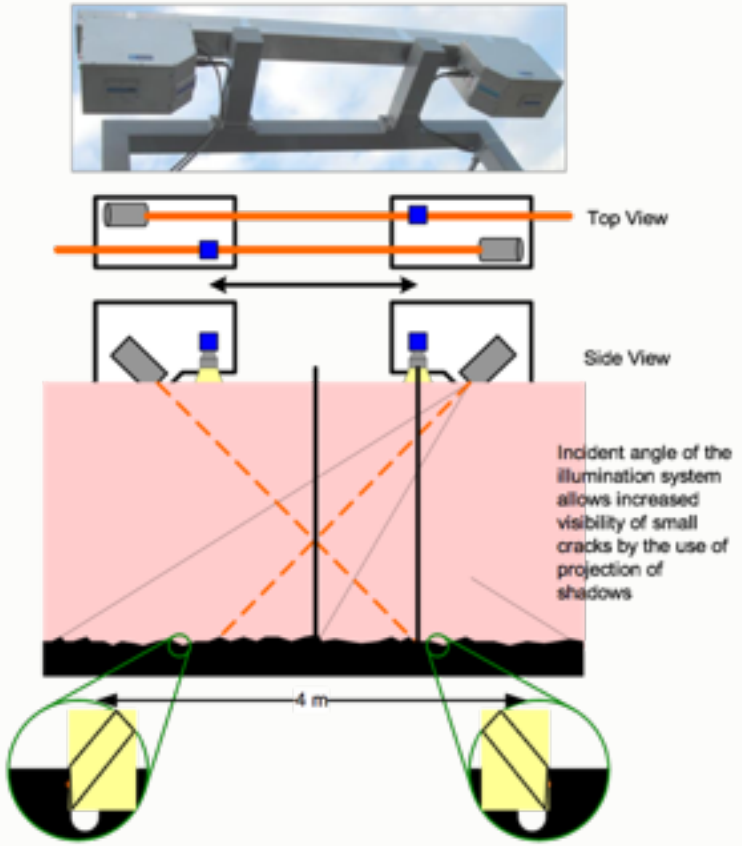
# Automated PCI Survey

*Dynatest Pavement Condition Survey System (PCSS)*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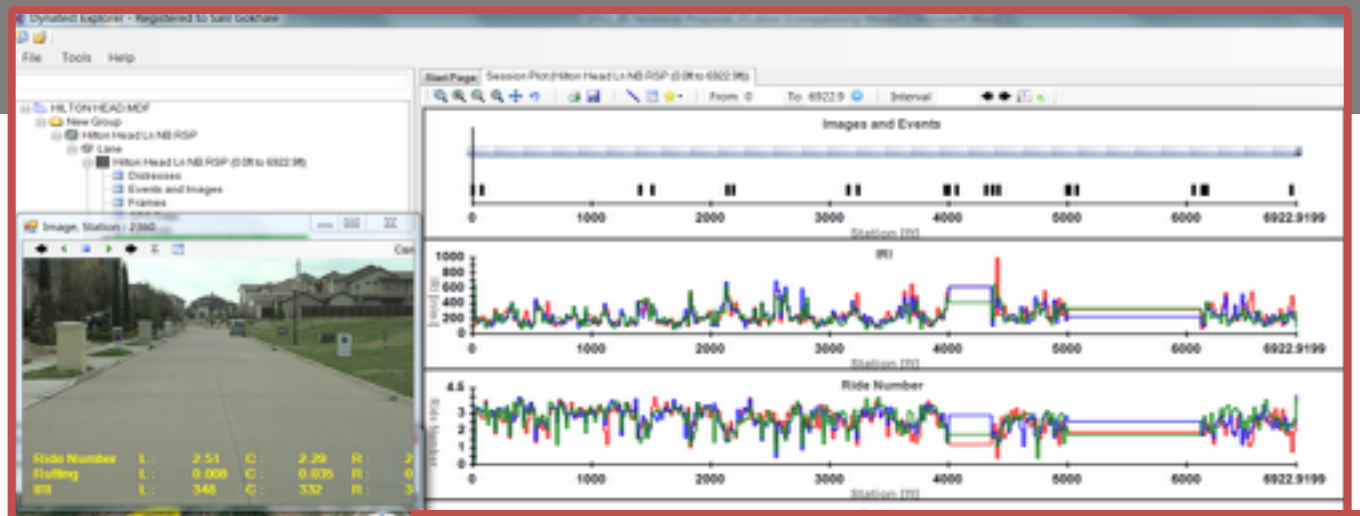


