Internationaal Spoorwegonderhoud en de rol van data

Koninklijk Instituut Van Ingenieurs Rail en AMM

The importance of Railway Infra Digitisation and Data Collection for Predictive Maintenance

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Reasons to acquire, analyse and action data in infra (but also valid for Rolling Stock)

Reasons:

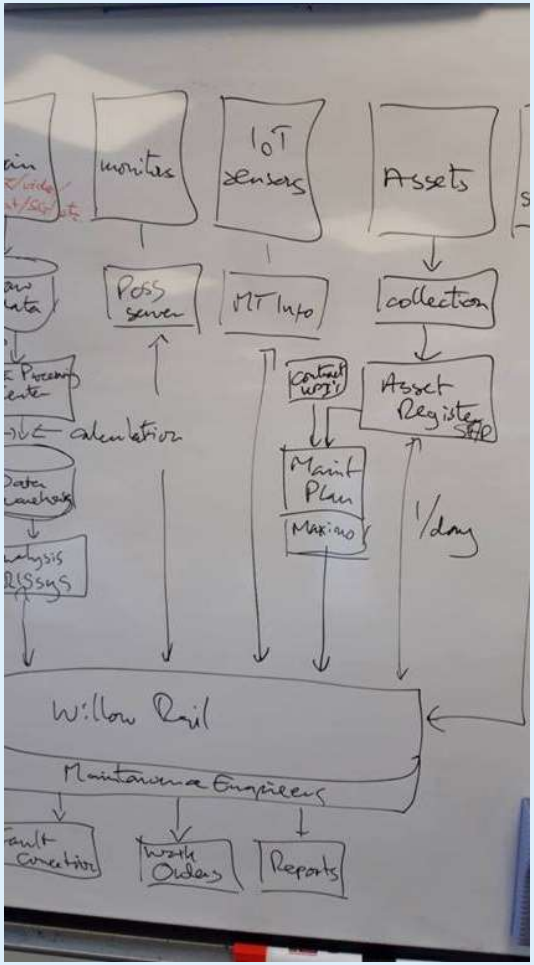
- Pressure on budgets and performance **-20%**
- Agreed levels of RAMS and KPI's in contracts
- Minimal (safety) risks
- Technical opportunities, including new infra in Digital Twins

Strategies:

- Passive, regular use by infra managers
- Active, frequent use by maintainers
- So, different types & frequency of data

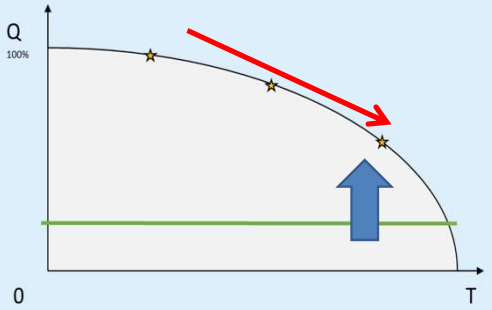
Also:

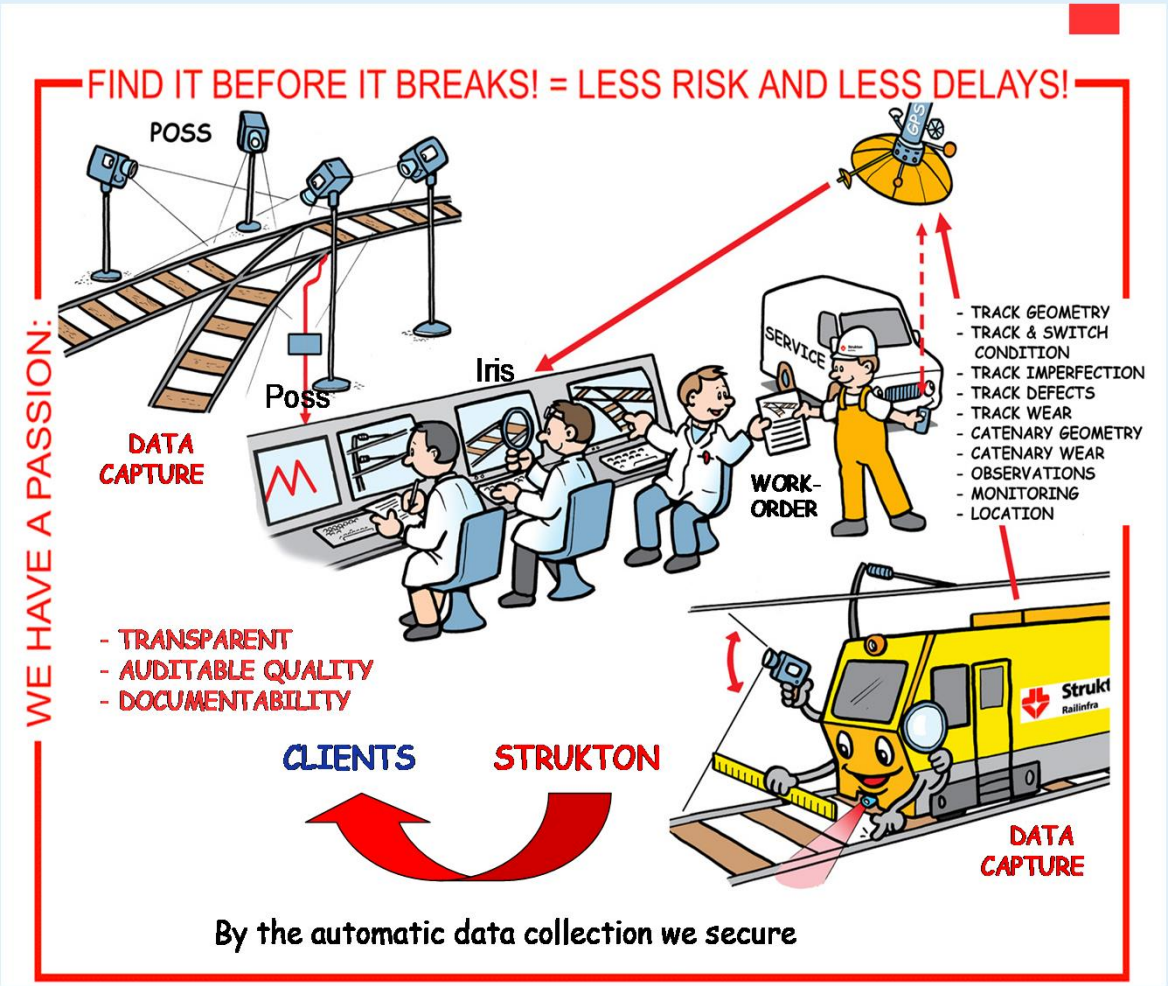
- To feed and update the assets in the Asset Register
- To activate use of the Faults Database
- To optimise the FMECA's of the Assets
- To spot anomalies and spark research



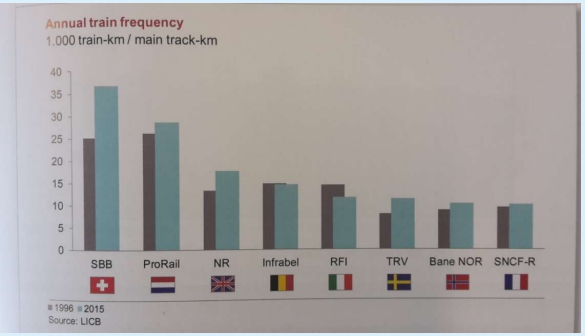
Asset Management Philosophy

Fix it before it breaks!

