

Automated Pavement Rating – National Practice

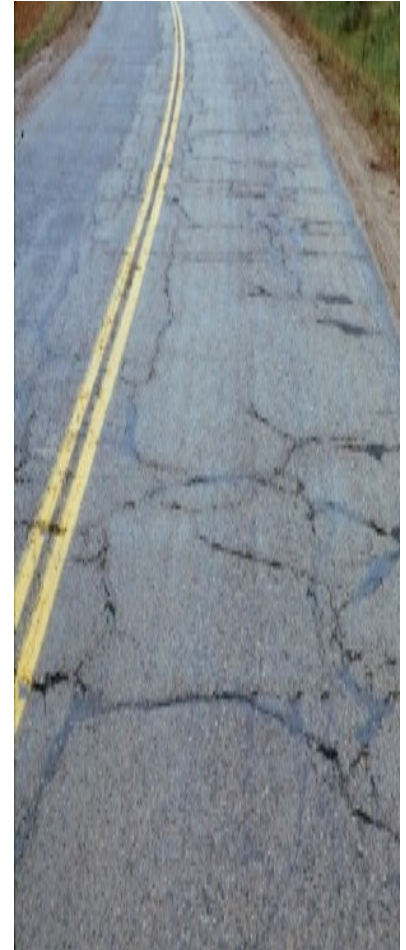
2018 NWPMA Fall Conference
October 24, 2018

Organization

- Condition surveys
 - Data collection
- Automated surveys
- Highway agency trends with automated data collection
- Data quality

Condition Surveys

- Assess existing condition
- Predict future condition
- Estimate budget needs
- Evaluate budget impacts
- Support asset management
- Project selection
- Treatment selection



Data Collection



Manual
Walking &
Windshield

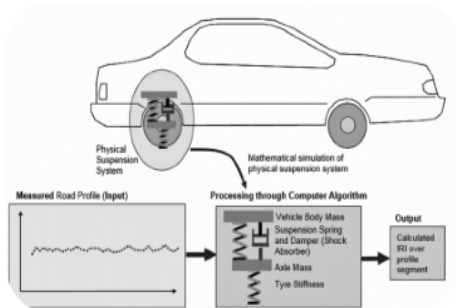


Semi-
Automated



Fully
Automated

What Do We Collect



Data Collection

AASHTO / ASTM
Standards



Rutting



Faulting

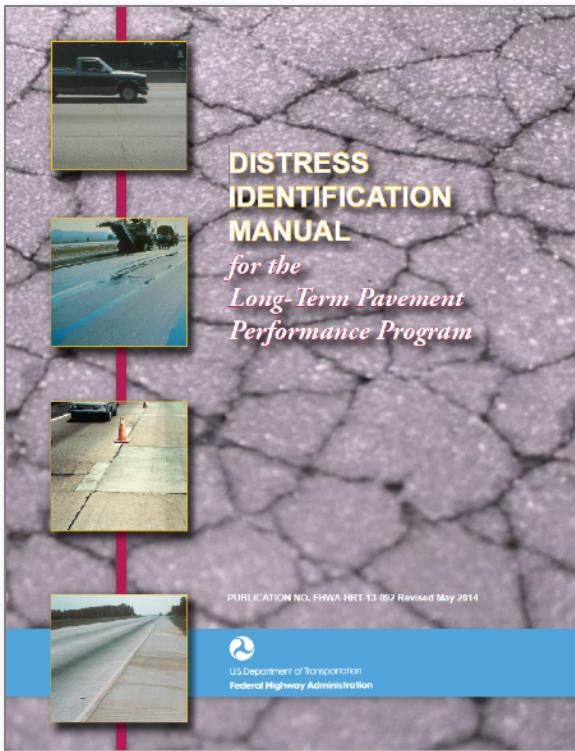


Roughness

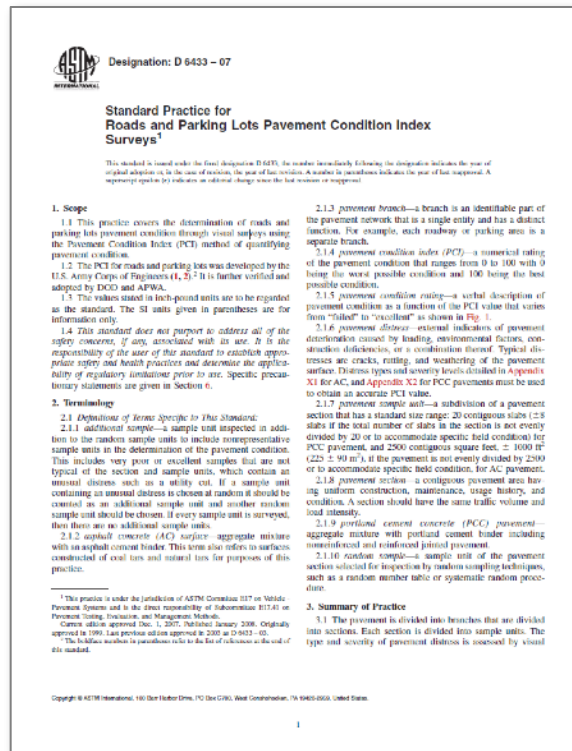
- Cross slope
- Radius of curvature
- Grade

What Do We Collect (continued)

