Improved Decision Making For Maintenance Using Data

William Marsh
Electronic Engineering and Computer Science

Queen Mary University of London

Arnab Majumdar, Khalid Nur, Nicole Kudla
Centre for Transport Studies

Imperial College London

Outline

- Project aims and outline
- Principles of probabilistic decision support
- Maintenance data
- Decision model: outline architecture
- Conclusions and future directions

Project Aims and Outline

- ‘Find and fix’ → ‘Measure and predict’
  - Information and **decision making**

> Investigate the feasibility of developing a new computer-based intelligent decision-support tool for maintenance planning using the data currently available to NR

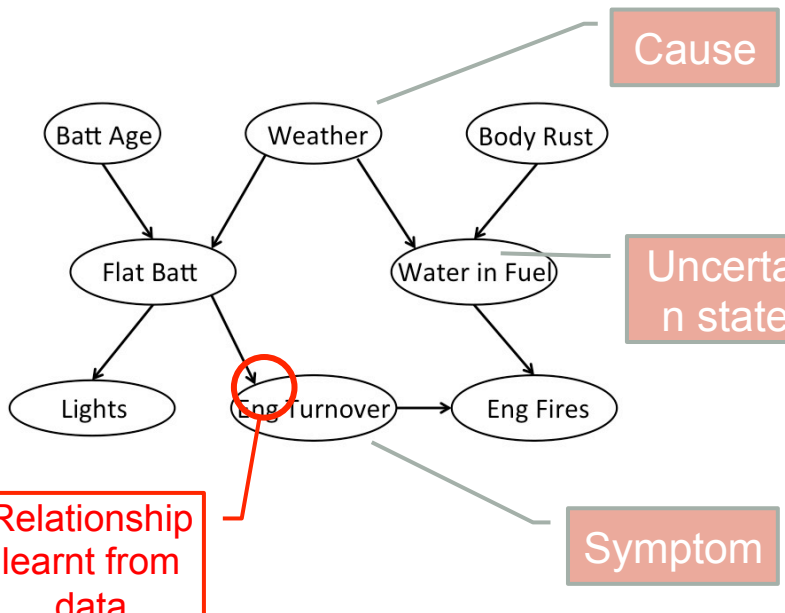
- What we did
  - Meetings with maintenance specialists at NR
  - Visit to Maintenance Depot at Bletchley for Bedford Line
  - Example small data samples
  - Spoke to ORBIS project team

Switch & Crossing

- 5% of the track miles but 17% of the track maintenance budget
  - Less automated maintenance and inspection processes
  - Fewer location issue
- Complex component & failures
  - Track and signalling
  - Track bed
- Decision making at
  - Maintenance depot: TME, section
  - Delivery unit

Probabilistic Decision Support

- (Bayesian) network of uncertain variables
- Reasoning
  - Causal: from cause to effect
  - Diagnostic: from effect (symptom) to cause
- S&C problem
  - Infer underlying state of S&C components
  - Use this to predict failures



The Available Data

Data Sources

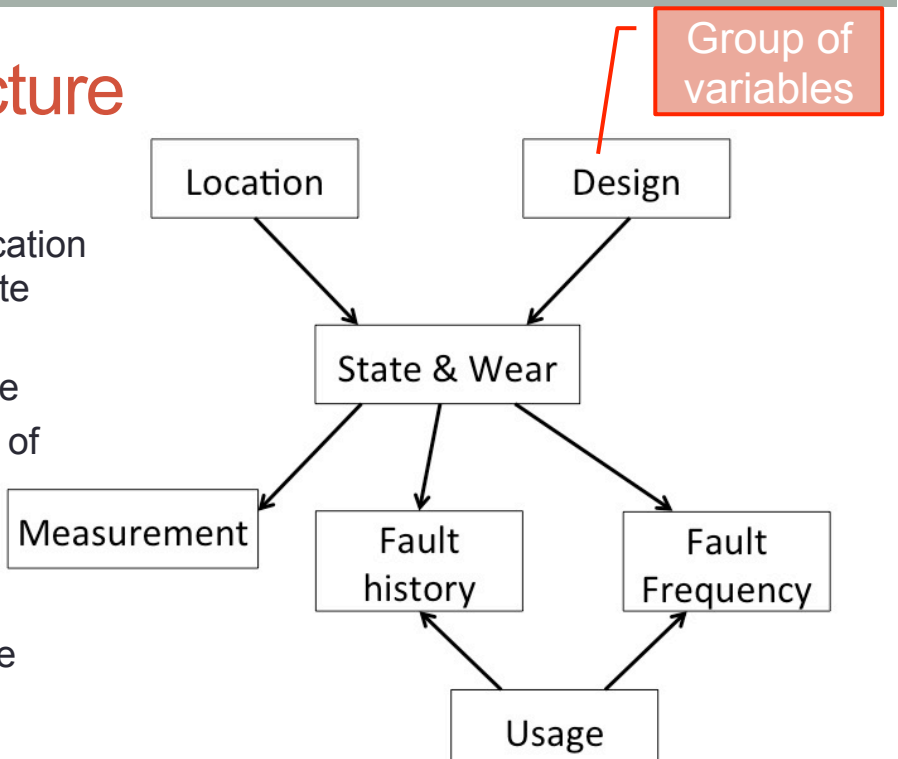
- Asset register
- Record of usage
- Observed faults & delays
- Maintenance processes
- Inspection
- Remote condition monitoring
- Automatic measurement: NMT, UTU, GPR

Databases

- GEOGIS
- Usage: NETRAFF/ACTRAFF
- FMS, TRUST
- ELLIPSE, Weekly Operating Notices
- RDMS
- Track Geometry Data (CDDS, TrackSys)
- **Paper records**

Outline Architecture

- Logic
  - Information about the location and design influence state
  - Measurements and fault history symptoms of state
  - State predicts frequency of faults
- Data
  - No single database
  - Need to combine multiple database



Data Quality and Data Issues

- Data from multiple databases must be combined
  - Data currently supports specific operational use
  - Difficult to link records (e.g. to a fault)
- Grouping assets
  - Hierarchy of asset numbers by asset class
  - Difficult to extract ‘whole system’
- Manual records
  - Ellipse records dates but not details
  - E.g. detailed maintenance actions or measurement results

Conclusions: Future Directions

- Feasible to improve decision-support
  - Better use of data: depot staff ‘under-use’ data
- Challenge of combining data sources. Bring together
  - Understanding of processes generating data
  - Understanding of data organisation
- Expert-led model structure: variables and their links
- Training dataset: including data from paper records

- Why Now? Better data in future!
  - Not just data: model structure
  - Data will not support this need unless explicit