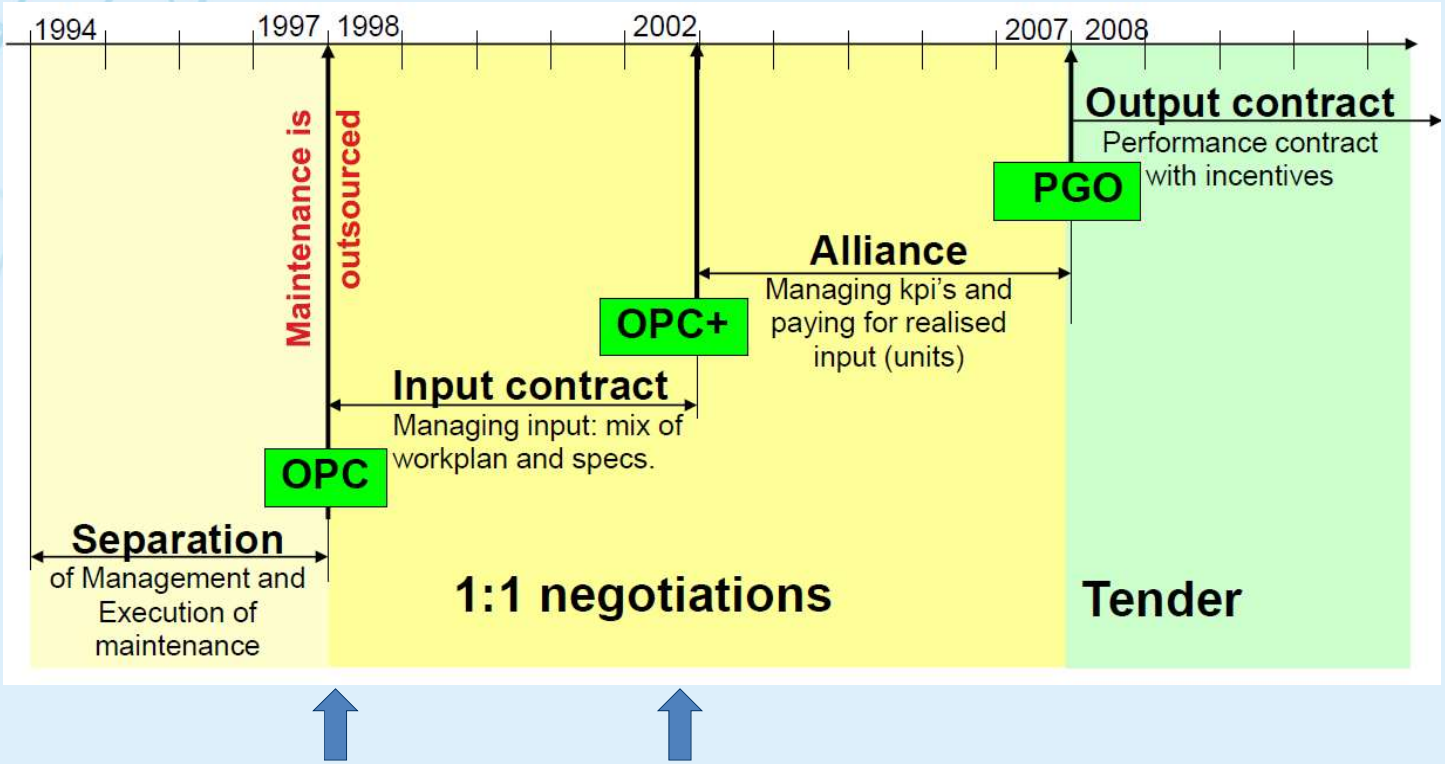




KPI-drivers of performance based maintenance



- Maintenance costs
- Safety issues
- % Technical Availability
- Mean Time to Restore Service
- One-off reduction of "train affecting disturbances",
- One-off reduction of "infrastructure failures"
- EU comparison



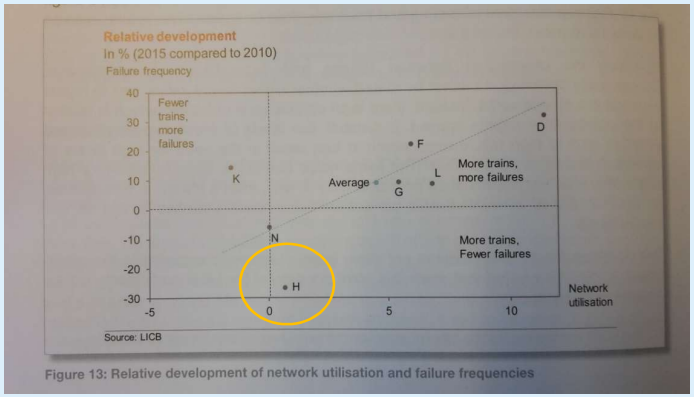


Figure 13: Relative development of network utilisation and failure frequencies

Model developed with RIB/ProRail (in 2002)

IAMS Flow Chart (ISO55000)