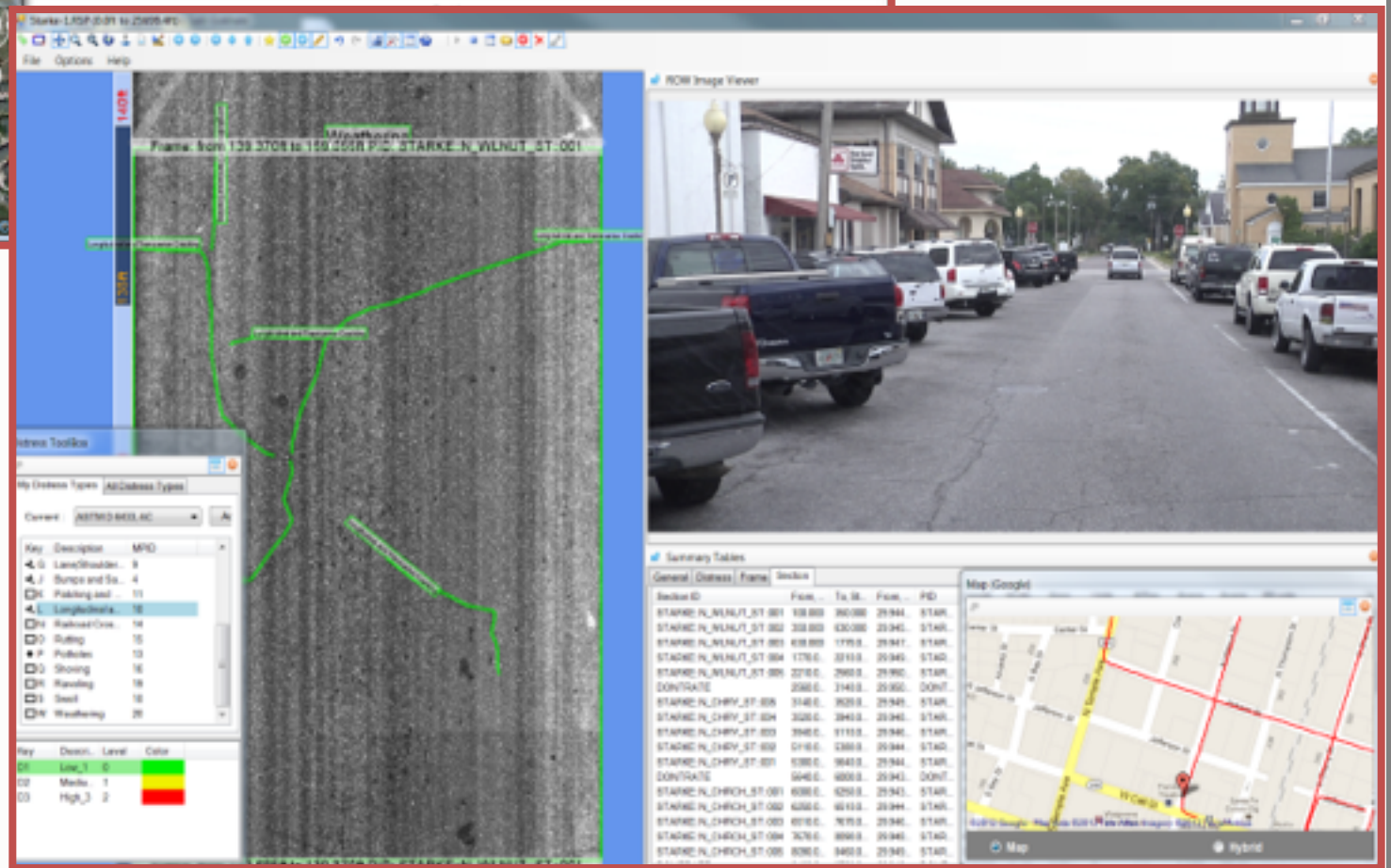


Dynatest Explorer (DE)

Distress Rating Module (DRM)

