

Verification of Automated Pavement Distress Detection, Evaluation and Reporting Processes – Canadian Experience

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Highlights of Presentation

- Overview of MTO ARAN System Functions
- Pavement Distress Data Collection, Process and Reporting by ARAN
 - Distress Detection and Classification
 - Distress Evaluation and Severity Rating
 - Performance Assessment Reporting (Visions)
- Verification Sites for Validating ARAN Outputs
- ARAN Applications to Ontario Provincial Pavement Management at Both Network and Project Levels
- Technical Issues and Discussions





1	1	1	
1980	1990	2000	2010

Four Generations of MTO ARAN System



MTO ARAN System Functions

- High-speed collection of road location and condition data
 - Right of Way Asset Data Collection Road Asset Management
 - Pavement Surface Profiles IRI and RUT
 - Pavement Distresses LCMS Integration
 - Road Location GPS and Map
 - Performance Assessment Reporting



- Automatic Process of Integrated Pavement Location and Condition Evaluation Data – Vision Software
- Analysis Result Data Generating and Reporting iVision Website



MTO ARAN Data Collection and Process Workflow





PDDC V.2./.1.0

File Edit Subject Record Reports Tools Help

Survey Month/Year: 6 2006 Evaluator: Todd Filson Under Construction 677		FLEXIBL	LE PAVEMENT CONDITION EVALUATION	SEVERIT	Y OF SEVERITY OF
HWY : 41		AC-PA	AVEMENT DISTRESS TYPES	DISTRE 1 2 3	SS DISTRESS 4 5 1 2 3 4 5
LHRS : 29610		SURFACE	Ravelling and Course Aggregate Loss		T
Offset: 4		DEFECTS	Flushing		0
Direction: B BOTH			Rippling and Shoving	0	0
Class: A ARTERIAL	D	SURFACE	Wheel Track Rutting	0	0
Distance From (100 C2) To (121 02)			Distortion	3	1
Erom : DENBIGH LAKE RD			Single and Multiple	2	4
To : 6.6 KM N OF HWY 28		WHEEL TRACK	Alligator	2	3
Reg : Eastern Dist Bancroft			Single and Multiple	2	2
	CR	CENTRE LINE	Alligator	0	0
Pavement and Shoulders Distress Comments (Maximum - 255 Characters)	A		Single and Multiple	1	1
Consider Micro or Ultrtathin in future. Cracks are	K	EDGE	Alligator	1	1
	NC		Half, Full and Multiple	2	5
	G	TRANSVERSE	Alligator	1	1
		Longitudinal Me	ander and Midlane	2	4
Indexes/Ratios :		Random		0	
PCI: 76 RCI: 7.57 DMI: 8.05 PCR: 83 RCR: 7.9 IRI: 1.36				Re-Se	et All Distress To Zero



Distress Manifestation Index (DMI)

$$DMI = \sum_{i=1}^{15} w_i (s_i + e_i)$$

i = distress type i w_i = weighting factor assigned to distress i s_i = severity of distress i e_i = extent of distress i

The scale of DMI is ranged from 0 to 10



MTO ARAN/LCMS Capabilities

 The ARAN/LCMS identifies and reports 8 individual distresses, and provides evaluation results with 6 quantitative Metrics for a given highway section, at every 10 m pavement section

• Eight Individual Distresses:

- 1. Midlane Single & Multiple Cracking
- 2. Single & Multiple Pavement Edge Cracking
- 3. Longitudinal Wheel Track Cracking
- 4. Single & Multiple Transverse Cracking
- 5. Centre Line Single & Multiple Cracking
- 6. Centre Line Alligator Cracking
- 7. Wheel Path Alligator Cracking
- 8. Alligator Pavement Edge Cracking

- **Quantitative Metrics**
 - 1. Extent (m)
 - 2. Count
 - 3. Area (m²)
 - 4. Length (m)
 - 5. Width (m)
 - 6. Transverse Extent (m)



Zones Defined for Distress Data Collecting, Evaluation and Reporting



Anchor points can be either on edge or centreline and they can be allocated by ARAN. 3.6 m wide pavement image is used for evaluating pavement conditions



