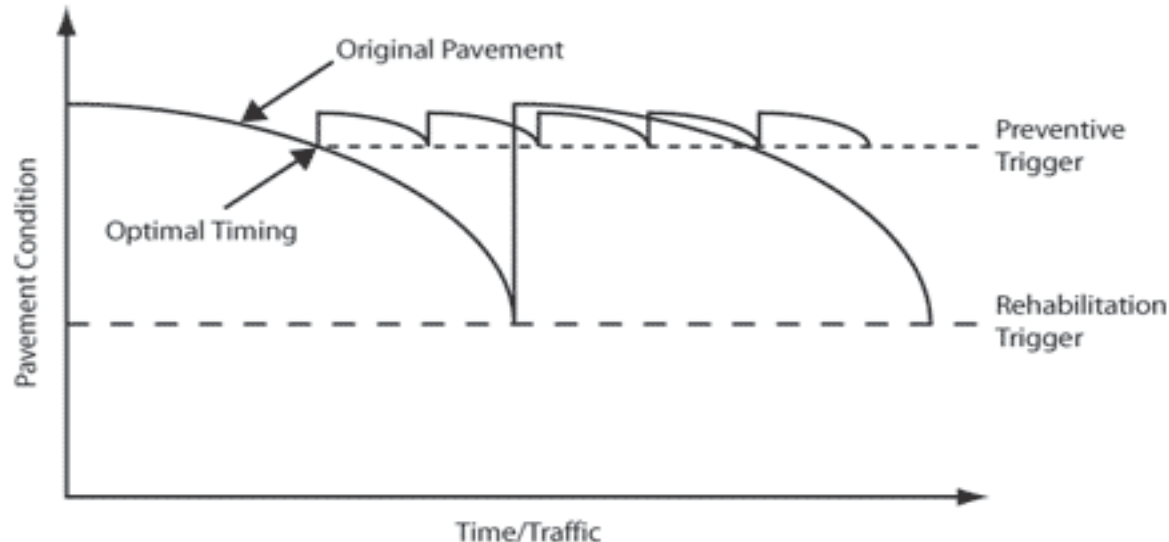




# Optimization of Maintenance Practices

- The **right strategy**, at the **right time**, on the **right road**
- Preventative maintenance and rehabilitation is more cost-effective than reconstruction
- Preventative maintenance provides a better driving experience