# Trained, Experienced PCI Inspectors

*Excellent "In the Field" or "In the Office"*

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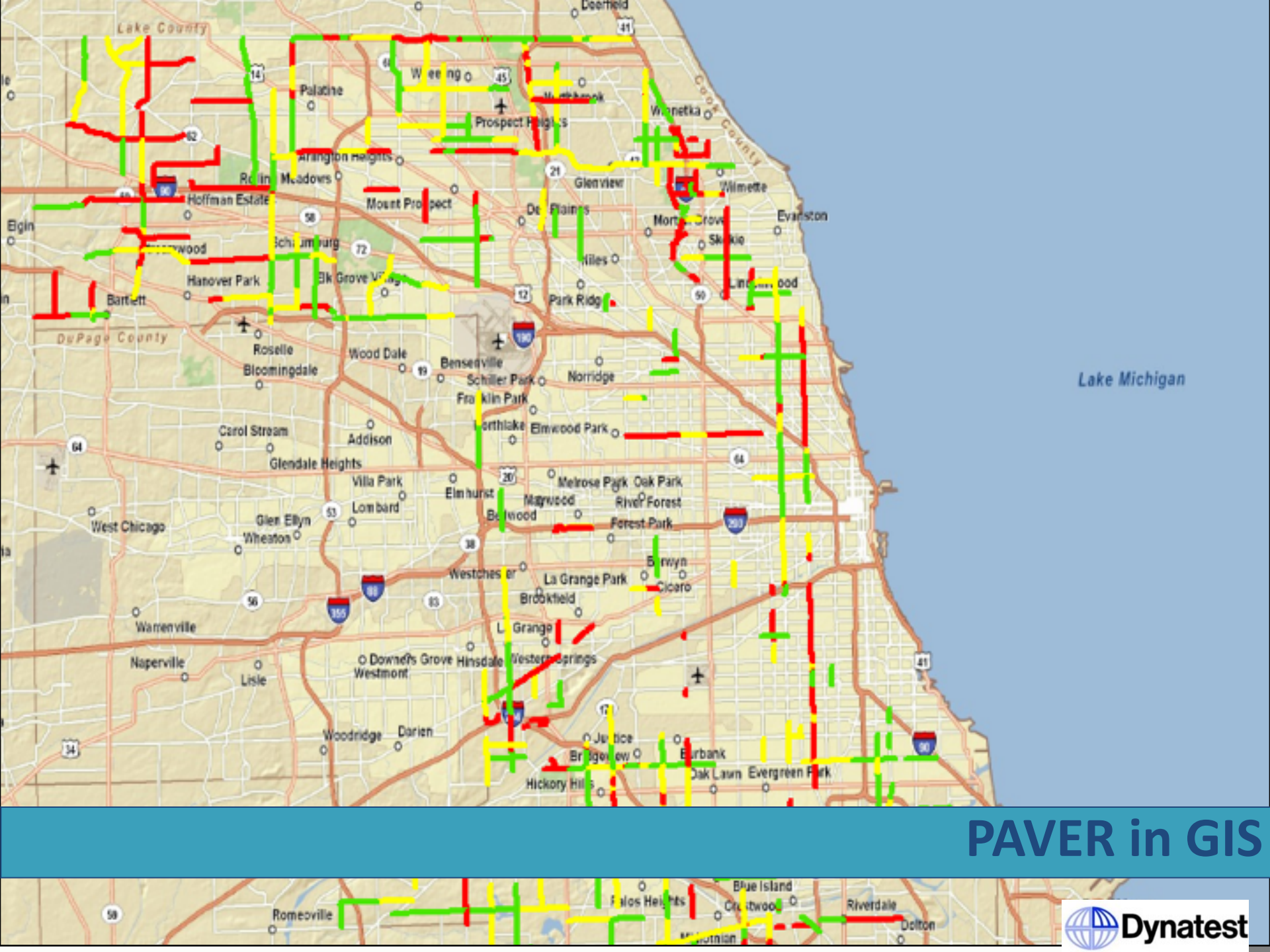


# PAVER in GIS

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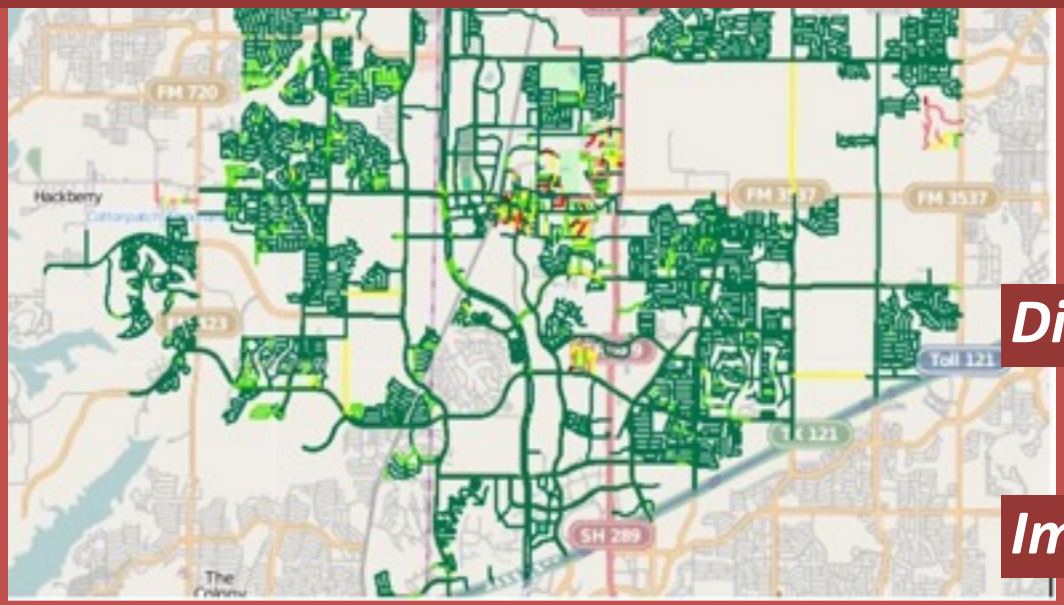
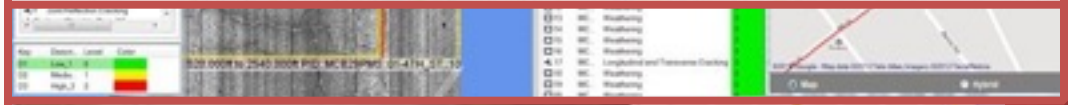
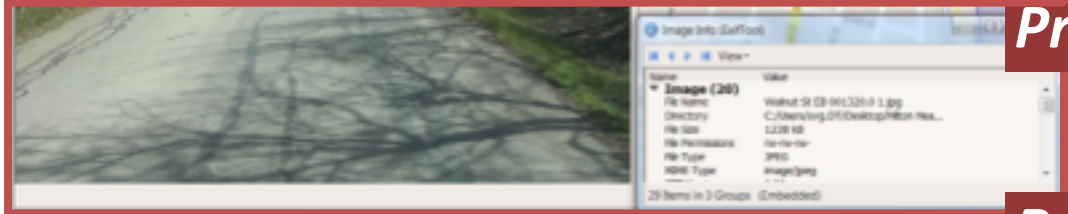
# Pavement Condition