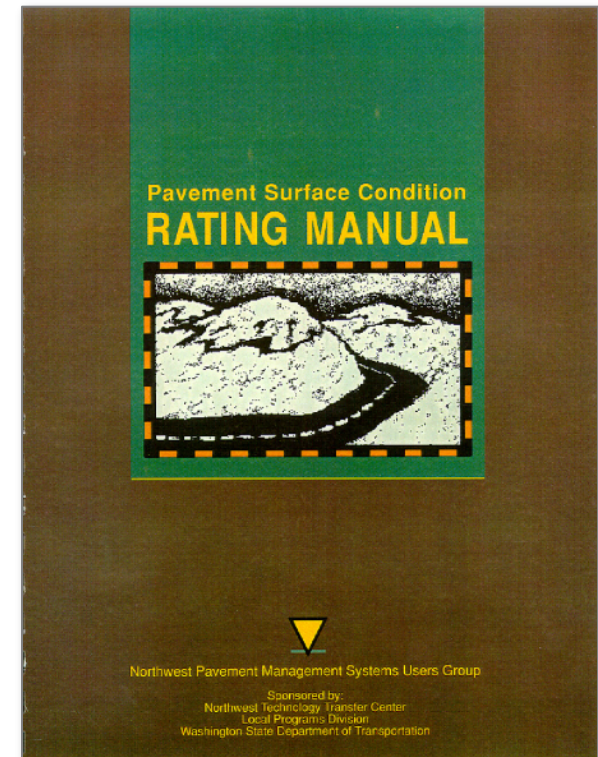
LTPP



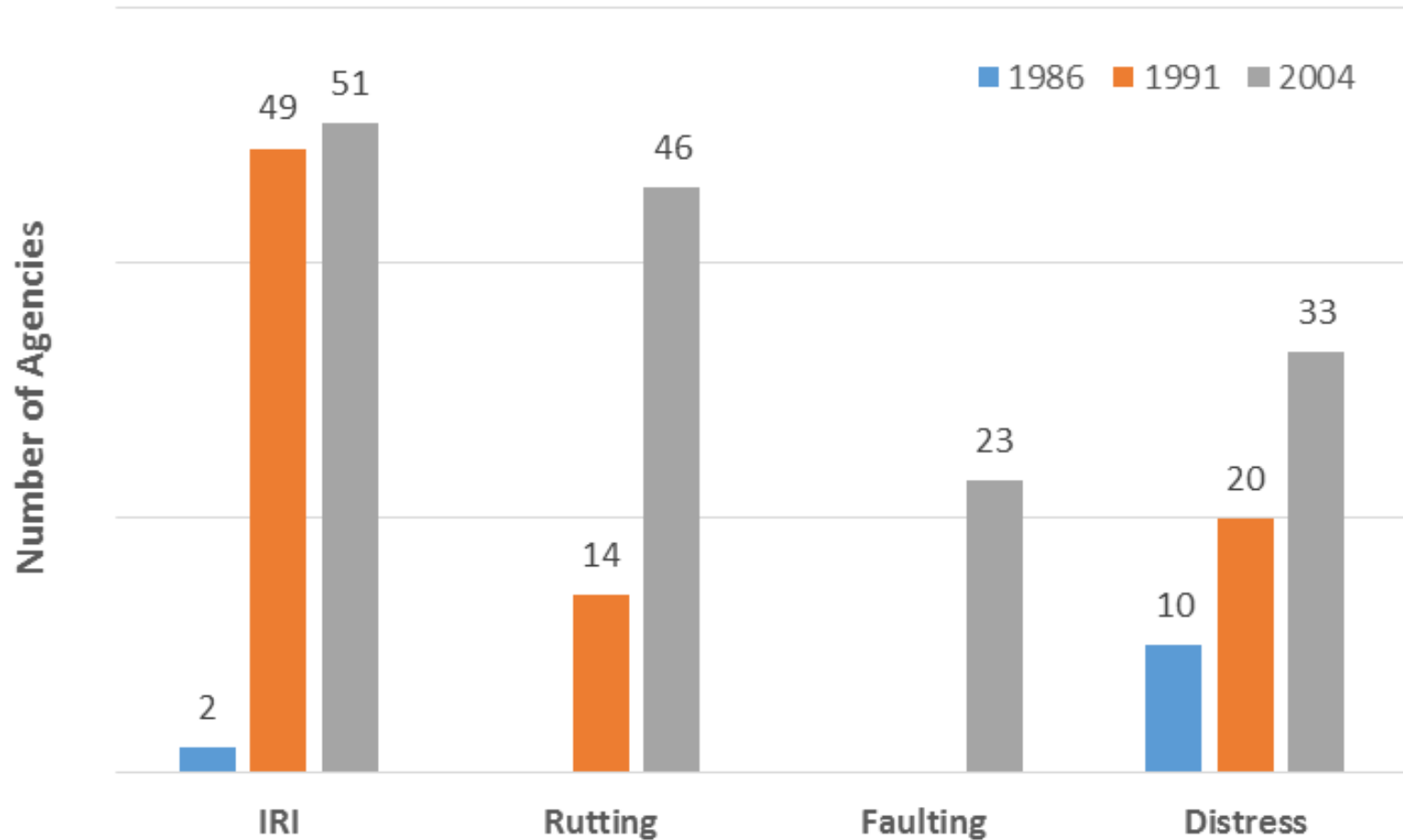
ASTM



NWPMA/WSDOT

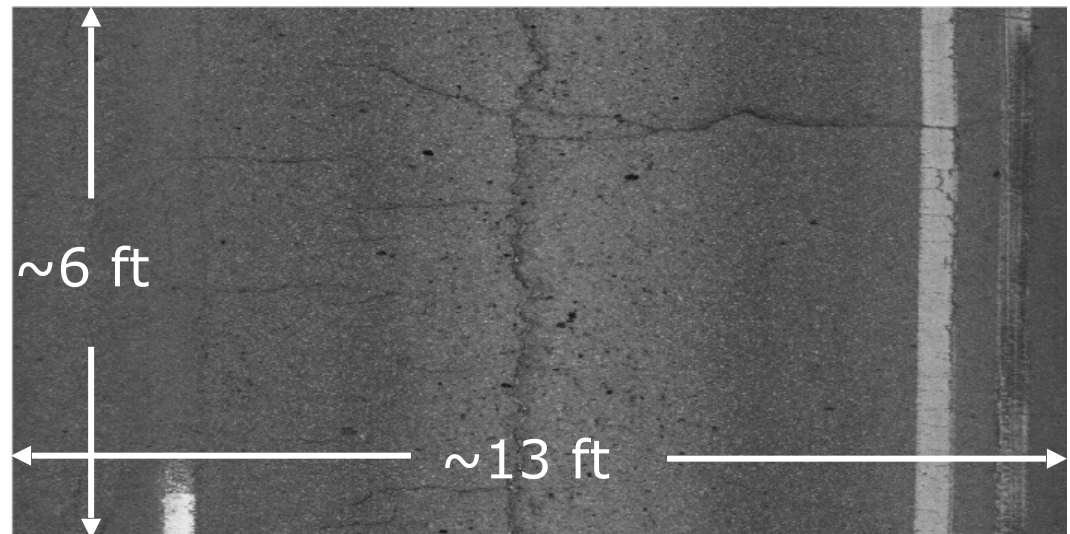


Automated Data Collection



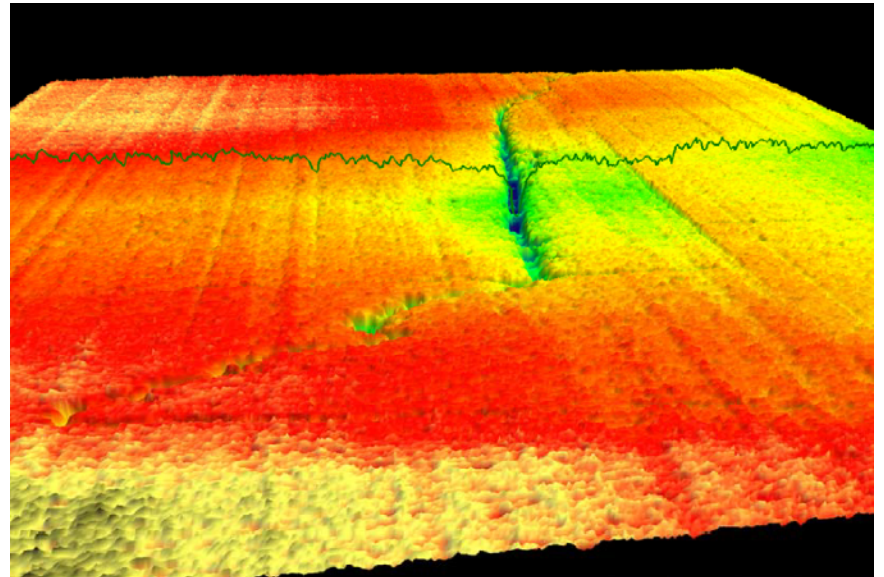
2D Systems

- Area or **line-scan** camera
 - Captures laser beam reflection
 - Software generates surface image
- Surface distress determined by:
 - Human rater viewing images or
 - Analysis software