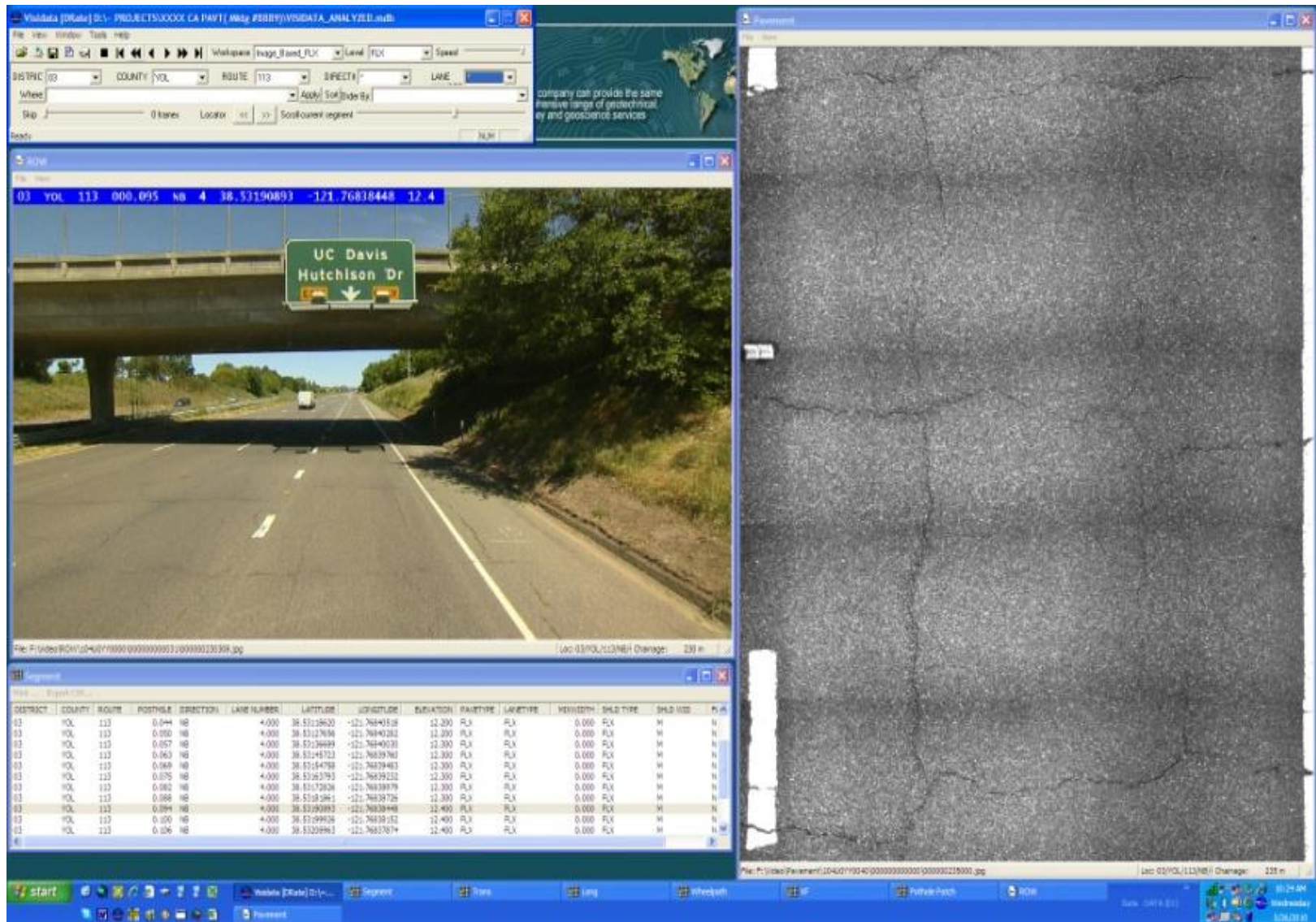
# What Does Roadway Management Require?

1. Accurate and repeatable **data** amassed over time
2. A system to compile and analyze **data** in order to create **information**
3. Engineering expertise to turn **information** into **action**



# Evolution of Automation





The screenshot displays a software interface with three main panels. The top-left panel shows project settings for DISTRICT 03, COUNTY VOL, ROUTE 113, and DIRECTION NB. The top-right panel features a world map and a text box stating "company can provide the same extensive range of geotechnical, survey and geoscientist services". The middle-left panel shows a street view of a highway with a green overhead sign for "UC Davis Hutchison Dr". The middle-right panel is a large, detailed image of a pavement surface with visible cracks. The bottom-left panel contains a data table with columns for DISTRICT, COUNTY, ROUTE, POSTMILE, DIRECTION, LAKE NUMBER, LATITUDE, LONGITUDE, ELEVATION, PAIRTYPE, LAYERTYPE, WIDTH, SHLD TYPE, SHLD WID, and PS. The bottom-right panel shows the file path for the pavement image.

DISTRICT	COUNTY	ROUTE	POSTMILE	DIRECTION	LAKE NUMBER	LATITUDE	LONGITUDE	ELEVATION	PAIRTYPE	LAYERTYPE	WIDTH	SHLD TYPE	SHLD WID	PS
03	VOL	113	0.044	NB	4.000	38.5126620	-121.76843528	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.050	NB	4.000	38.5127636	-121.7684281	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.057	NB	4.000	38.5128449	-121.7684030	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.063	NB	4.000	38.5148733	-121.7683960	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.068	NB	4.000	38.5154789	-121.7683940	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.075	NB	4.000	38.5162793	-121.7683923	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.082	NB	4.000	38.5172828	-121.7683879	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.088	NB	4.000	38.5182941	-121.7683829	12.200	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.094	NB	4.000	38.5193093	-121.7683848	12.400	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.100	NB	4.000	38.5199028	-121.7683812	12.400	FLX	FLX	0.000	FLX	M	N
03	VOL	113	0.106	NB	4.000	38.5208963	-121.7683784	12.400	FLX	FLX	0.000	FLX	M	N



