Research project IRIS
Integrerat Dynamiskt Prognostiserande Underhållsstöd
Integrated Dynamically Prognosticating Maintenance Support

Dr Jonas Biteus
jonas.biteus@scania.com
Scania CV
Vehicle Service Information

Financed by: FFI – Transporteffektivitet and Scania CV
Outline

- Scania R&D
- Traditional Maintenance
- Flexible Maintenance
- Research Project IRIS
2,825 employees
500 consultants

Turnover:  ~SEK 5,500m.
Provider of Transport Solutions

Products
- Heavy trucks
- Heavy buses
- Engines

Services
- Workshops
- Service agreements
- Parts
- Driver training
- Scania Assistance

Financing
- Operational leases
- Financial leases
- Hire purchase
- Insurance solutions
More than 1,600 sales and service points globally

Non-captive
Captive
Modular Vehicle Design

Modern commercial vehicles are built based on a modular design to optimize the customers return of investment.

Modular electrical system

Modular chassis and powertrains

Customer

Customer optimized vehicle
TRADITIONAL MAINTENANCE
Traditional Maintenance

Maintenance defined from user’s perceived needs:

- Vehicle spec
- Operation type
- Oil quality

Time/milage

Interval defined upon purchase of vehicle

Start of life

End of life

Oil exchange

Filter, grease, etc.
The operation types for trucks are:

0:0 Very light long distance haulage
0 Light long distance haulage
1 Long distance haulage
2 Heavy long distance haulage
3 Construction
4 Distribution

and for buses:

1 Long distance
2 Intercity
3 City bus
Example Maintenance Interval

Interval specification:

- **Operation type**
  - Long distance haulage

- **Vehicle spec**
  - V8 with 520 hp

- **Oil quality**
  - LDF-3

→ **60 000 km oil exchange interval**
FLEXIBLE MAINTENANCE
Flexible Maintenance

Oil prognostics

Start of life

End of life

Time/Milage

Uptime €

End of life

Oil

Oil prognostics

Start of life
Flexible Maintenance for Modular Systems

- To perform flexible maintenance, individual, data driven, health-indicators are needed
  - Manage modular products
  - Manage time, (10-30 years for Scania)
Health Indicator Models

- Physical models
- Expert rules
- Cost
- Precision

High
Low
## Physical Models

### Chassis specification

- **Chassinummer:** 208
- **Vinnnummer:** YS2R4X
- **Oljebyrå:**

### Data used for prognostics

- **Utläsningsdatum:**
  - 2014-07-28 08:11:38
  - 2014-06-05 08:52:22
- **Vägmätarställning:**
  - 467623
  - 428294
- **Vald körsträcka:** 39329 km (52 dagar)
- **Angiven bränslekvalitet:**
  - Svavel: 10 ppm
  - FAME-inblandning: <=7 %

### Maximum predicted lifetime

- **Godkända oljor**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Distans (km)</th>
<th>Drifttid (h)</th>
<th>År*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scania LDF-3</td>
<td>114000</td>
<td>1580</td>
<td>1</td>
</tr>
<tr>
<td>Scania Low Ash</td>
<td>60000</td>
<td>830</td>
<td>1</td>
</tr>
<tr>
<td>ACEA E6, ACEA E9, API CJ-4</td>
<td>45000</td>
<td>620</td>
<td>1</td>
</tr>
</tbody>
</table>

- **Växellåda**

| STO 2:0 G                  | 498000       | 7480         | 2   |
| STO 1:0                    | 311000       | 4670         | 2   |

- **Bakaxel**

| Bakaxel med filter         | 498000       | 7480         | 2   |
| Bakaxel utan filter        | 311000       | 4670         | 2   |
Expert Models

- Maintenance experts define logical rules based on
  - Vehicle specification
  - Use factors
  - Etc.

Operational data: Mean ambient temperature

High

+100 km oil exchange

Low

-100 km oil exchange
RESEARCH PROJECT IRIS
Objectives

- **Why (Vision)**
  - A vehicle's operation should be predictable -> No Vehicle off road
  - Optimized revenue with respect to flexible maintenance

- **What**
  - How can a vehicle’s health status be predicted based on models developed using machine learning/data mining
  - How can maintenance be optimized considering
    - Health status
    - Customer preferences
    - Vehicle operations
  - Implementation of a demonstrator
Health Indicator Models

- Physical models
- AI models
- Expert rules

Precision

Cost

High

Low

General

Individualized
Prognostic Model

Component health

"Normal" wear

Prognostic model

Threshold for functional failure

Health status

Degradation unit (time, milage, ...)

Health status

"Normal" wear

Prognostic model

Component health
Methodology in IRIS

Data from vehicles and workshops

Data warehouse

Develop prognostic algorithms

Workshop

Data warehouse

Flexible maintenance based on prognostic algorithms

Workshop

Workshop

Vehicle data

Algorithms

Workshop
Research: Prognostics/ Health status

- Which factors affect a component's remaining lifetime?
- Which factors affect the remaining useful life for different components?
- How can machine learning and similar techniques be used to develop models for remaining useful life?
- How can expert knowledge and physical models be used to improve the models?
- How can health status be used to optimize the flexible maintenance?
Preliminary Results: Prognostic Model for Battery Health Status

Battery lifetime prediction for 20 vehicles with 5 time units.
Thank You for listening

Dr Jonas Biteus
jonas.biteus@scania.com
Scania CV
Vehicle service information