Zones Defined for Distress Data Collecting, Evaluation and Reporting





Which distresses can't be identified

Individual Distresses for Asphalt Concrete (AC) Pavement	ARAN/LCMS Capability
Ravelling and Coarse Aggregate Loss	x
Flushing	x
Rippling and Shoving	X
Wheel Track Rutting	✓
Distortion	x
Longitudinal Wheel Track: Sing. / Multi.	1
Longitudinal Wheel Track: Alligator	1
Longitudinal Meandering and Midlane	1
Transverse: Half, Full and Multiple	1
Transverse: Alligator	x
Centreline: Single and Multiple	1
Centreline: Alligator	1
Pavement Edge: Single and Multiple	1
Pavement Edge: Alligator	1
Random/Map	X

- Of the 15 individual distresses known to effect AC pavements the ARAN registers eight
- Ravelling and Course Aggregate Loss, Distortion, and Flushing have been omitted. Texture data is collected but not readily usable
- Map and random cracks are reclassified as alligator cracks
- Rutting data will be used as an independent component in PCI Calculation

An Example of Reporting Quantitative Metrics for an Identified Distress by ARAN/LCMS

Identification Metrics	Slight	Moderate	Severe
Count	2	1	1
Crack Area (m ²)	1.59	1.44	0.23
Length (m)	5	3	2.5
Extent (m)	2.6	1.8	1.5
Transverse Extent (m)	1	0.8	0.5
Width (m)	0.004	0.012	0.025

- When multiple cracks of the same type are evident then aggregation is applied to sum the identified distresses occurs in different severities.
- Crack length and area are summed, crack width is averaged.
- Count represents the number of cracks identified. For alligator cracking, count represents the number of times the distress appears.



LCMS Capabilities and Applications



- LCMS Calculates Rutting in Both Wheel Paths
- Determines Crack, Width, Depth, and Extent.



Sample Images of Pavement Distresses Taken from ARAN/LCMS





LCMS- Crack Detection & Classification





Classification of Cracking Types





Performance Index DMI Component



$$DMI = (X \times DMI_{long}) + (Y \times DMI_{trans}) + (Z \times DMI_{gator})$$



Flow Chart of ARAN Data Process





Example of Web Deployment Software (iVision)

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Sample Reports Generated by ARAN/LCMS Vision