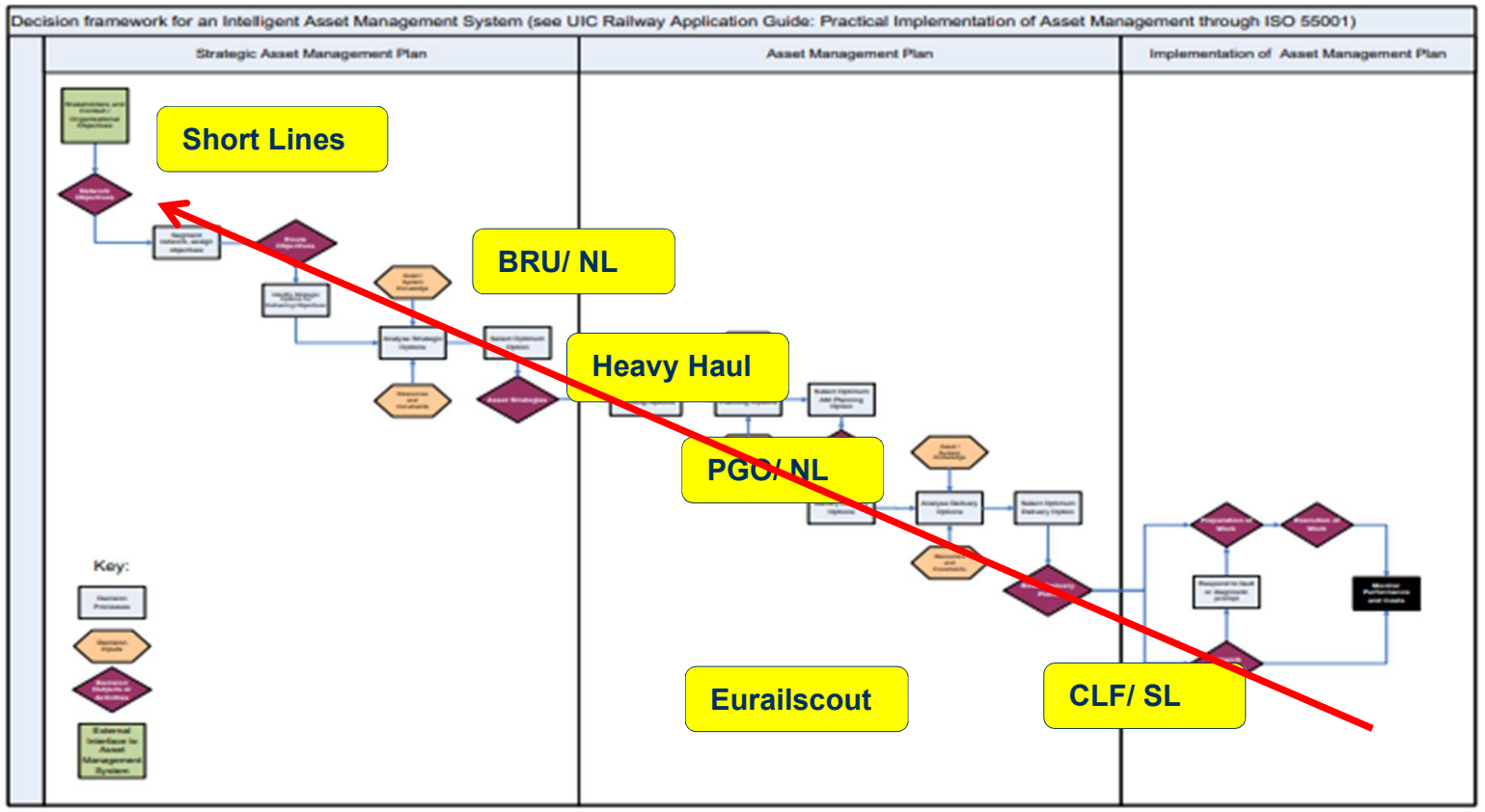
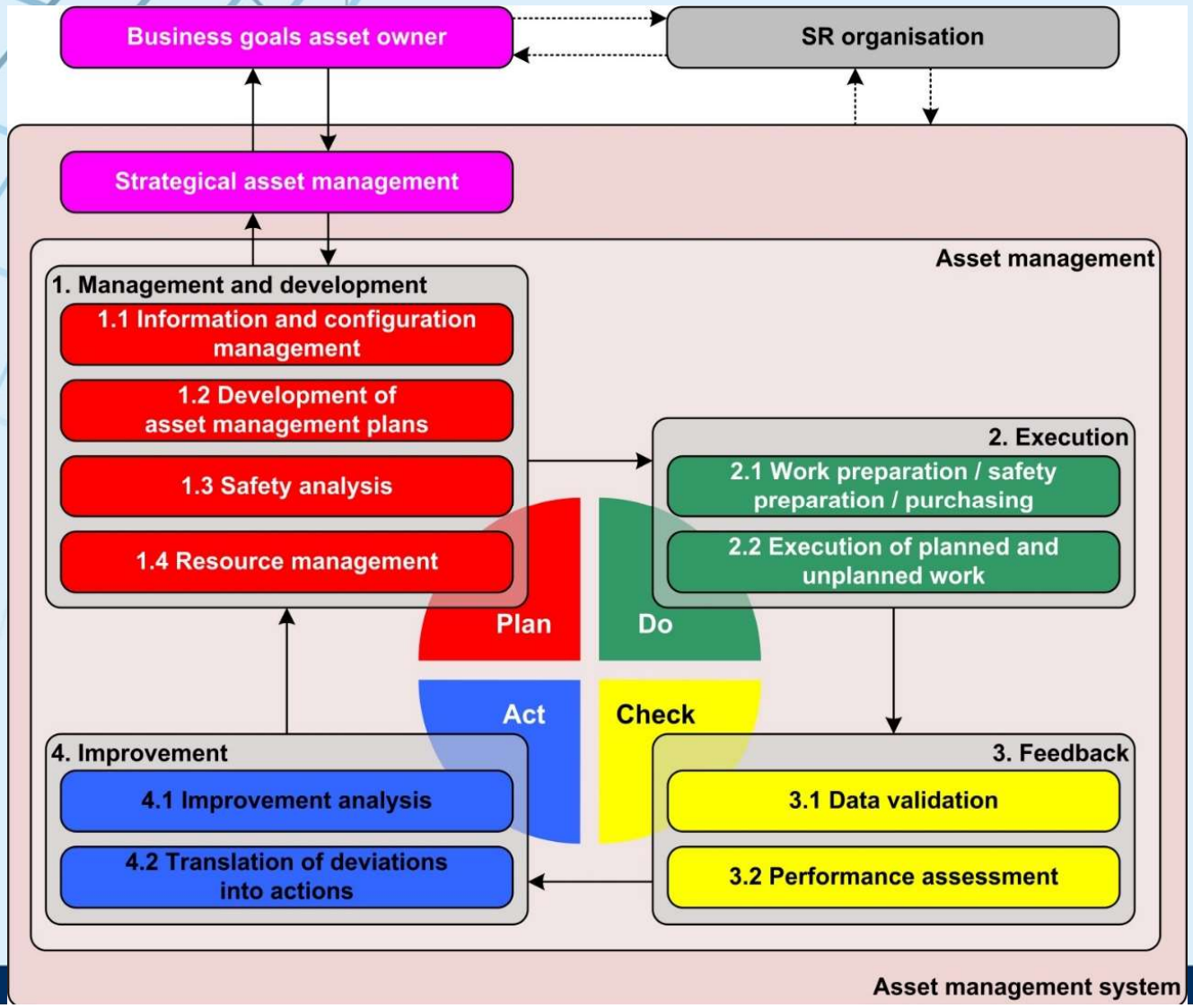
