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**4. Procedures for the evaluation of automated crack detection systems**  
**The British Experience**

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 International Workshop on  
 Automated monitoring of pavement surface cracking  
 conditions - Quebec  
 13 August 2006

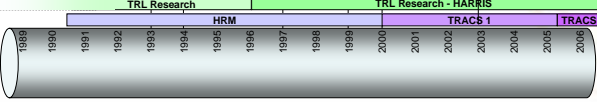



### Surface Condition Survey Timeline in UK

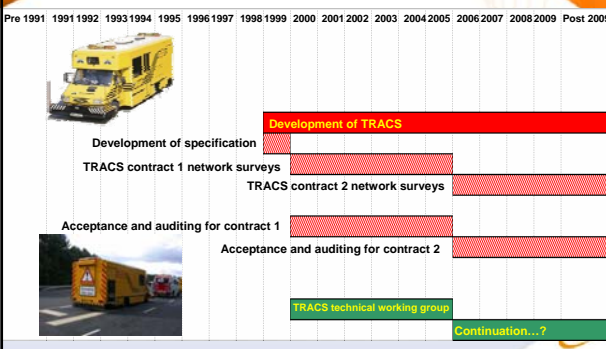
**Surface Condition**



1<sup>st</sup> prototype of image collection by line scan  
 2<sup>nd</sup> prototype on HSV  
 2<sup>nd</sup> prototype on HARRIS  
 Development of specification for TRACS  
 Commencement of TRACS on HA network  
 SCANNER on Local Authority network

### TRACS Development



Pre 1991 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 Post 2009

Development of TRACS

Development of specification

TRACS contract 1 network surveys




TRACS contract 2 network surveys

Acceptance and auditing for contract 1

Acceptance and auditing for contract 2


TRACS technical working group

Continuation...?

### Survey lane coverage in the UK

| Yr.   | Vehicles | Lane kms. | Coverage started               |
|-------|----------|-----------|--------------------------------|
| 99/00 | 1        | 1000      | Research only                  |
| 00/01 | 2        | 15000     | England Main roads (TRACS1)    |
| 01/02 | 2        | 26000     |                                |
| 02/03 | 3        | 44000     | Scotland local roads (SRMCS)   |
| 03/04 | 3        | 44000     | English local roads (TTS)      |
| 04/05 | 4        | 99000     |                                |
| 05/06 | 6        | 123000    | (TRACS2 & TTS becomes SCANNER) |
| 06/07 | 8        | 171000    |                                |
| 07/08 | 9        | 171000    |                                |
| 08/09 | 10?      | ?300000   | All local roads?               |



### TRL input to the Delivery of TRACS

- Specification
- Acceptance
- Quality Auditing
- Ongoing Research



## TRACS - Specification

- An “end result” specification for measurement of:
  - Section location
  - Geographical position
  - Raw longitudinal profile
  - Raw transverse Profile
  - Raw texture Profile
  - Raw cracking
  - Derived parameters
    - For cracking
      - Crack intensity
      - Crack map



## Acceptance



## Profile - Reference Surfaces



## Cracking



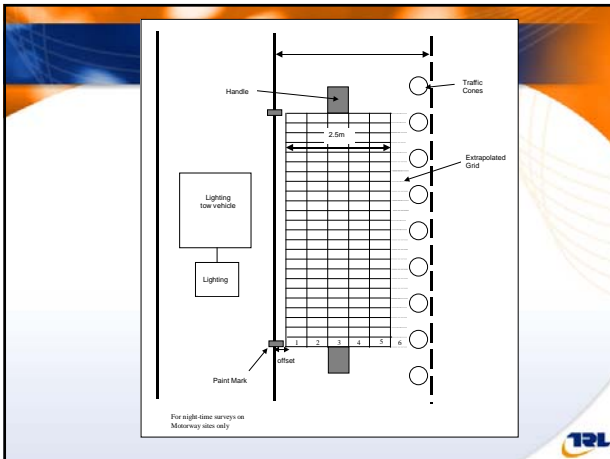
## Cracking - Reference

- Need to establish a reference
  - Current manual surveys difficult to compare with automated surveys
  - HARRIS shows scaling required
  - Still differences due to opinions and estimates of inspectors
  - Development of grid method