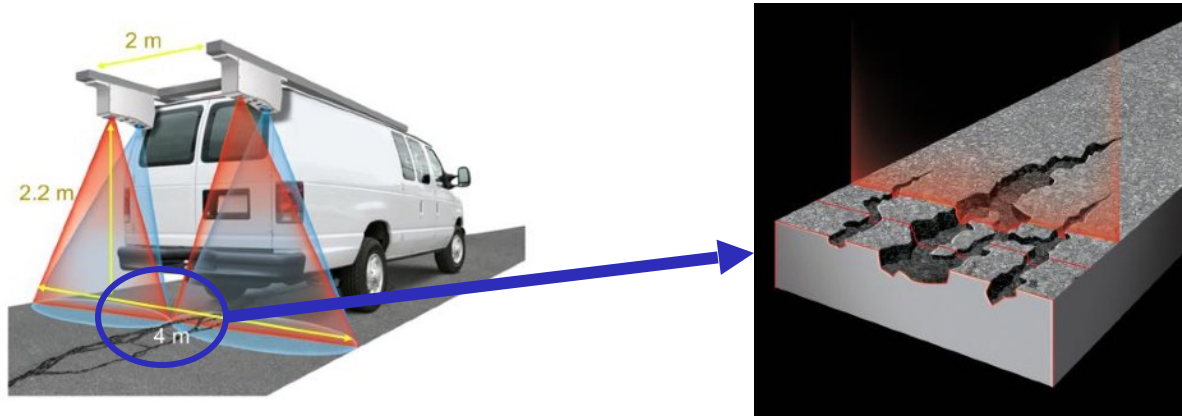


3D Systems

- High resolution 2D and 3D continuous profile
- Software & algorithms to detect:
 - Cracking ($>1\text{mm}$)
 - Raveling
 - Potholes

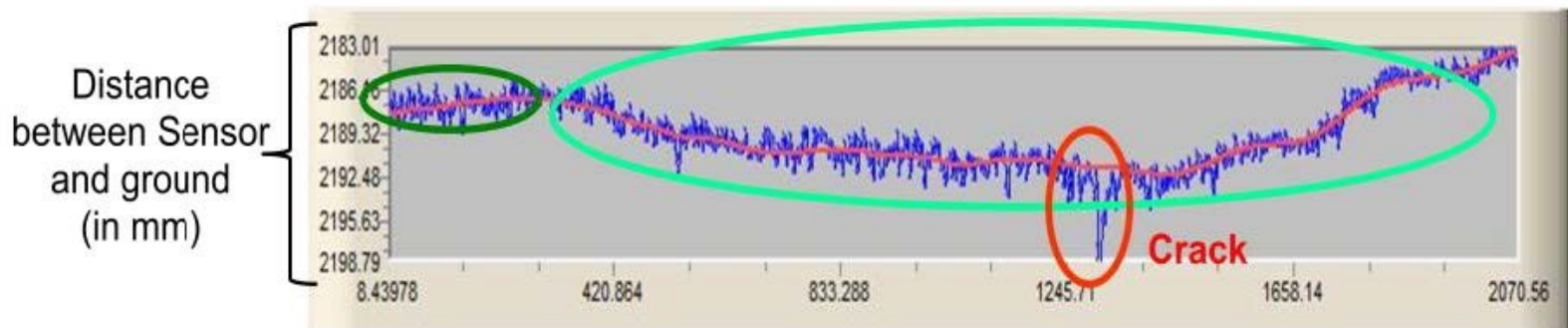


3D Systems (continued)