*Distresses*

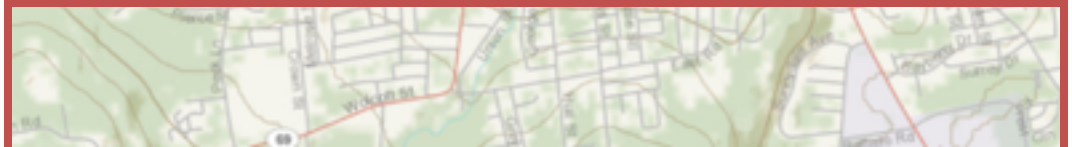


*Images*



*Profile Data*

*Base GIS*



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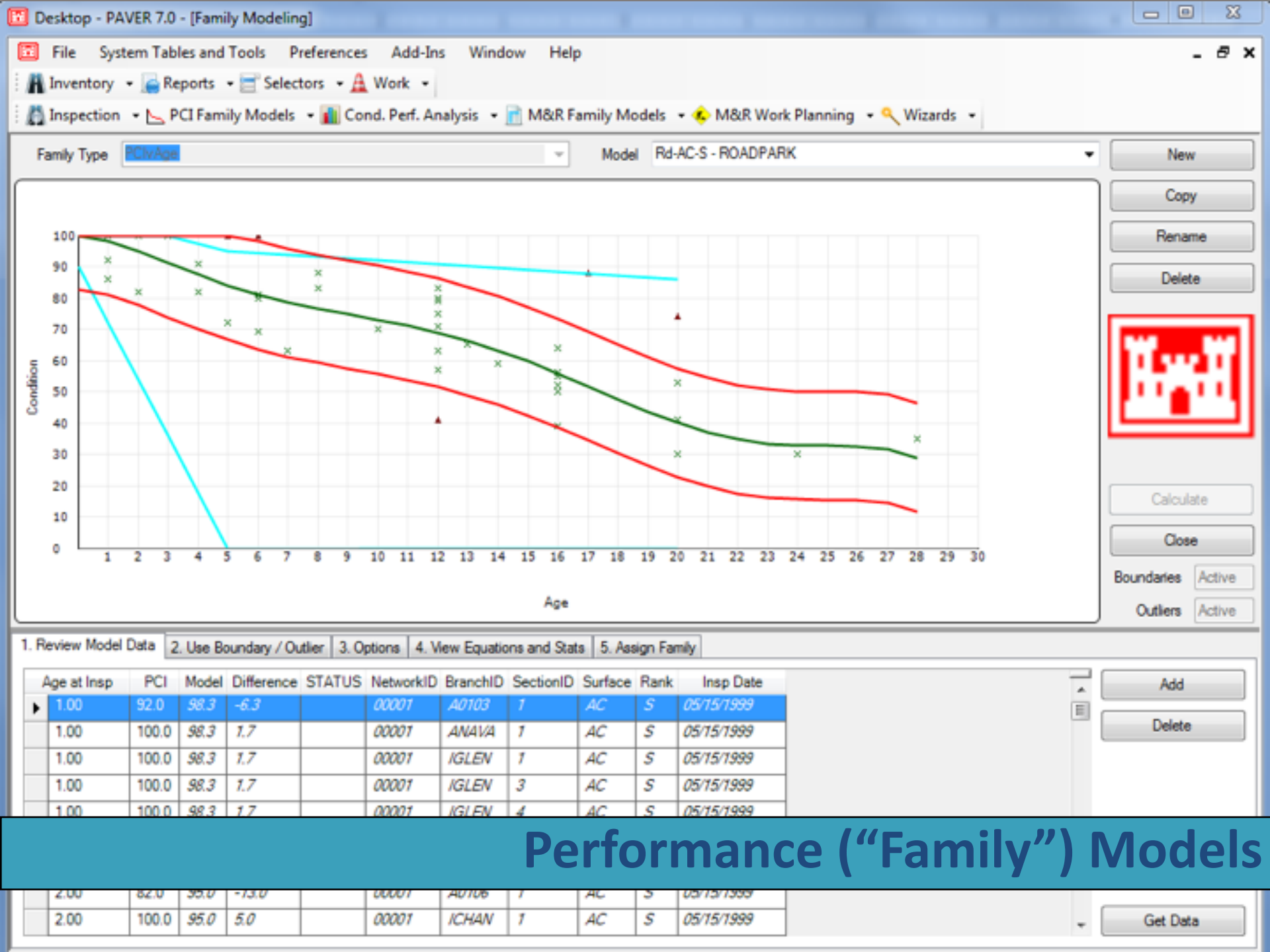
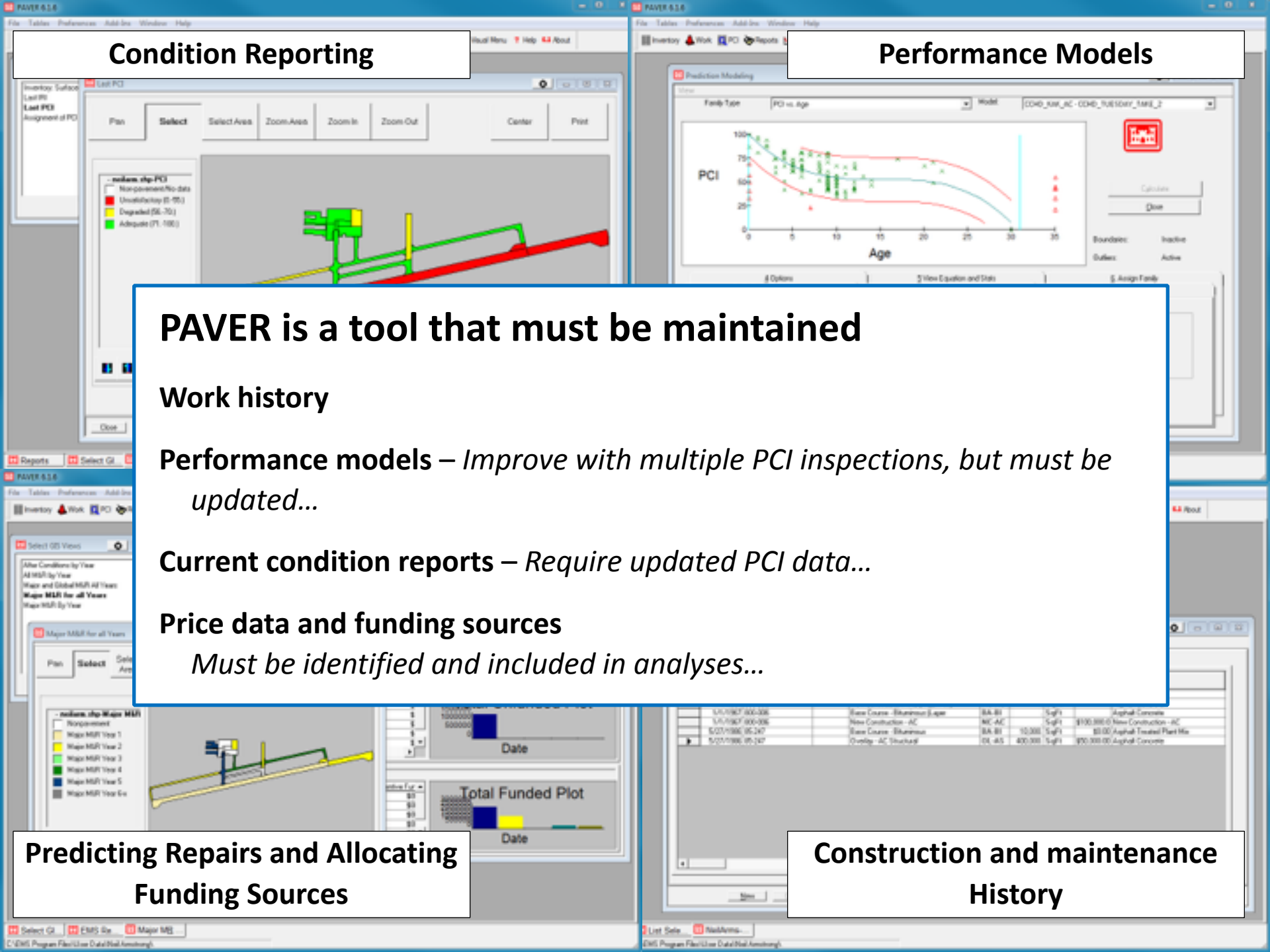

Desktop - PAVER 7.0 - [Family Modeling]
File
System Tables and Tools
Preferences
Add-Ins
Window
Help
Inventory
Reports
Selectors
Work
Inspection
PCI Family Models
Cond. Perf. Analysis
M&R Family Models
M&R Work Planning
Wizards
Family Type
PCIvAge
Model
Rd-AC-S - ROADPARK
New
Copy
Rename
Delete
Calculate
Close
Boundaries
Active
Outliers
Active
Condition
Age
1. Review Model Data
2. Use Boundary / Outlier
3. Options
4. View Equations and Stats
5. Assign Family
Age at Insp
PCI
Model
Difference
STATUS
NetworkID
BranchID
SectionID
Surface
Rank
Insp Date
1.00 92.0 98.3 -6.3 00001 A0103 1 AC S 05/15/1999
1.00 100.0 98.3 1.7 00001 ANAVA 1 AC S 05/15/1999
1.00 100.0 98.3 1.7 00001 IGLEN 1 AC S 05/15/1999
1.00 100.0 98.3 1.7 00001 IGLEN 3 AC S 05/15/1999
2.00 100.0 95.0 5.0 00001 ICHAN 1 AC S 05/15/1999
Add
Delete
Get Data
Performance ("Family") Models