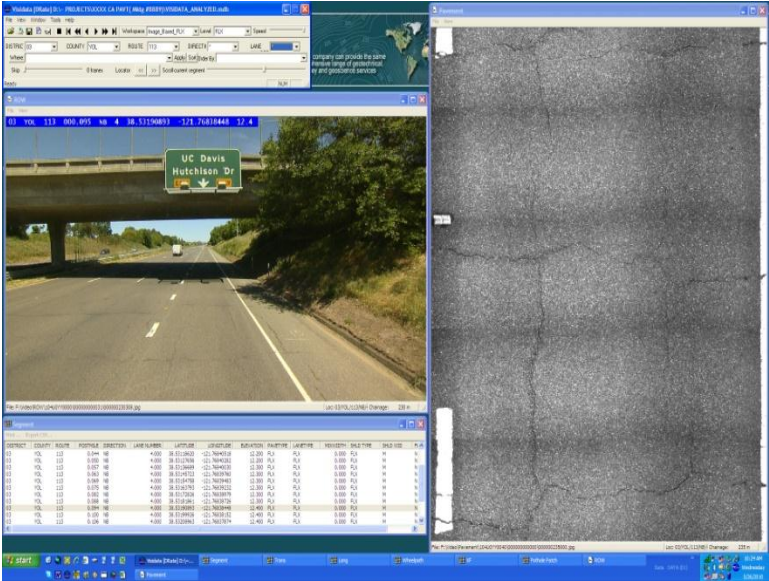
# Why Automated Data Collection?



- Safety
- Efficiency/Economy
- Accuracy
- Repeatability
- Standardization



# Automated Data Collection









# The ARAN

## Photolog

- Single view
- Panoramic view
- 1300 x 1030 pixel
- 1920 x 1080 (HDTV)
- Direct-to-digital
- Custom angles

## Pavement

- Pattern recognition software
- Strobe-lit pavement video
- Roughness
- Texture
- Rutting
- Surface Distress



## Geometry & Spatial

- Inertial measurement unit
- HPMS curve type
- Long. Grade
- Cross slope
- Centerline mapping
- Spatial referencing for GIS integration