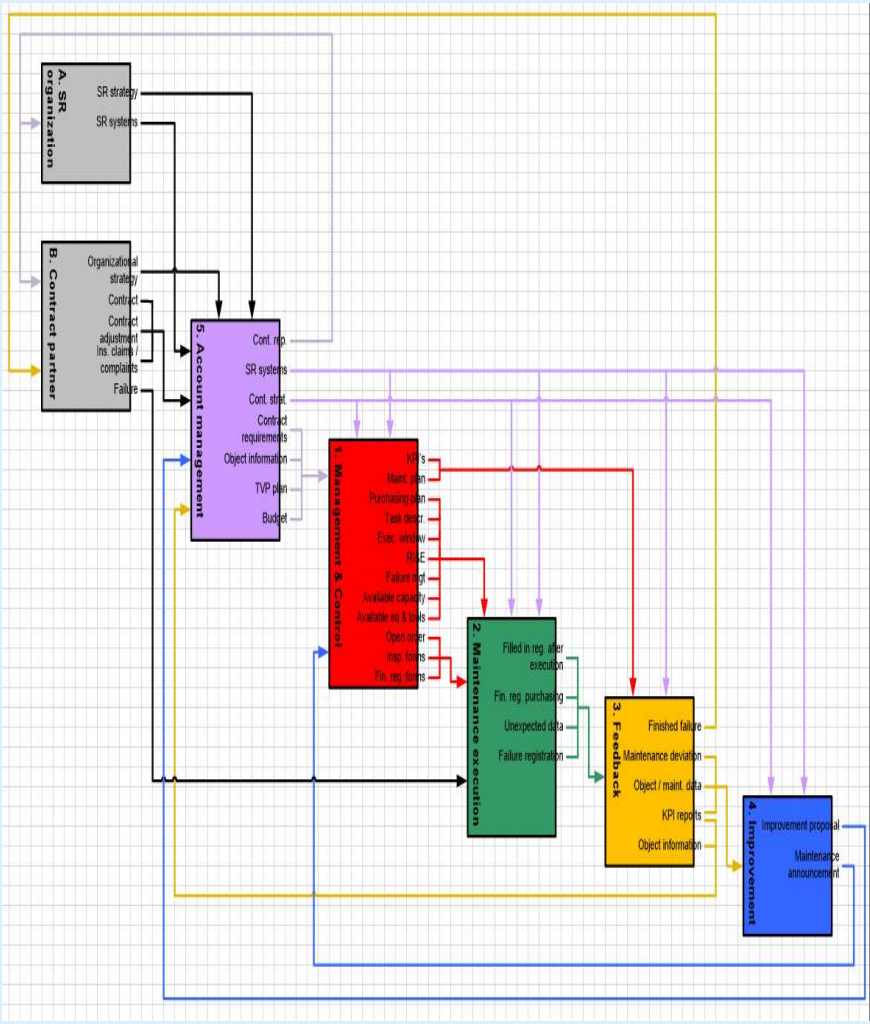