Condition Reporting
Performance Models
PAVER is a tool that must be maintained
Work history
Performance models – Improve with multiple PCI inspections, but must be updated…
Current condition reports – Require updated PCI data…
Price data and funding sources
Must be identified and included in analyses…
Predicting Repairs and Allocating Funding Sources
Construction and maintenance History

# Data QC/QA

## 7. Project QC/QA Tasks

| | Responsible Parties | | |
|---|---|---|---|
| ***Data Element(s)*** | ***Quality Control*** | ***Quality Assurance*** | ***Description of Check (Standard Practice)*** |
| ***Pavement Inventory Definition and Database Integrity*** | ***Dynatest Team Project Engineers*** | ***Dynatest Project Manager and County Staff – Before and after the automated PCI survey*** | ***Verify pavement section attribute data were collected and entered into PAVER prior to and after survey.*** |
| | | | |
| ***GIS Sectioning*** | ***Dynatest Team Project Engineers*** | ***Dynatest Project Manager and County Staff – Before and after the automated PCI survey*** | ***Verify pavement sections were correctly defined in GIS and properly linked to the pavement management database.*** |
| | | | |
| ***Automated PCI Inspection Data Collection*** | ***Dynatest Project Engineers and Technicians*** | ***Dynatest Project Manager (in the field)*** | ***Daily checks and calibration of vehicle instrumentation – GPS, DMI, RSP, and image collection hardware and software.*** |
| | | | |
| ***Automated PCI Inspection Data Interpretation*** | ***Dynatest Project Engineers and Technicians*** | ***Dynatest Project Manager and County Staff (in the field/office)*** | ***Verify accuracy of processed data during and following data interpretation.*** |
| | | | |
| ***Analysis and Reporting*** | ***Dynatest Project Engineers*** | ***Dynatest Project Manager and County Staff*** | ***Verify accuracy of analyses.*** |

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# *PAVER Analysis and Reporting*

## *Cook County Conditions and M&R Budget Scenarios*

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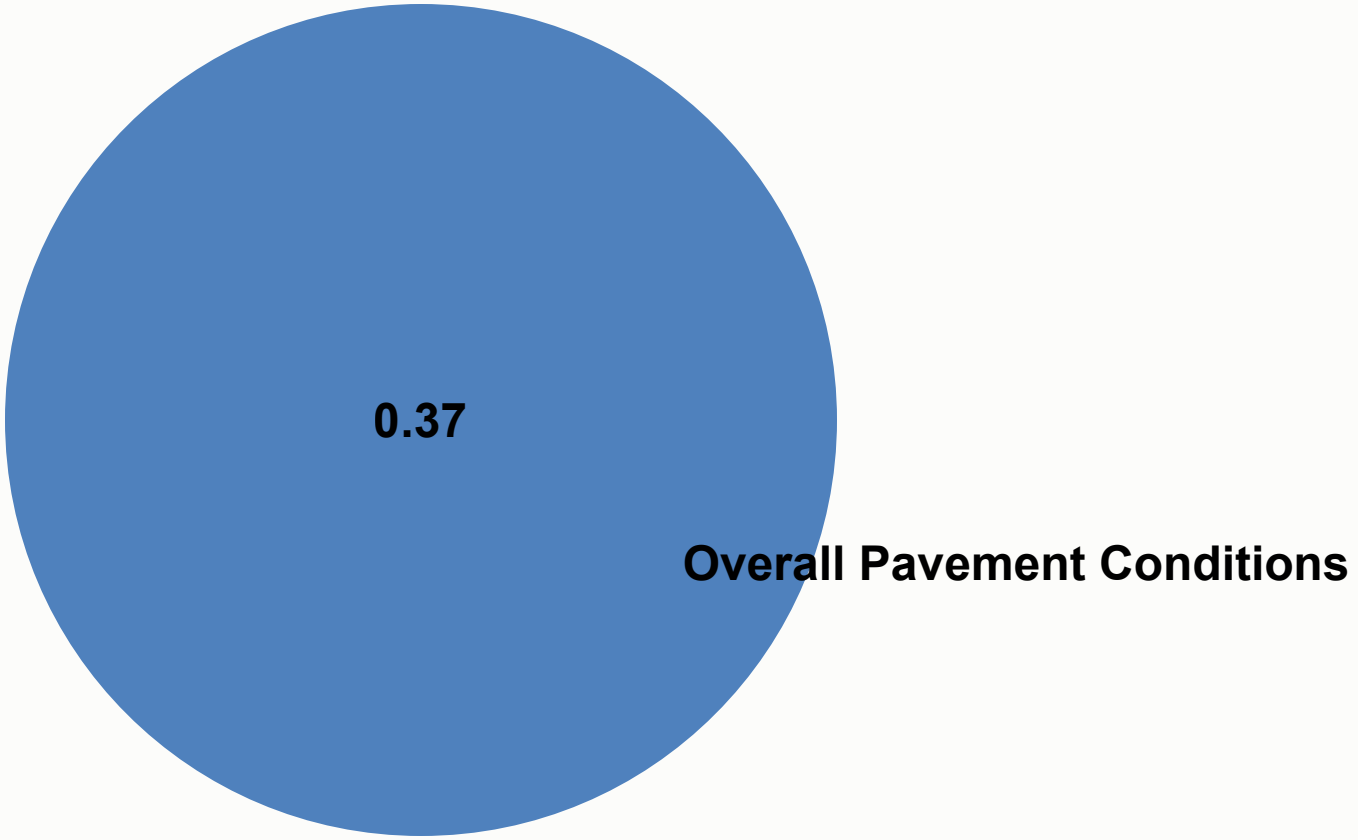
# Overall Pavement Conditions