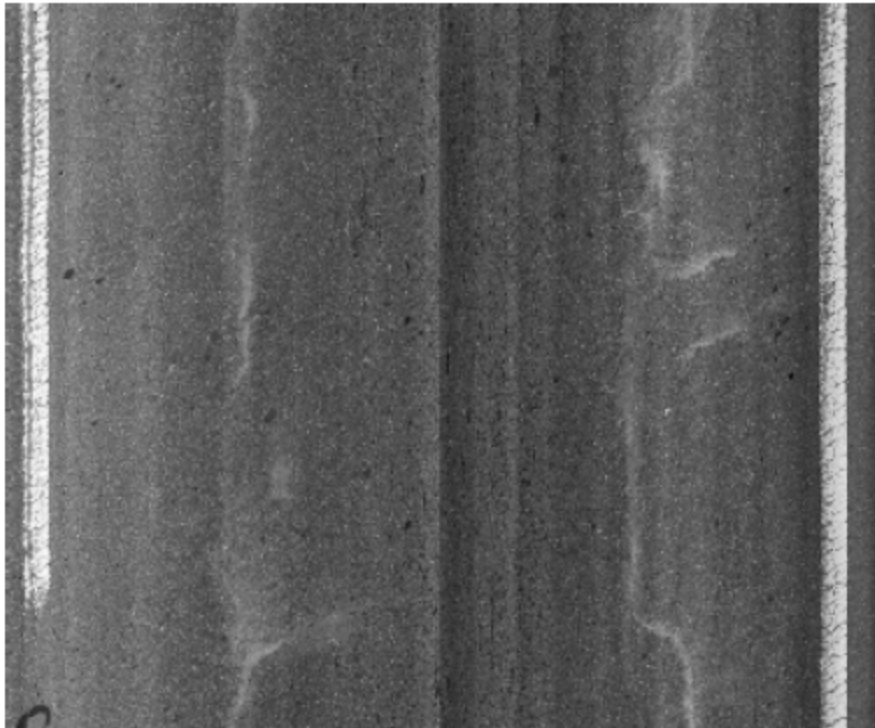
Macro-texture

Rut

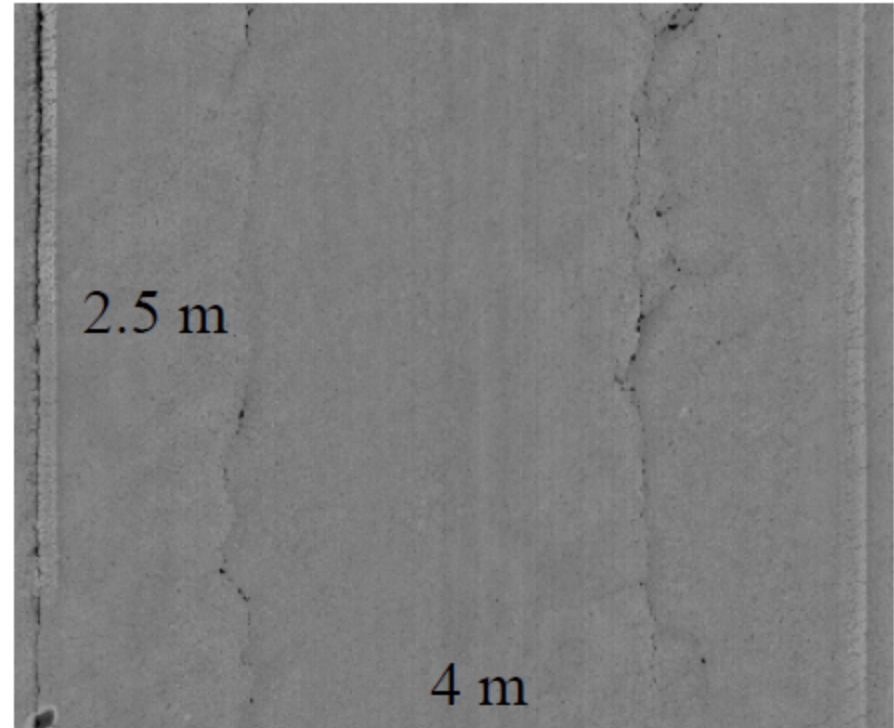


3D Systems *(continued)*

**2D Intensity Data
(reflected light)**

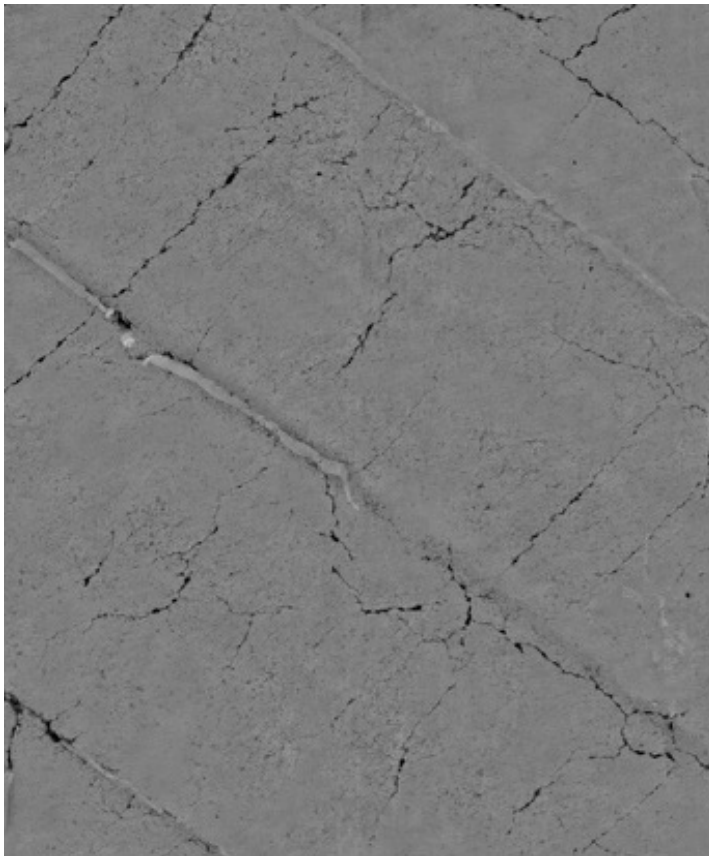


**3D Range Data
(height)**

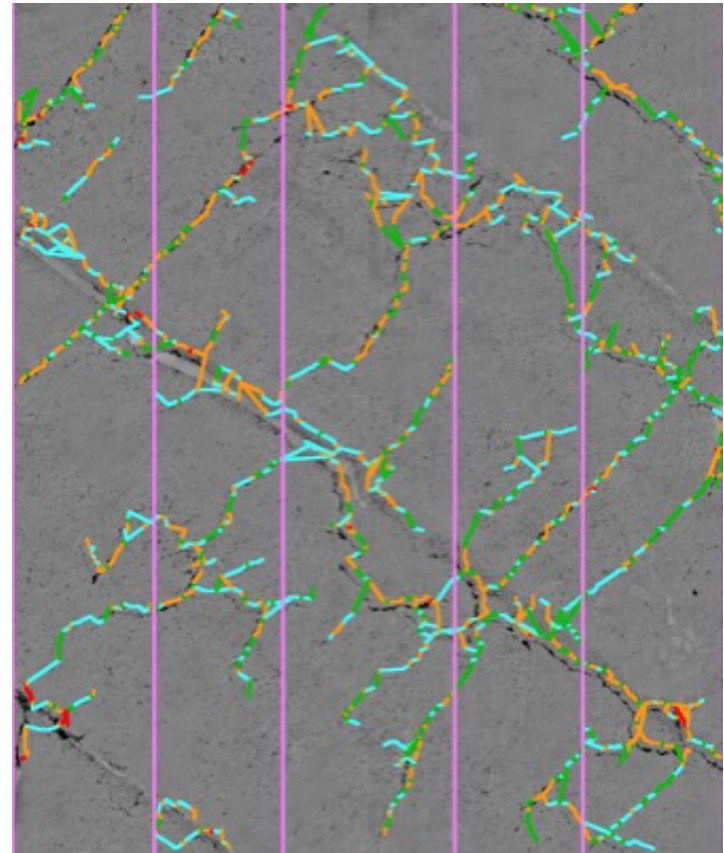


3D Systems *(continued)*

3D Laser Image



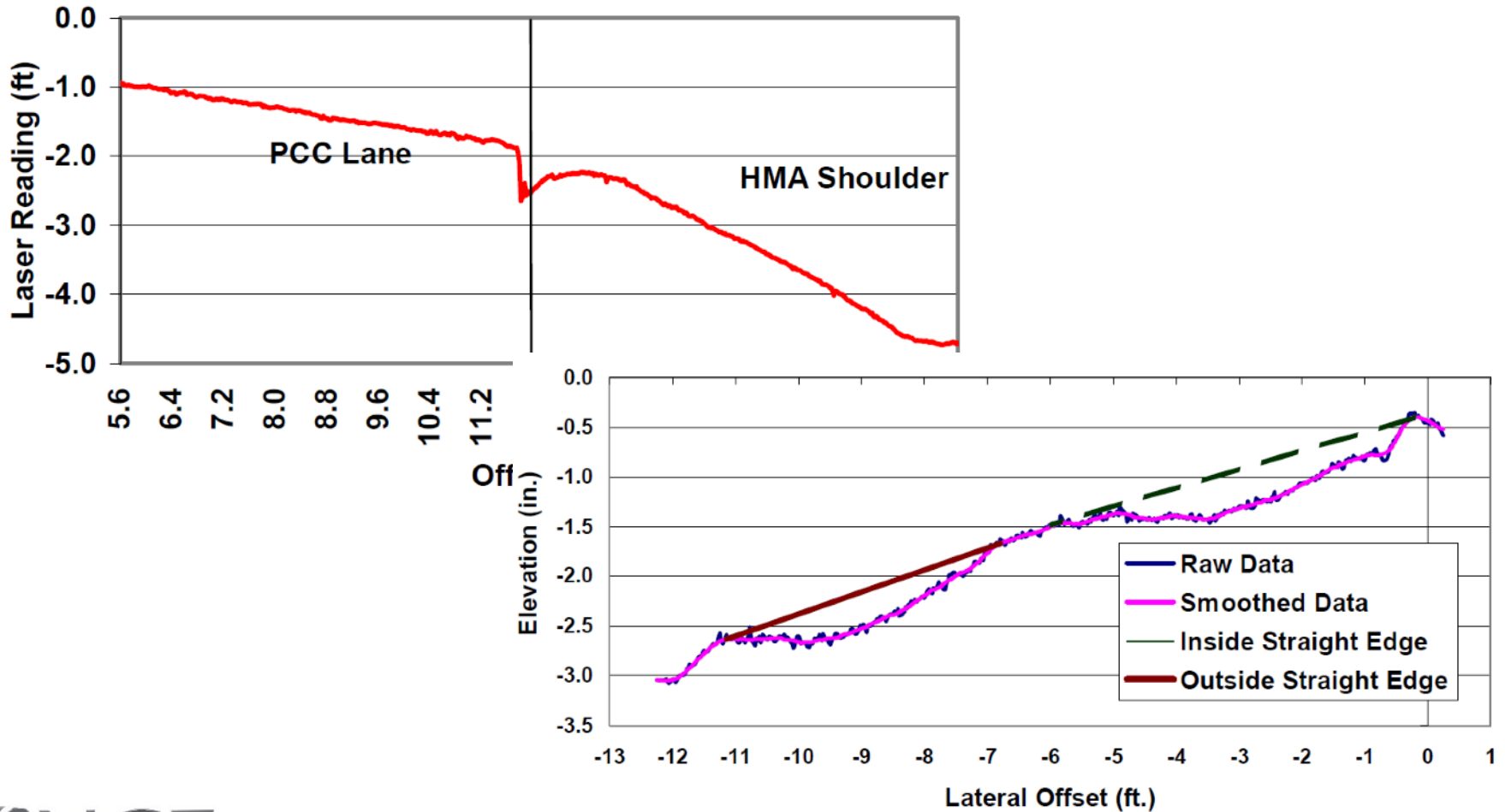
Automated Crack Detection



How good is 3D?

- Need precise and clear distress definitions