Figure 1 - Level 1 IAMS Decision and Activity Flowchart linked to ISO 55001

- Performance agrmt
- Asset mgmt. plan
- LCC consideration
- Production plan
- Develop maint.plan
- Decide intervention
- Plan/ prepare work
- Maintenance work
- Monitor results

Rail Asset Management





Asset Management Business Case

Data acquisition systems

Research & Development

Operational

Satellites

Drones/UAVs

Commercial trains

Crowd sensing

Measurement trains

Inspection tablets

Remote devices

Wayside sensors

Data management & analytics

Asset characteristics

Local conditions

Usage

Weather

Environment

data

Smart algorithms

Extracting relevant information (A.I.)

asset condition

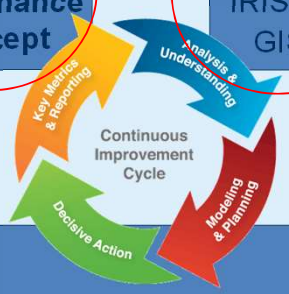
FMECA

Maintenance concept

Tooling

IRISsys

GIS



Analytics

Trend analysis

Operation support

Control Room

alerts

optimized maintenance plan

maintenance reports

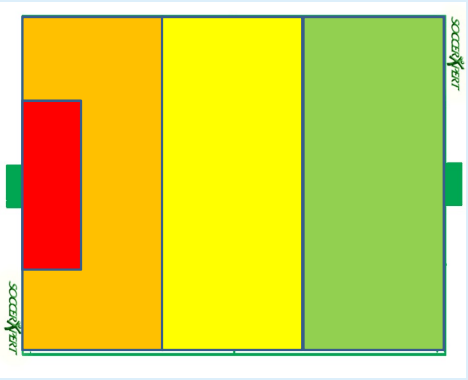
Maintenance products & services

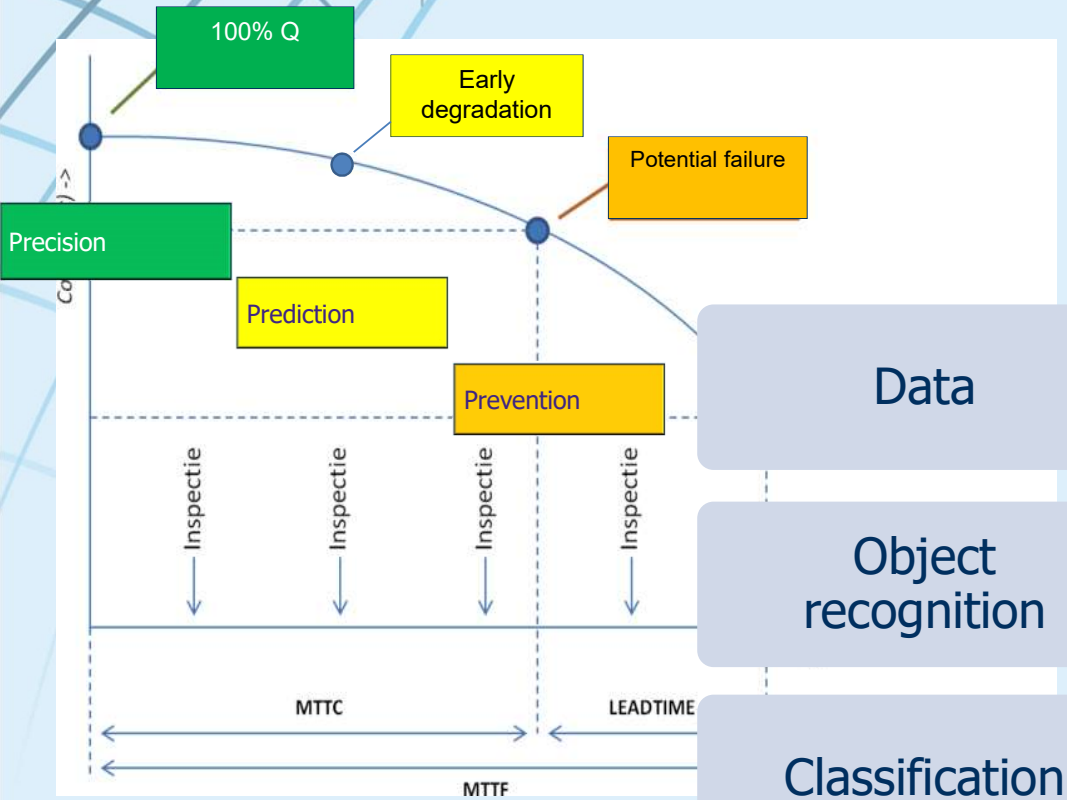
€

€ffective Maintenance

repair orders

Coherent data-led process





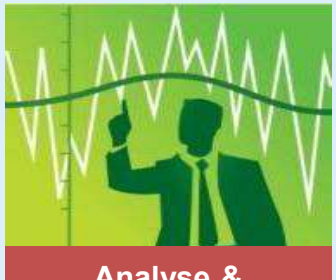
Data	ABA / US / ECT / VIS / POSS			
Object recognition	Objects / Components			
Classification	**Good condition**	**Minor defects**	**Poor condition**	**Serious defect**
Action	Trend analysis	Predictive maintenance	Preventive maintenance	Corrective maintenance