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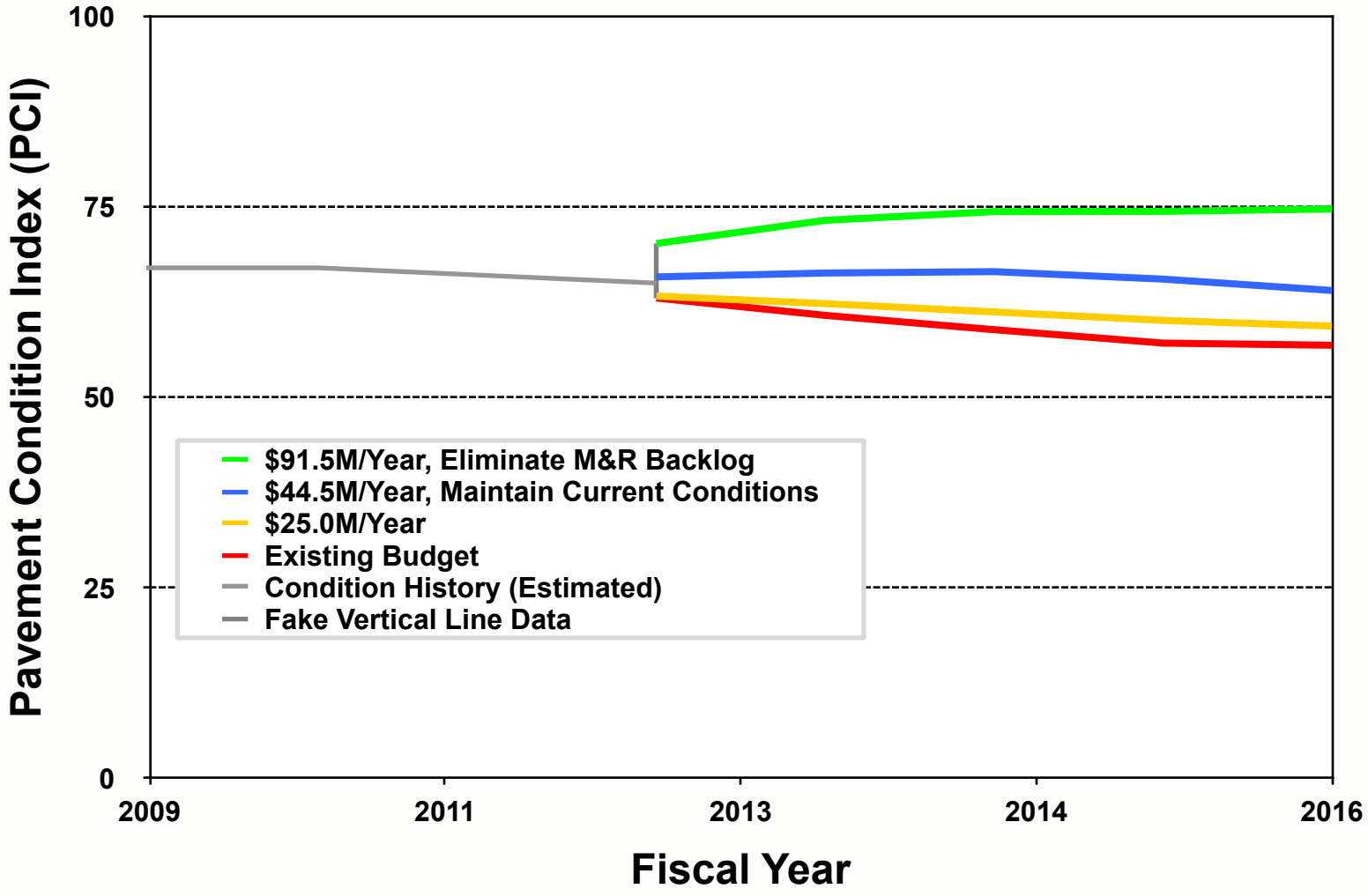
# Impact of Funding on Pavement Condition