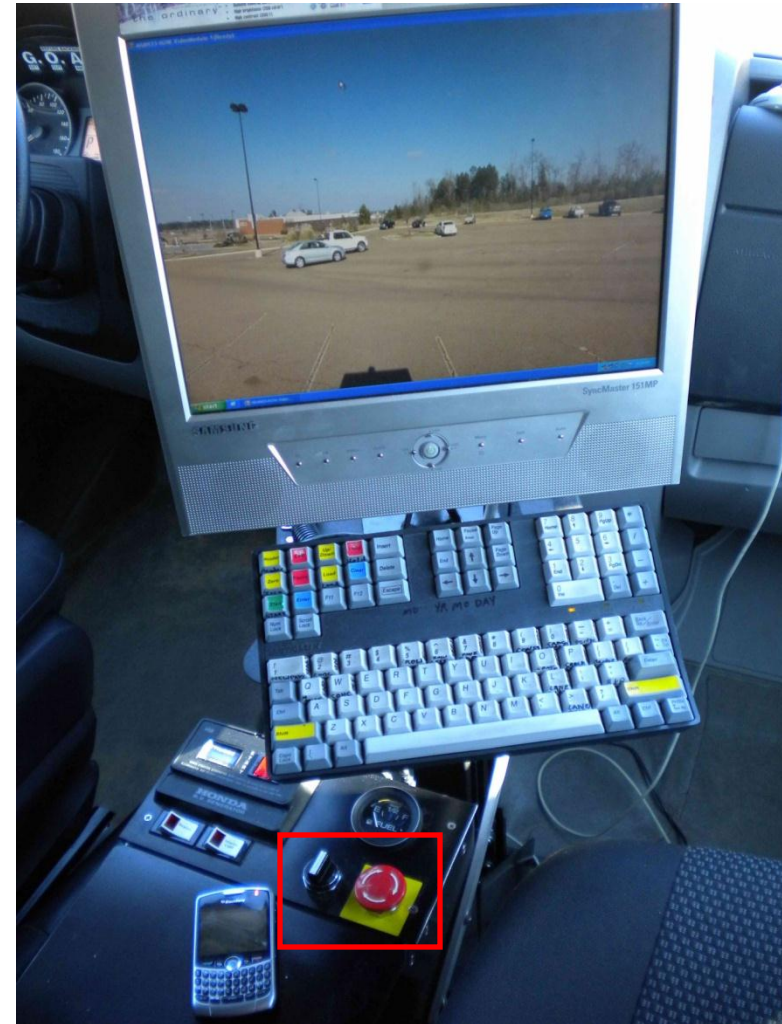
## Assets

- Inventory from imagery
- Location determined
- Offset measured
- Height and width measured
- Sign code recorded
- Condition assessment

# Operators Console

- All controls are easily accessible within operators reach
- System main power and emergency shut down of LaserSDP (profile) and LaserXVP (Transverse) lasers

Secondary System Power and  
Emergency Shut off



# Distance Measuring Instrument (DMI)

- DMI utilizes a precision optical shaft encoder that is mounted on the left rear driving wheel.
- The DMI records 2,000 pulses per revolution.
- Accuracy is  $\pm 0.02\%$  of the linear distance traveled.





# Pavement Images

- Rear downward facing cameras
- Continuous pavement images of full lane width
- Renders pavement distresses down to 2mm (0.08 inches) in width
- Laser Road Imaging System (LRIS)



# Pavement Distress Marking



File View Window Tools Help | Summary | LENAME: 03K0A700 | Where: | Order By: | Ready

ID	FILENAME	From	To	Length	Pavement ...	Direction	Lane	ARAN	Units	Co
1	03K0A700	0.000000	0.100000	0.100000	11	1	1	1727	IMPERIAL	<E
2	03K0A700	0.100000	0.200000	0.100000	11	1	1	1727	IMPERIAL	<E
3	03K0A700	0.200000	0.300000	0.100000	11	1	1	1727	IMPERIAL	<E
4	03K0A700	0.300000	0.400000	0.100000	11	1	1	1727	IMPERIAL	<E
5	03K0A700	0.400000	0.490000	0.090000	11	1	1	1727	IMPERIAL	<E

File View | DRate Pavement View, Camera 4 | File View

File: C:\Roadware Video\Drate\Video\103K0A70000\000000000000\000000048000.jpg | Loc: 03K0A700 | Offset: 253 ft

Chainage (mm)	Type	Severity	Length (ft)	Width (ft)	Hyp (ft)	Area (ft^2)
9.072	TC RORJ	LO	1.566	7.072	7.243	0.000
12.890	TC RORJ	LO	1.609	7.072	7.253	0.000
43.432	PATCH	MD	3.754	1.310	3.976	4.918
76.866	TC RORJ	LO	1.630	7.689	7.860	0.000
72.560	TC RORJ	LO	1.652	7.633	7.810	0.000
61.214	PATCH	MD	1.609	1.195	2.004	1.922

File View | DRate Inventory View

File: C:\Roadware Video\Drate\Video\103K0A70000\000000000000\000000048000.jpg | Loc: 03K0A700 | Offset: 253 ft