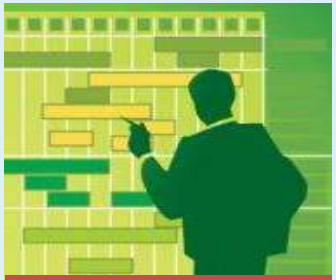
Rail Asset Management

Define & Select

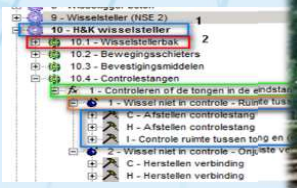
Measure & Monitor

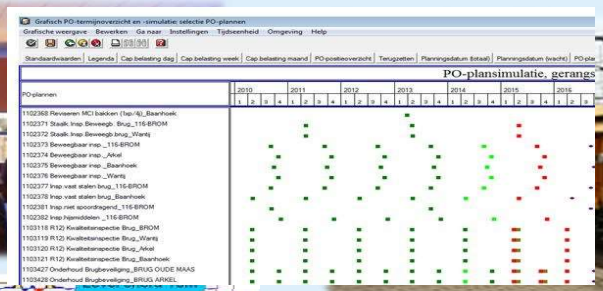
Manage Data & Interface

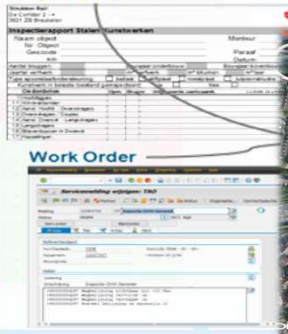

Analyse & Interpret

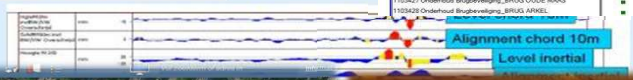

Organise & Plan

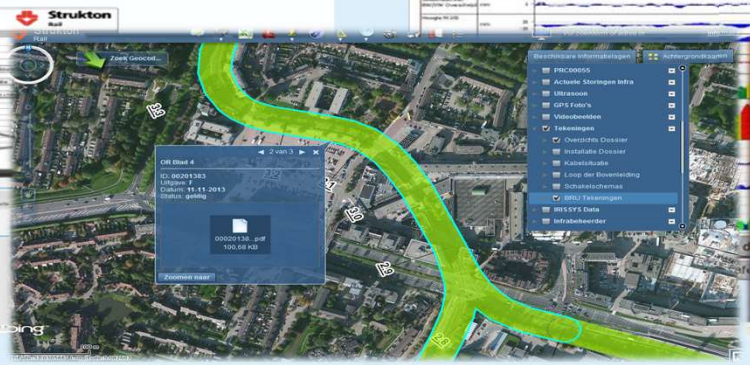
Maintain & Feedback











Rail Asset Management

From 99% to 99.92% availability of the rail system

90% reduction on rail safety related exceedances
- 70% less track geometry threshold exceedances
- High tech data capturing
- IRISsys predictive modelling
- Effective tamping process
- 50% failure reduction on assets in 30% shorter maintenance windows

30% reduction on total maintenance costs
- Performance based contracting @ fixed price
- Control Centre, Pro active: incentivised
- Do things intelligently; Reliability Engineering, Asset Management, Big Data
- Risk based maintenance, FMECA, LCC
- MMS + linear asset management (Optimizer+)
- MQM, automated plausibility analysis on-site

Up to 75% less maintenance costs on switches
- Physical upgrades; track sure bolts, best in class bearings
- Root Cause & Fault Tree Analysis
- Functional modelling
- Image capturing and video analysis
- Advanced Big Data analytics …….