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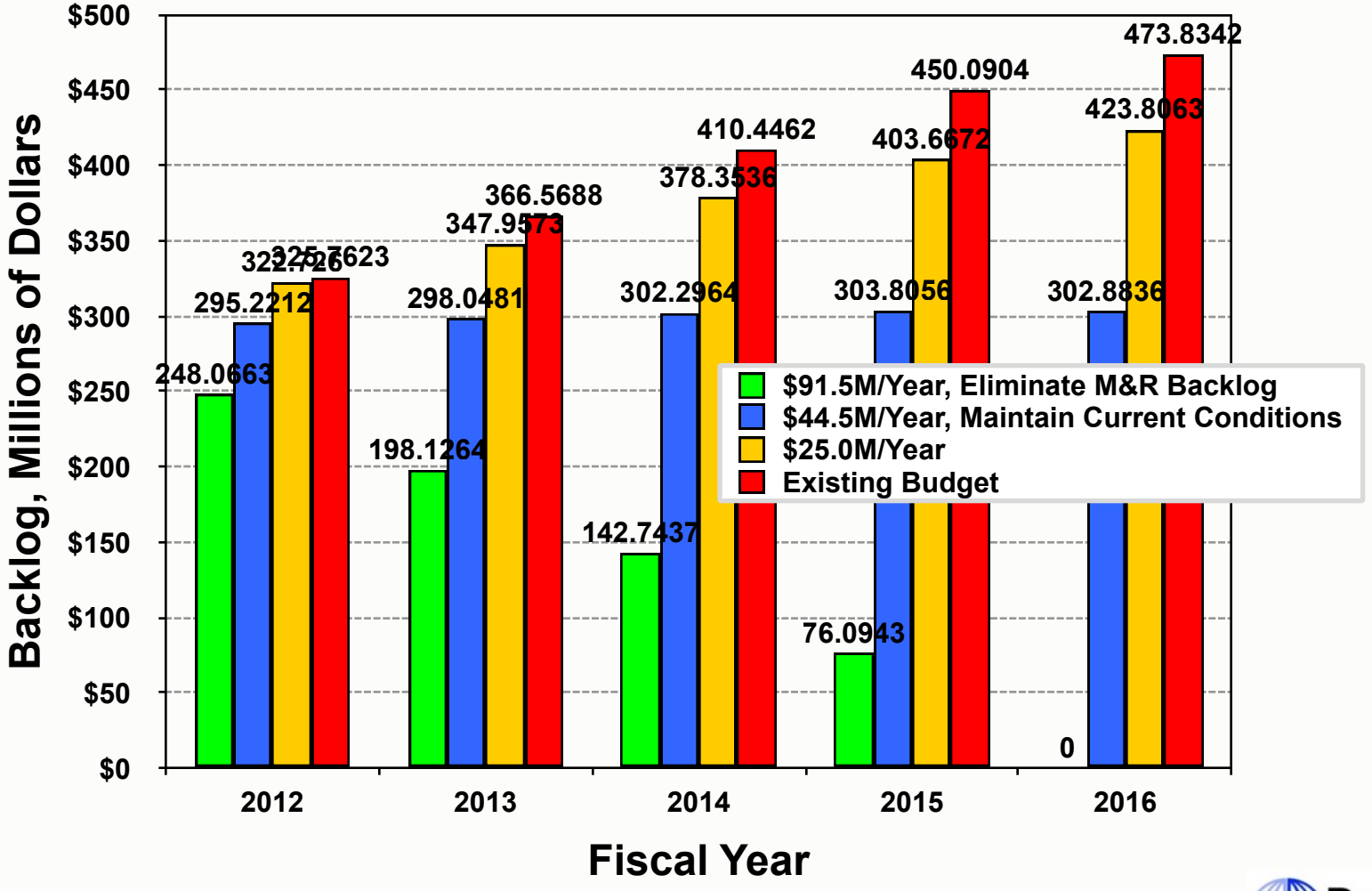
# Impact of Funding on Pavement M&R Backlog

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# Summary

**Pavement Imaging Technologies**

- ✓ Faster Data Collection
- ✓ Comprehensive (Surface distresses + Profile + Rutting + Pavement Geometry)
- ✓ Safer
- ✓ Day and Night (Airports)
- ✓ Permanent Record (QC/QA)
- ✓ Geo-referenced Data
- ✓ Automatic Export to PMS Software (PAVER)

**A Successful Application of Pavement Imaging Technologies for PMS implementation requires:**

- ✓ Excellent trained and experienced PCI inspectors
- ✓ Excellent project management and communication
- ✓ In-house pavement management “champions” – along with GIS and IT resources
- ✓ Trained and experienced project staff with subject matter expertise
- ✓ Active QC/QA program

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# Thank You!


**Northwest Pavement Management Association Conference – 2014**

**Presented By:** **Alvaro Ulloa-Calderon, PhD**
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**Dynatest Consulting, Inc.**

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