File View | Area Distress

Type	Severity
Alligator Cracking	Low
Block Cracking	Medium
Patching	High
Pothole	

OK | Cancel

File: 03K0A700 | Loc: 03K0A700 | Offset: 255



# WiseCrax<sup>®</sup> Automated Distress Analysis

WiseCrax Demo.wcx:1 - WinWise

File View Station Options Window

STN: 320 -> 340

	A	B	C	D	E																				
1	Project:	<div style="border: 1px solid gray; padding: 5px;"> <b>Classify Options</b> <table border="0"> <tr> <td>Classify</td> <td></td> <td>Joints</td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> Longitudinal</td> <td>50</td> <td>Classify Joints</td> <td><input type="checkbox"/></td> </tr> <tr> <td><input checked="" type="checkbox"/> Transverse</td> <td>50</td> <td>Sensitivity</td> <td>800</td> </tr> <tr> <td><input checked="" type="checkbox"/> Block</td> <td>25</td> <td>Min Length</td> <td>0.5</td> </tr> <tr> <td><input checked="" type="checkbox"/> Alligator</td> <td>50</td> <td></td> <td></td> </tr> </table> <p>Radius of Influence: 1000</p> <p><input type="checkbox"/> Auto Close    Close    Save Settings    Classify</p> </div>				Classify		Joints		<input checked="" type="checkbox"/> Longitudinal	50	Classify Joints	<input type="checkbox"/>	<input checked="" type="checkbox"/> Transverse	50	Sensitivity	800	<input checked="" type="checkbox"/> Block	25	Min Length	0.5	<input checked="" type="checkbox"/> Alligator	50		
Classify						Joints																			
<input checked="" type="checkbox"/> Longitudinal	50					Classify Joints	<input type="checkbox"/>																		
<input checked="" type="checkbox"/> Transverse	50					Sensitivity	800																		
<input checked="" type="checkbox"/> Block	25					Min Length	0.5																		
<input checked="" type="checkbox"/> Alligator	50																								
2	File:																								
3	Section:																								
4	Station:																								
5	Chain																								
6		Type																							
7																									
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**Rating Scheme**

Schemes: Penn98    New Scheme    Delete Scheme

Rating Categories	Category Details																								
<ul style="list-style-type: none"> <li>Fatigue</li> <li><b>Fatigue</b></li> <li>Miscellaneous</li> <li>Transverse</li> <li>Trans Count</li> </ul> <p>New    Delete</p> <p>Move Up    Move Dn</p>	<table border="0"> <tr> <td>Crack Type</td> <td>Location</td> </tr> <tr> <td><input checked="" type="checkbox"/> Longitudinal</td> <td><input type="checkbox"/> Left WheelPath</td> </tr> <tr> <td><input type="checkbox"/> Transverse</td> <td><input checked="" type="checkbox"/> Right WheelPath</td> </tr> <tr> <td><input type="checkbox"/> Alligator</td> <td><input type="checkbox"/> Left Edge</td> </tr> <tr> <td><input type="checkbox"/> Block</td> <td><input type="checkbox"/> Right Edge</td> </tr> <tr> <td></td> <td><input type="checkbox"/> Lane Center</td> </tr> </table> <p>Severity</p> <table border="0"> <tr> <td>Thresh</td> <td>Width</td> <td>Metric</td> </tr> <tr> <td>L-&gt;M</td> <td>6</td> <td>Crack Extent</td> </tr> <tr> <td>M-&gt;H</td> <td>13</td> <td>Min Crack Length (cm)</td> </tr> <tr> <td></td> <td></td> <td>15</td> </tr> </table> <p>Cancel    Rate</p>	Crack Type	Location	<input checked="" type="checkbox"/> Longitudinal	<input type="checkbox"/> Left WheelPath	<input type="checkbox"/> Transverse	<input checked="" type="checkbox"/> Right WheelPath	<input type="checkbox"/> Alligator	<input type="checkbox"/> Left Edge	<input type="checkbox"/> Block	<input type="checkbox"/> Right Edge		<input type="checkbox"/> Lane Center	Thresh	Width	Metric	L->M	6	Crack Extent	M->H	13	Min Crack Length (cm)			15
Crack Type	Location																								
<input checked="" type="checkbox"/> Longitudinal	<input type="checkbox"/> Left WheelPath																								
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<input type="checkbox"/> Alligator	<input type="checkbox"/> Left Edge																								
<input type="checkbox"/> Block	<input type="checkbox"/> Right Edge																								
	<input type="checkbox"/> Lane Center																								
Thresh	Width	Metric																							
L->M	6	Crack Extent																							
M->H	13	Min Crack Length (cm)																							
		15																							

Ready    NUM



# Laser Rut Measuring System (LRMS)



- Pair of rear mounted INO Lasers
- Measure full transverse profile of the road surface to over 4600 points
- Transverse profile is evaluated to determine the depths of ruts