Software

	Microsoft Excel - SENSOR DATA-Metric_10.csv															
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2	2	6	N	A	1A602M00	1/42	*****	3	0	8.190501	0	10	Matched	1/3.3/51	-2.04299	283.
3	2	6	N	A	1A602M00	1/42	*****	3	8.190501	16.381	10	20	Matched	1/3./658	-2.66501	282.
4	2	6	IN N	A	1A6021000	1742	*****	3	10.301	24.5715	20	30	Matched	174.1564	-2.10515	20
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7	2	6	N	A A	146021000	1742	******	3	40.95251	40.95251	40	50	Matched	176 3282	1 31677	276
8	2	6	N	Â	106021000	1742		3	40.33231	67 33361	50	70	Matched	175.3202	-1.02126	276
ä	2	6	N	2	146021000	1742		3	67 33361	65 52401	70	80	Matched	176 1095	-1.02120	273
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11	2	6	N	Δ	146021000	1742		3	73 71/51	81 90501	90	100	Matched	176.8907	-1 22515	271
12	2	6	N	Δ	1A602M00	1742	****	3	81 90501	90.09552	100	110	Matched	177 2813	-1 25065	270
13	2	6	N	A	1A602M00	1742	***	3	90.09552	98 28602	110	120	Matched	177 6719	-1 37881	269
14	2	6	N	A	1A602M00	1742	#########	3	98 28602	106 4765	120	130	Matched	178 0625	-1 45778	268
15	2	6	N	A	1A602M00	1742	***	3	106 4765	114 667	130	140	Matched	178 4532	-1 25995	268
16	2	6	N	A	1A602M00	1742	#########	3	114,667	122.8575	140	150	Matched	178.8438	-1.17782	267
17	2	6	N	A	1A602M00	1742	#########	3	122.8575	131.048	150	160	Matched	179.2344	-1.09857	267
18	2	6	N	A	1A602M00	1742	#########	3	131.048	139.2385	160	170	Matched	179.625	-0.9967	267
19	2	6	N	A	1A602M00	1742	#########	3	139.2385	147.429	170	180	Matched	180.0156	-0.94662	266.
20	2	6	N	A	1A602M00	1742	#########	3	147.429	155.6195	180	190	Matched	180.4062	-0.72685	266.
21	2	6	N	A	1A602M00	1742	****	3	155.6195	163.81	190	200	Matched	180.7969	-0.67317	266.
22	2	6	N	A	1A602M00	1742	#########	3	163.81	172.0005	200	210	Matched	181.1875	-0.70178	266.
23	2	6	N	A	1A602M00	1742	#########	3	172.0005	180.191	210	220	Matched	181.5532	-0.85455	266.
24	2	6	N	A	1A602M00	1742	#########	3	180.191	188.3815	220	230	Matched	181.5707	-0.533	266.
25	2	6	N	A	1A602M00	1742	#########	3	188.3815	196.572	230	240	Matched	181.5963	-0.40771	266.
26	2	6	N	A	1A602M00	1742	#########	3	196.572	204.7625	240	250	Matched	181.6031	-0.46196	267.
27	2	6	N	A	1A602M00	1742	#########	3	204.7625	212.953	250	260	Matched	181.6159	-0.51105	267.
28	2	6	N	A	1A602M00	1742	#########	3	212.953	221.1435	260	270	Matched	181.6286	-0.50006	267.
29	2	6	N	A	1A602M00	1742	#########	3	221.1435	229.334	270	280	Matched	181.6414	-0.48452	267.
30	2	6	N	A	1A602M00	1742	#########	3	229.334	237.5245	280	290	Matched	181.6541	-0.56733	267.
31	2	6	N	A	1A602M00	1742	#########	3	237.5245	245.715	290	300	Matched	181.6669	-0.45968	267.
32	2	6	N	A	1A602M00	1742	#########	3	245.715	253.9055	300	310	Matched	181.6797	-0.49102	267.
33	2	6	N	A	1A602M00	1742	****	3	253.9055	262.096	310	320	Matched	181.6924	-0.61326	267.
34	2	6	N	A	1A602M00	1742	****	3	262.096	270.2865	320	330	Matched	181.7052	-0.84999	267.
35	2	6	N	A	1A602M00	1742	****	3	270.2865	278.477	330	340	Matched	181.718	-0.73262	267.
36	2	6	N	A	1A602M00	1742	##########	3	278.477	286.6675	340	350	Matched	181.7307	-0.84849	267.
37	2	6	N	A	1A602M00	1742	##########	3	286.6675	294.8581	350	360	Matched	181.7435	-0.8672	268.
38	2	6	N	A	1A602M00	1/42	*****	3	294.8581	303.0486	360	370	Matched	181.7563	-0.74487	26
39	2	6	N	A	1A602M00	1/42	****	3	303.0486	311.2391	3/0	380	Watched	181.769	-0.613//	270.
40	2	6	N	A	146021000	1742	******	3	311.2391	319.4296	380	390	Matched	101.7018	-0.56723	271
41	2	6	N	A	146021000	1742	*******	3	319.4296	327.6201	390	400	Matched	101./946	-0.61454	271
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Integration of Pavement Image and Data Process Reports by ARAN/LCMS Vision



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Highlights of Presentation

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The 90 m section of pavement had many light, moderate and severe cracks. Several individual evaluations were recorded so that the average data could be used for comparison.





Disagreements on the method of evaluation, Due to time constraints, the 90 m was evaluated without

zones.









Section 1 (90 m) Summary

DMI:	Sections Sections																					
		1		2	:	3		4		5	Ţ	6	7	7		8	ç	9	1	0	Ονε	erall
Longitudinal	100	96	100	93	78	93	0	100	0	92	65	95	0	98	0	36	0	80	100	100	44	88
Transverse	0	0	0	86	100	93	33	57	100	47	0	25	100	27	0	0	0	100	100	100	43	53
Alligator	53	74	0	0	0	73	0	20	0	26	8	99	38	84	74	99	87	97	100	100	36	67
	51	59	30	54	53	85	10	55	30	52	22	75	45	71	30	50	35	93	100	100	41	69

Data:

					Sections												Secti	ons			
Туре	Severity	1		2	2		3	4	4	Ę	5	(6		7	8	3	ç	9	1	0
Longitudinal	Light	0	0.21	0	0.33	0	0.38	0	0.00	0	0.95	0	0.00	0	0.26	0	0.00	0	0.00	0	0.00
	Moderate	0	0.17	0	0.39	2	0.32	10	0.00	3	0.00	2	0.49	6	0.00	14	5.79	0	0.00	0	0.00
	Severe	0	0.00	0	0.00	0	0.00	0	0.00	7	0.00	1	0.00	5	0.00	0	0.00	10	1.49	0	0.00
Transverse	Light	0	1.70	0	0.52	0	0.27	0	1.62	0	0.37	0	0.65	0	0.85	0	3.07	6	0.00	0	0.00
	Moderate	6	2.10	0	0.00	0	0.00	2	0.00	0	1.31	0	1.72	0	1.52	6	1.90	9	0.00	0	0.00
	Severe	6	0.00	3	0.00	0	0.00	0	0.00	0	0.00	6	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Alligator	Light	0	0.86	0	0.00	0	0.08	0	0.16	0	0.16	0	0.00	0	0.00	0	0.05	0	0.00	0	0.00
(Area)	Moderate	25	0.08	0	4.54	0	0.54	0	1.83	0	2.07	0	0.08	0	0.48	7	0.00	4	0.01	0	0.00
	Severe	0	0.00	29	2.39	31	0.15	25	0.36	29	0.01	22	0.01	14	0.01	0	0.00	0	0.00	0	0.00
*Organized b	by crack type	and se	ction																		
Totals:		_																			
	Longitudinal	0.00	0.34	0.00	0.66	2.00	0.62	10.00	0.00	11.40	0.76	3.20	0.49	12.00	0.21	14.00	5.79	12.00	1.79	0.00	0.00
	Transverse	13.20	3.45	3.60	0.42	0.00	0.22	2.00	1.30	0.00	1.60	7.20	2.24	0.00	2.20	6.00	4.36	13.80	0.00	0.00	0.00
	Alligator	13.20	3.45	35	7	37	1	30	2	35	2	26	0	17	0	7	0	4	0	0	0

Black text = Manual

Red text = ARAN



DMI:			S	ections	5				Sections									
	1 (Ja	ason)	1 (L	ynn)	1 (G	roup)		2		3	4 8	& 5	6	6		7	Ove	erall
Longitudinal	71	86	65	86	89	86	42	81	100	95	100	100	0	97	0	100	43	92
Transverse	0	72	27	72	27	72	0	63	100	70	100	100	100	4	0	100	44	62
Alligator	61	100	86	100	82	100	60	97	100	100	100	100	38	100	74	100	70	99
	46	87	62	87	68	87	37	82	100	90	100	100	45	70	30	100	54	86

Section 3 (67 m) Summary

Data:

		5	Section	s											Se	ections	5
Туре	Severity	1 (Ja	ison)	1 (L	ynn)	1 (Gr	oup)	2	2	3	}	4 8	& 5	6	6	7	7
Longitudinal	Light	2	1.54	2	1.54	0	1.54	4	1.80	0	0.00	0	0.00	0	0.32	0	0.00
	Moderate	1	0.00	2	0.00	1	0.00	2	0.25	0	0.45	0	0.00	6	0.00	14	0.00
	Severe	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	0.00	0	0.00
Transverse	Light	2	1.04	0	1.04	0	1.04	2	1.40	0	1.12	0	0.00	0	3.59	0	0.00
	Moderate	5	0.00	1	0.00	1	0.00	1	0.00	0	0.00	0	0.00	0	0.00	6	0.00
	Severe	4	0.00	1	0.00	1	0.00	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Alligator	Light	0	0.02	0	0.02	0	0.02	4	0.02	0	0.00	0	0.00	0	0.01	0	0.00
(Area)	Moderate	6	0.00	4	0.00	5	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	0.00
	Severe	1	0.00	0	0.00	0	0.00	7	0.05	0	0.00	0	0.00	14	0.00	0	0.00
*Organized k Totals:	by crack type	and se	ection														
	Longitudinal	2.60	1.23	3.20	1.23	1.00	1.23	5.20	1.69	0.00	0.45	0.00	0.00	12.00	0.25	14.00	0.00
	Transverse	11.06	0.83	2.20	0.83	2.20	0.83	3.96	1.12	0.00	0.90	0.00	0.00	0.00	2.88	6.00	0.00
	Alligator	11.06	0.83	4	0	5	0	11	0	0	0	0	0	17	0	7	0

Black text = Manual

Red text = ARAN

Note: Sections 4 & 5 were locations of new pavement and thus had minimal distresses. Both manual and ARAN have evaluated it as distress free. Section not included in overall DMI.











Ruts Measured on Right and Left Wheel Paths

Right (ARAN)	Manual	Left (ARAN)	Manual
3.99	Х	2.26	Х
4.00	Х	2.25	Х
3.95	2.00	2.10	3.00
4.51	2.00	1.76	3.00
5.80	5.00	2.27	3.00
6.091	5.00	2.39	3.00
4.705	3.00	1.95	3.00
4.09	4.00	2.34	3.00
4.94	3.00	2.37	3.00
4.46	4.00	2.76	3.00





















QUESTIONS?

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