- Algorithm accuracy is critical
- Compare to manual surveys
 - Laurent et al. (2014) evaluated 6,200 mi, 96% good agreement in crack type, multiple runs very repeatable
 - TxDOT (2014) evaluated 20 different sections, similar distress values

Example of Results



Advantages/Disadvantages

- **Advantages**

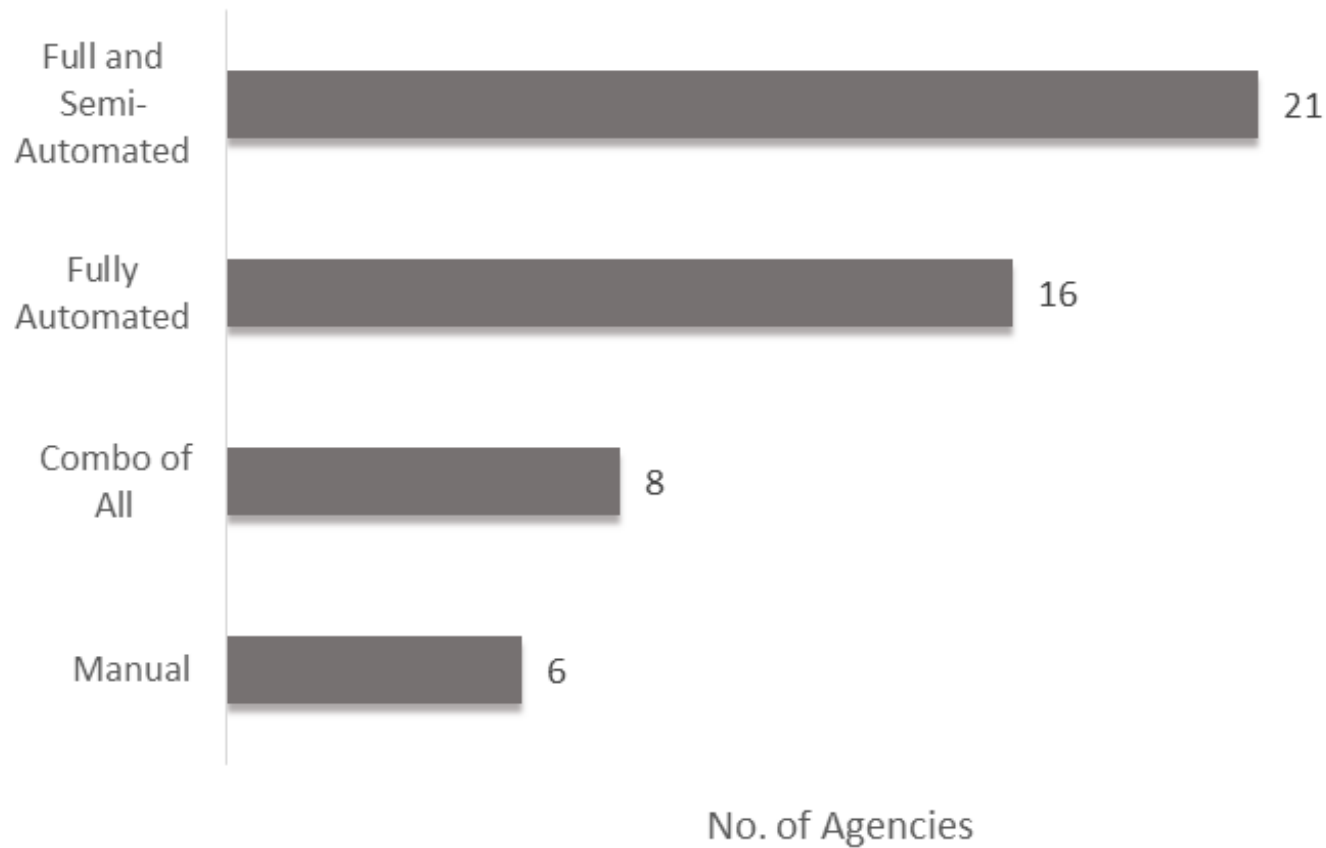
- Safety
- Accuracy for certain distresses
- Faster data collection and processing
- Track distress over time
- Asset data collection