## Visual inspection using wire grid to establish reference crack data





## Cracking - Reference Surveys

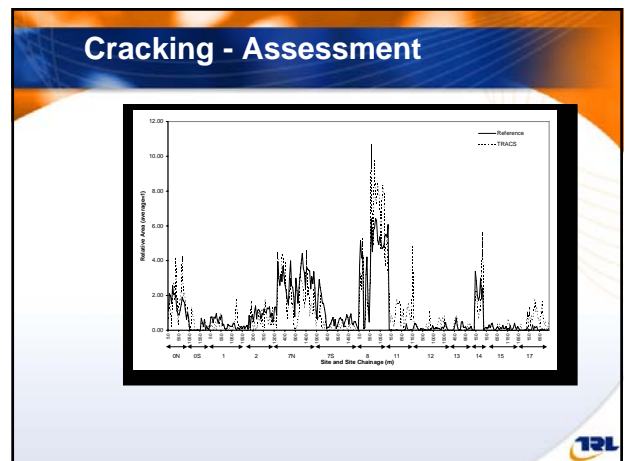
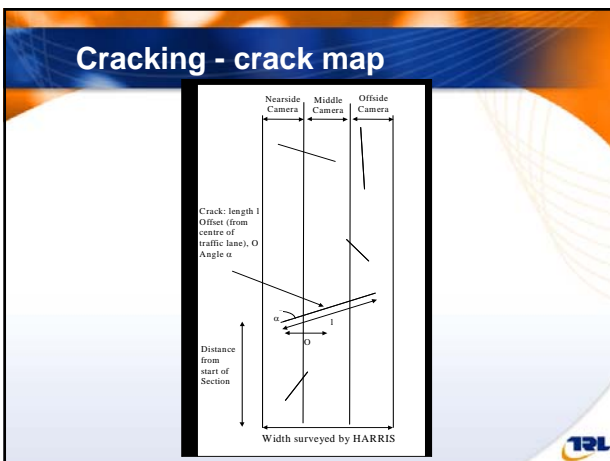
- Manual grid surveys:
  - Two inspectors survey the grid (20m) the first carries out the survey over each 500mm square the second records the results.
  - 13 Sites, of length 18km covering flexible, composite and concrete constructions and different surface types
  - Mostly surveyed at night, over three week period

## Cracking assessment

- Surveys carried out soon after manual surveys
- Data delivered as crack map
- 500mm grid placed over crack map in software to obtain areas of cracking
- Areas of cracking from contractor and manual surveys summed over 50m lengths
- Contractor provided with sample data to investigate sensitivity
  - Resulted in good agreement on these sites but poor agreement on other sites. Contractor provided with further data to adjust sensitivity

## Cracking - Assessment

- Systems generally record less cracking than the reference
  - Typically <15% on acceptance using final sensitivity
  - Issue of surface type
- For assessment the data is classed in terms of high, medium and low levels of cracking
- System assessed in terms of
  - The number of subsections that are showed to have high, medium and low levels of cracking that were also shown to contain this level of cracking in the reference survey
  - Also plots of the "relative area" of cracking recorded



## Cracking - Assessment

- Assessed as percentage of sections having high and low levels of cracking that agree with the reference

|   | Sensitivity Level 1 | Sensitivity Level 2 |
|---|---------------------|---------------------|
| Percentage of sub-sections in the reference data containing a high level of cracking that were also reported to contain a high level of cracking by TRACS                       | 73%                 | 72%                 |
| Percentage of sub-sections in the reference data containing a high level of cracking that were reported to contain higher than 1.5 times the average level of cracking by TRACS | 80%                 | 77%                 |
| Percentage of sub-sections in the reference data containing a high level of cracking that were reported to contain a higher than average level of cracking by TRACS             | 88%                 | 85%                 |

High levels of cracking



## Cracking - Assessment

- Network tests - repeatability

| Route | Low level | High level | % of sub-sections which were shown to contain low levels of cracking in run 1 that were also shown to contain low levels of cracking in run2 | % of sub-sections which were shown to contain high levels of cracking in run 1 that were also shown to contain high levels of cracking in run2 |
|-------|-----------|------------|--|--|
| Rural | 0.5       | 2.5        | 68   | 69   |
| Urban | 0.5       | 2.5        | 40   | 65   |
| Rural | 0.2       | 1.25       | 61   | 67   |
| Urban | 0.2       | 1.25       | 56   | 58   |

- And comparison with reference



## Current reference sites

Now provided

- By manual analysis of video images
- Over at least 70 lane kilometre



## QA developments

- Basic system carried over to local authority use i.e. TTS and SCANNER
- And for TRACS2

NB. It is required that the system be fully automatic with no human intervention in the processing stages



## Summary of quality procedures (1)

External processes

- Acceptance tests
- Accreditation
  - Quarterly TRACS2
  - Annually SCANNER
  - Or after major equipment change
- Independent audits by HARRIS
- Weekly progress reports to auditor



## Summary of quality procedures (2)

Internal processes

- Daily repeat surveys
  - Weekly repeat surveys
  - Monthly repeat surveys
- Additionally
- Monthly meetings between contractor, client and auditor
  - Annual revision of specification



## UK Highways Agencies views on introduction to local authority roads.....



## 1 TRACS payment schedule

- “The Contractor shall carry out annual surveys on all of the following: -
  - Both directions of Single Carriageways
  - Lanes one and two in each direction on Dual Carriageways
  - All Slip Roads”
- For Single Carriageways this has been interpreted to mean lane 1 in each direction regardless of the number of lanes.
- Payment is based on a kilometrage basis and is made to the Contractor on acceptance of processed data into the client's database.



## 2 Requirements for data to be accepted

- Accuracy – measurement of data to tolerances as specified in Contract documents
- Quality – checks against longitudinal and co-ordinate tolerances as specified in Contract documents
- Surveys – fully completed within financial year
- Processing – fully completed within 30 days of collection



## 3 Critical success factors

- Solid research base
- Sound business case
- Performance contract
- Underlying data management regime
- Audit regime
- Strong intelligent client



## 4 Summary of issues for local authorities

- Clear understanding of why you are collecting cracking data – is it just for Performance Indicators or for sound operational reasons
- Data quality – need accredited vehicle with data to required accuracy
- Strong performance contract – what incentives are there to deliver, what penalties should be considered?



## TRL's messages on evaluation of automated crack systems

- Consider need
- Define requirement
- Implement quality audit procedure
- Apply procedure with understanding!