# International Roughness Index (IRI)



- Laser SDP System
- 16 kHz laser in each wheelpath
- Measures continuous longitudinal profile of the roadway





# High Definition Right Of Way Images

- True High Definition Camera
- Wide angle High Definition images
- A single image every 4 millimiles / 21.12 feet (variable)





# GPS Data

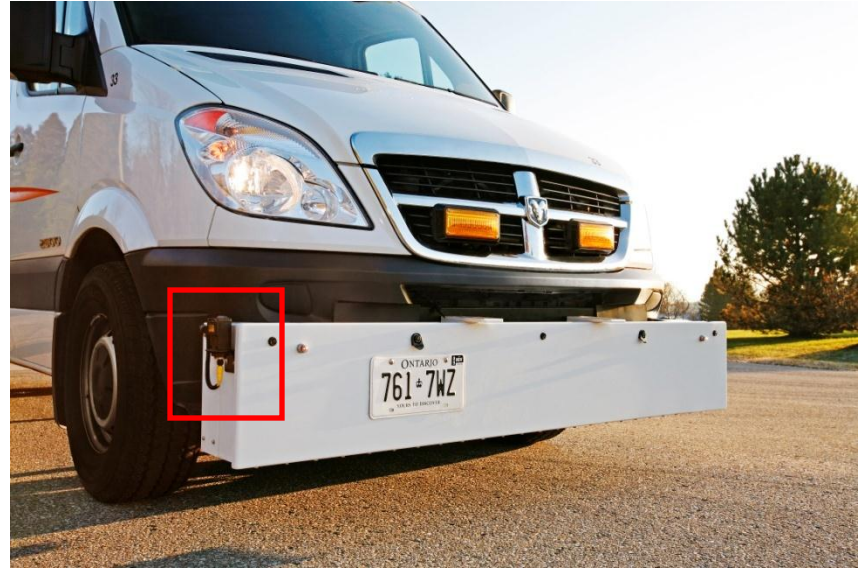


- Trimble System
- Applanix® **POS**LV (Position and Orientation System)
- Collected every station interval
- Two antennas to give vehicle heading



# Auto-Start

- The Auto-start feature is used on control site collection to ensure each run is accurately matched
- Uses an infrared sensor to coordinate data collection with the DMI sub-system