- **Disadvantages**

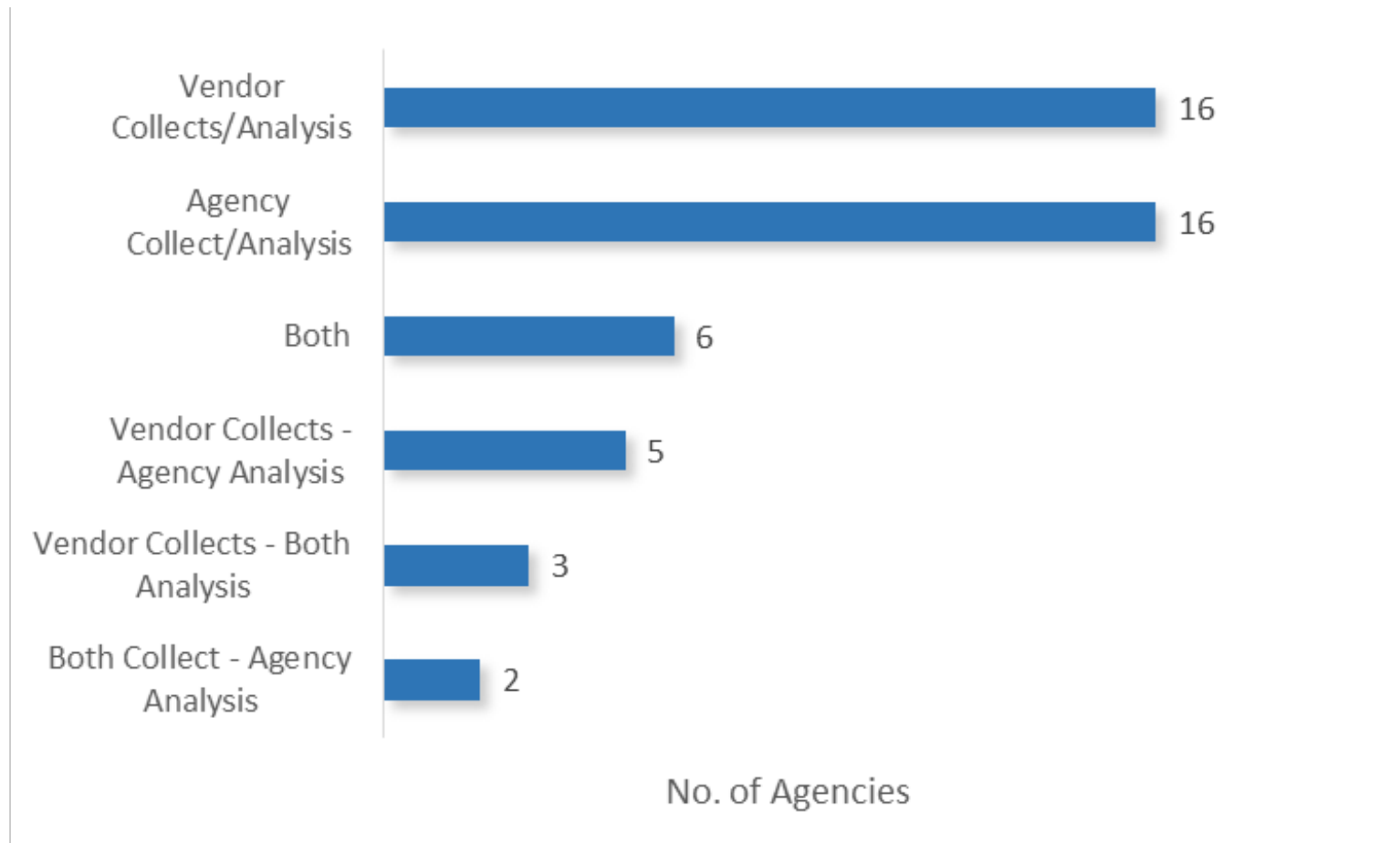
- Link to historical manual distress data
- Changing technology
- Higher cost
- Potential vendor variability
- May required modification to distress manual, decision trees, models, etc.

***Trends in Automated Data
Collection
(2018 survey)***

Collection/Analysis Methods

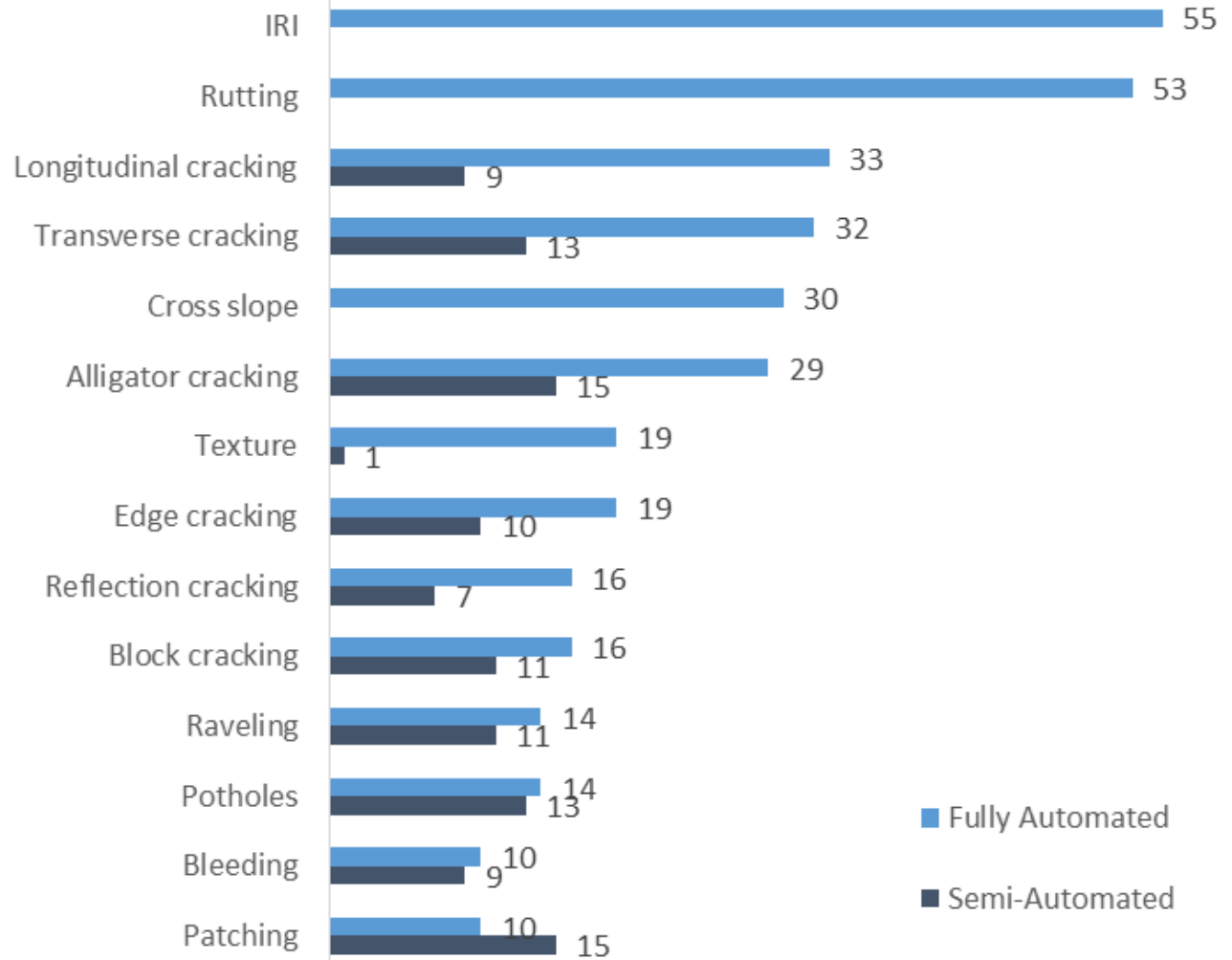


Who does what?