# Processing Software



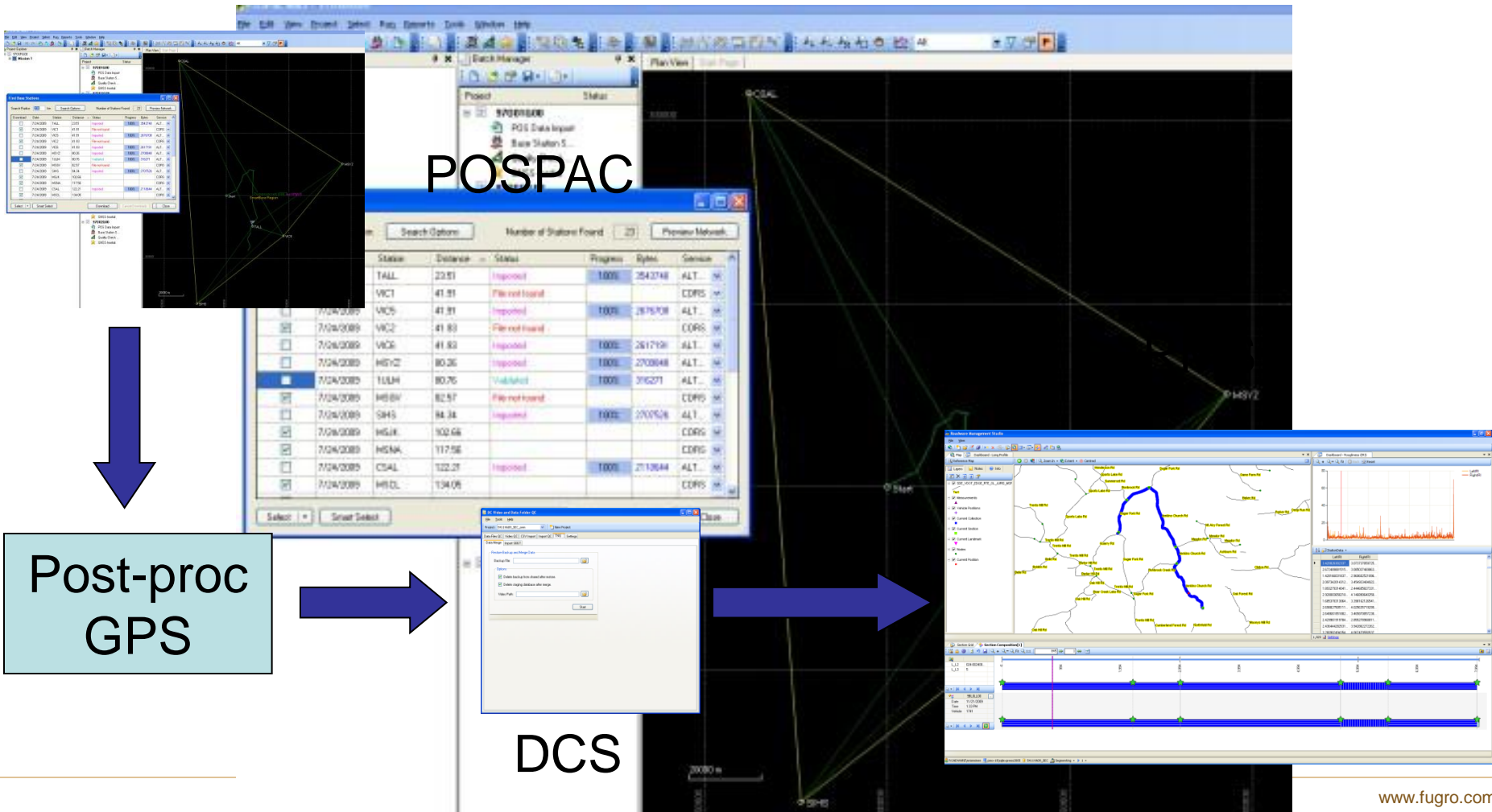
The screenshot displays the Roadware Management Studio interface with several active windows:

- Top Left:** A video feed showing a road surface texture.
- Top Middle:** A video feed showing a road from a driver's perspective with a speedometer overlay.
- Top Right:** A data table with columns for L\_ID, L\_CD, L\_PD, L\_D, L\_SEC, and a list of items with numerical values.
- Bottom Left:** A "Dashboard" window with a table of "LeftFlt", "RightFlt", and "AverageFlt" data, and a line graph showing "AverageFlt", "LeftFlt", and "RightFlt" over time.
- Bottom Right:** A "Map" window showing a street map with yellow and blue lines indicating road segments and vehicle paths.



# Data Control System

- GPS post-processing is done with Applanix POSPAC software
- Importing is done in one easy step



# Enhanced View of Data

The screenshot displays the WAM Management Studio interface, which is used for managing and visualizing data. The interface is divided into several key sections:

- Section Composition Editor (Navigator 1):** This top-left pane shows a detailed view of a data section. It features a horizontal timeline with various colored markers (green, yellow, purple) indicating data points or events. The section is identified as 'RDL 14 AV E' with a length of 'L 1'. Metadata includes 'Time: 4:05 PM' and 'Date: 7/11/2007'.
- Map View:** The bottom-left pane shows a street grid map. A vertical red line highlights the specific location of the data section along 14th Avenue. The map includes street names such as LITON AVE, HARVARD AVE, BROADWAY, and various numbered streets from 10th to 32nd.
- Street View (Right Pane):** This pane provides a real-time, 3D perspective view of the intersection of 14th Avenue and Broadway. A blue header bar at the top of the view displays the address '100590 14 AV E', the lane number '5 1', a distance of '0.1', and the date '07/11/2007'. The view includes a 'Bank of America' sign, traffic lights, and a utility pole with an 'SDOT' sign.

The bottom of the image shows the Windows taskbar, indicating the system is running on Windows XP with the date 'Wednesday 8/22/2007' and time '5:46 PM'.