What's collected?

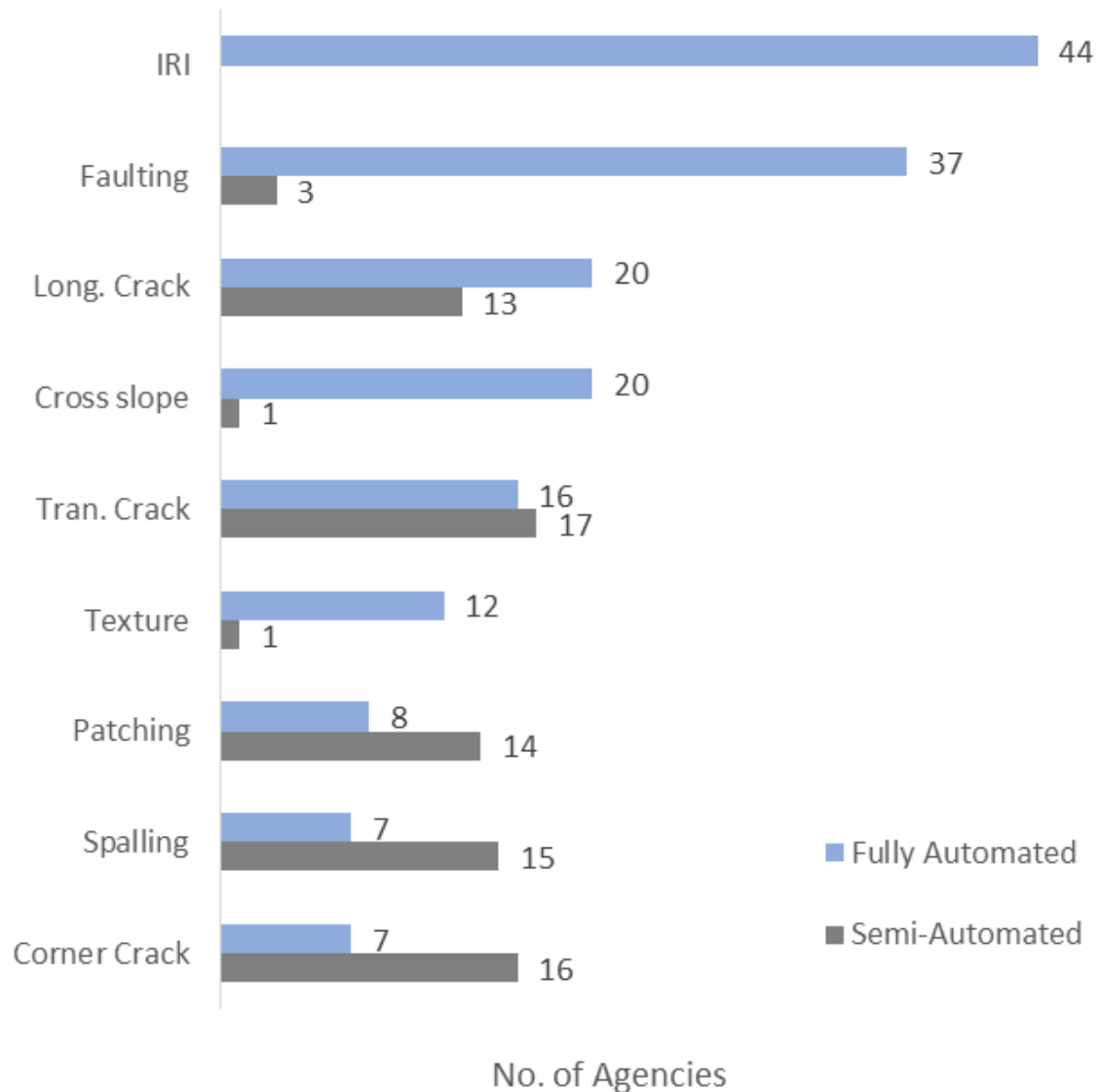
Asphalt Pavements



No. of Agencies

What's collected (continued)?

Jointed Plain Concrete Pavements



Data Quality

- DOTs required to have data quality management plan (FAST Act)
 - Equipment calibration & certification
 - Certification process for manual data collection
 - Quality control
 - Sample, review & check processes
 - Error resolution procedures
 - Data acceptance criteria

Process Overview

Standards



- Equipment
- Rater

Control Site



- Ground truth
- Automated
- Compare for accuracy & repeatability

Production



- Verification sites
- Quality control (collection team)

Data Processing



- Acceptance (collection team)

Independent Verification



- Sampling
- Data checks
- Image quality

Agency Acceptance



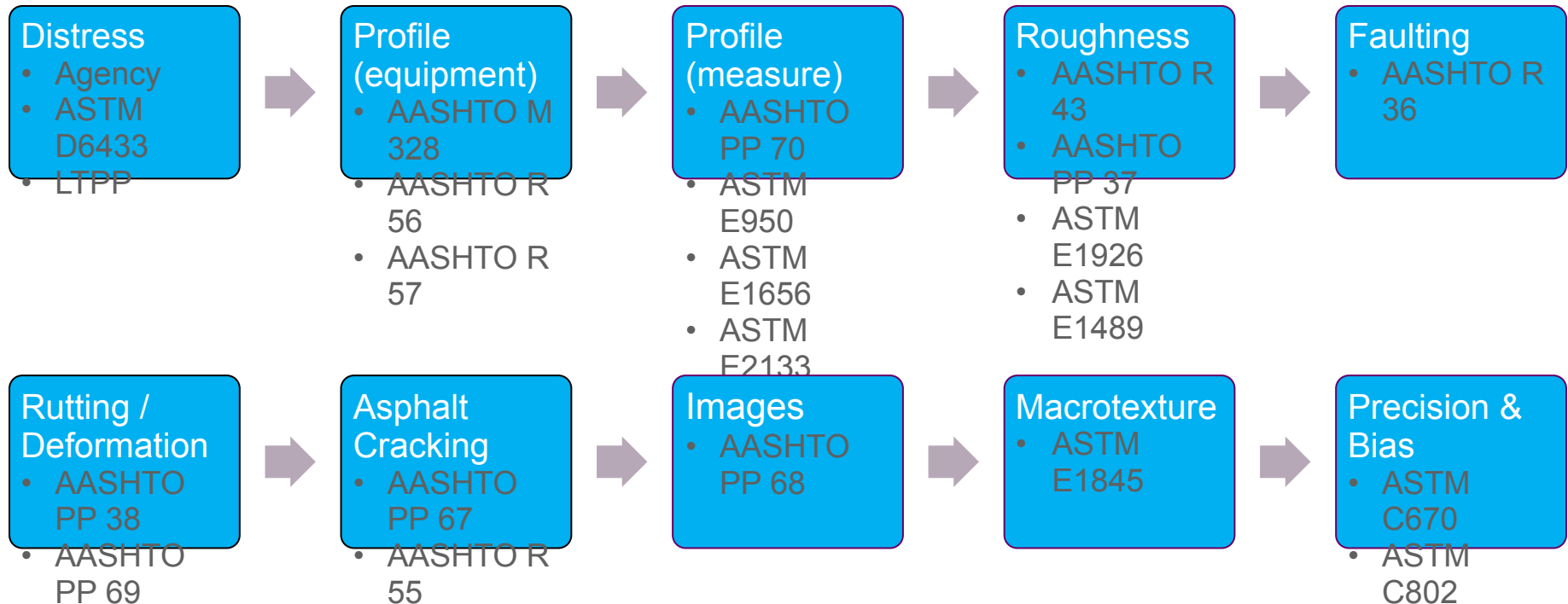
- Data checks
- Image quality
- Compare to previous results

PMS



- Data load
- Additional functional checks

Standards



Monitoring Sites

- **Control**
 - Conducted by agency
 - Establish ground truth
 - Certify, calibrate, verify equipment
 - Rater training and certification
 - Located proximity to central office
- **Verification**
 - Conducted by agency
 - Spread across network
 - Location known by collection team
 - Can be traversed multiple times during collection
- **Blind**
 - Same as verification
 - Location unknown to collection team

Rater Certification

- Agency-specific distress definitions
- Training
 - Conducted by agency or vendor
 - Identify and recognize agency distress
- Certification
 - Must be done by agency

Quality Control (examples)

- Equipment calibration & certification
 - Profiler
 - Distance measuring instrument
 - Linear referencing system
- Location
 - Match agency
- Data completeness
 - Length
 - Number of sections
 - Blank or null values
- Distress/condition
 - Expected range
 - Pavement type
- Images
 - Quality
 - Confirm distress

QC Detail Examples

- Profiler
 - Repeatability $\pm 5\%$ (three runs)
 - Accuracy $\pm 10\%$ of agency value
 - Bound test ≤ 8 in/mi
 - Block check ± 0.1 in
- Imagery focus, color, luminance quality
- Location ≤ 30 ft
- IRI (3 runs):
 - Std ≤ 0.06 in/mi and
 - ± 0.06 in. agency
- Rut (3 runs):
 - Std ≤ 0.06 in. and
 - ± 0.06 in agency
- Fault (multiple runs and historical avg):
 - Std $\leq 15\%$

Example of Control, Verification, and Blind Site Requirements

Condition	Criteria (3 runs)
IRI	Std \pm 5% Class 1 profiler
Rutting	Std \pm 0.06 in Class 1 profiler
Faulting	Std \pm 0.06 in manual survey
Distress	\pm 10% manual survey
Images	<ul style="list-style-type: none">• Displayable and clear, continuous, correctly stitched with no missing or overlapping images, synchronized with geographic locations and associated attributes• \leq 10 images/mi or \leq 2 consecutive images/mi with poor quality• 1/8 in. wide cracks are visible



Example of Acceptance Requirements

- 100% data & image completeness
- Conduct field verification (5-10% sample)
 - Verify images & results
 - IRI: $>95\% \pm 10\%$ agency value
 - Rut: $>95\% \pm 0.06$ in. agency value
 - Fault: $>95\% \pm 0.06$ in. agency value
 - Cracking $>85\% \pm 10\%$ agency value

Example of Acceptance Requirements

(continued)

- Location: $>95\% \pm 30$ ft
- Downward and ROW images $> 95\%$ meet criteria
- Confirm 100% data upload to PMS
- Major rehabilitation segment $> 85\%$ of segments $\pm 10\%$ area agency value
- Year-to-year consistency checks

Example of Corrective Action

Deliverable	Acceptance	Testing	Action
Data completeness	> 98%	Total network miles	Re-collect
	100%	Delivered data accurately populated	Correct
	> 98%	Accurately populated with required data elements	Correct
	> 98%	Delivered data < 10 consecutive fixed missing segments	Correct
IRI, rut depth, & faulting	> 95%	Compliant with the verification testing requirements	Re-collect
Distress ratings	> 95%	Compliant with the verification testing requirements	Re-collect
Location Information	100%	Database check of accuracy and completeness	Correct
Photolog & pavement images	100%	20% random sample compliant with verification requirements	Re-collect

National Research

- NCHRP Synthesis (Spring 2019)
- NCHRP 1-57A (July 2019)
 - Standard definitions for automated cracking data
- NCHRP 1-60 (December 2021)
 - Calibration, certification, and verification of imaging systems

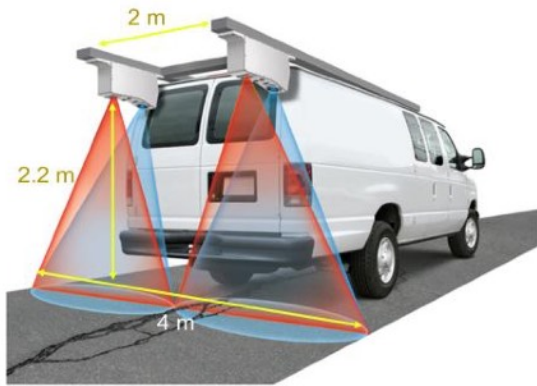
National Research *(continued)*

- FHWA Pooled Fund
 - Improving quality of distress and profile data collection and analysis
 - Standard data format
 - Transverse profile verif/valid/calib protocols
 - Cracking assessment protocols
 - Faulting collection and analysis standards
 - Quality management guide

<https://www.pooledfund.org/Details/Study/543>

Summary

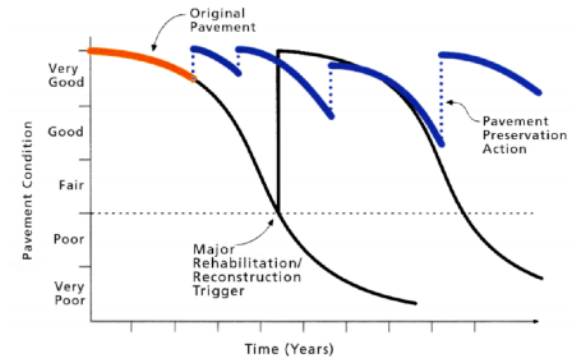
Data Collection



Data Quality



Pavement Management



Questions?



Linda Pierce

lpierce@ncenet.com

(505) 603-7993