# Web Visualization

**VisiWeb Import**

ROADWARE GRP VISIWEB

Select your directory of images: C:\

Select your data source Access Database file (\*.mdb): C:\

Select your summary data table:

Select your section data table:

Select your data's unique identifying field:

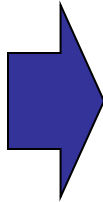
Enter the original video server URL:

Enter the thumbnail video server URL:

Enter the year of data to import:

Load these settings the next time?

Step 2 of 8



ROADWARE GRP VisiWeb - Microsoft Internet Explorer provided by Roadware Group Inc.

Region of Waterloo

Address: http://admin-gc/visiweb/

QUICK Locations

Map

Year	Segment	Begin Mile Point	End Mile Point	Road No.	Area	Road Name	Post	Direction	Begin Interval
2009	522	0	0.1	0067	WATERLOO	UNIVRSITY AV E	570000	5	0
2009	523	0.1	0.2	0067	WATERLOO	UNIVRSITY AV E	570000	5	0.1
2009	523	0.2	0.3	0067	WATERLOO	UNIVRSITY AV E	570000	5	0.2
2009	523	0.3	0.4	0067	WATERLOO	UNIVRSITY AV E	570000	5	0.3
2009	523	0.4	0.5	0067	WATERLOO	UNIVRSITY AV E	570000	5	0.4

Done

start | Internet Explorer | 12 Downloads | Adobe Acrobat Pro... | Roadware GRP - VisiWeb | http://05.68.10.141...



# Enhanced Data Presentation

The screenshot shows the Bentley Map interface with a 3D aerial view of a road intersection. A metadata window is open in the foreground, displaying the following information:

Field	Value
OBJECTID	715
REFID	715
COPYID	80861159
DATE	2009/11
MPRNT_ID	1
MPRNT_SR	30
NLINE	2
CONTRNO	4
NEE_HIP	0.101
NEE_HIP	0.101
CONV_TYPE	SPEED LIMIT
ORIGID	821
MPRNT_SR	1
COPYID	25
COPYID	MPRNT
INDICATOR_COLOR	White
COLOR_COLOR	Blue
COLOR_TYPE	METAL
SLPOST_CNT	1
SLPOST_TYP	SH-1 POST
C_FLAG_ABRG_ABRG	NOT NEEDED
CONTRNO	3
CYCLELOR	5
CYCLELOR	1
CYCLELOR	308
CYCLELOR	80861159
CYCLELOR	8-4-11
CYCLELOR	96
CYCLELOR	96
CYCLELOR	INSTRUMENT
LATTICE_START	34-422103
LATTICE_STOP	34-422103
LATTICE_START	41-151028
NEE_HIP	80861159
Shape	Point



The screenshot shows the Bentley ProjectWise interface with a 3D perspective view of a road. A data table is visible in the top left corner:

SYSTEM	DISTRICT	COUNTY	ROUTE	SU	DIRECTION	LANE
1	2	61	8400	G	S	1
1	2	61				
1	1	40				
1	1	20				

A metadata window is also open in the foreground, displaying the following information:

Field	Value
OBJECTID	715
REFID	715
COPYID	80861159
DATE	2009/11
MPRNT_ID	1
MPRNT_SR	30
NLINE	2
CONTRNO	4
NEE_HIP	0.101
NEE_HIP	0.101
CONV_TYPE	SPEED LIMIT
ORIGID	821
MPRNT_SR	1
COPYID	25
COPYID	MPRNT
INDICATOR_COLOR	White
COLOR_COLOR	Blue
COLOR_TYPE	METAL
SLPOST_CNT	1
SLPOST_TYP	SH-1 POST
C_FLAG_ABRG_ABRG	NOT NEEDED
CONTRNO	3
CYCLELOR	5
CYCLELOR	1
CYCLELOR	308
CYCLELOR	80861159
CYCLELOR	8-4-11
CYCLELOR	96
CYCLELOR	96
CYCLELOR	INSTRUMENT
LATTICE_START	34-422103
LATTICE_STOP	34-422103
LATTICE_START	41-151028
NEE_HIP	80861159
Shape	Point