95% accuracy for one FM to predict turnout failures 1 week ahead

Where are we in Europe?

Good news is that the Netherlands are at the forefront of data-led maintenance, thanks to the split between IM ProRail and maintenance contractors.

France, Germany and Italy are close behind, the UK has made a start.

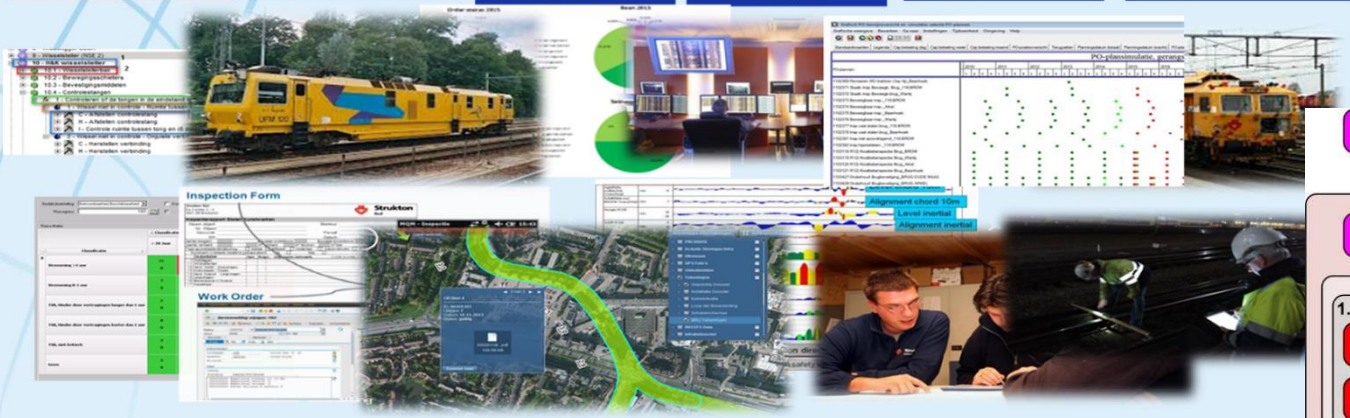
Problem for many countries is operationalising data-led decisions as this calls for a change in culture in a heavily unionised environment.

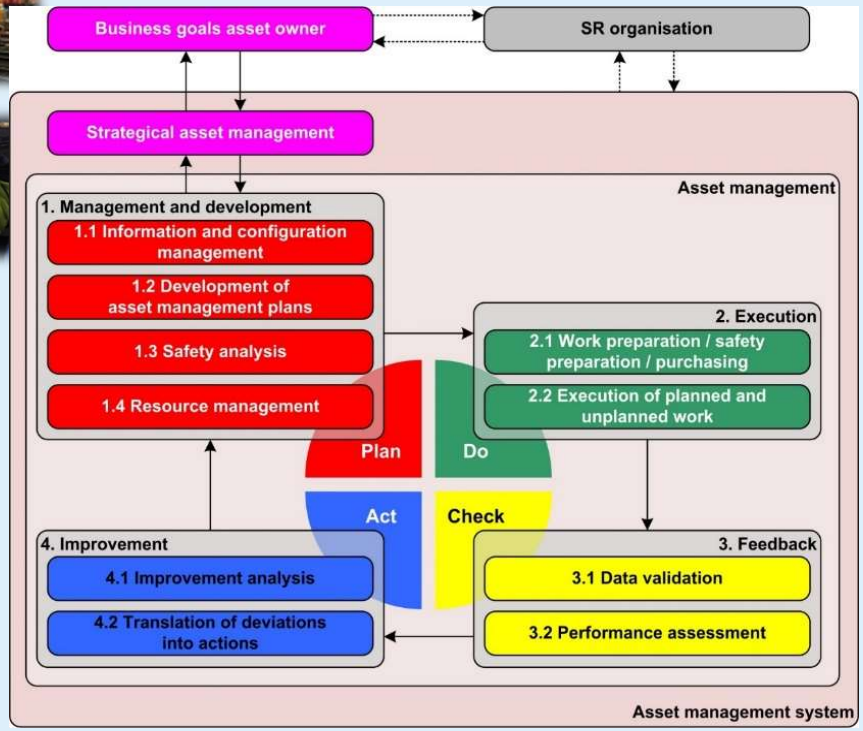
Measuring trains are used by most countries. Major fleets are:

- RFI Italy: 300M€ budget for renewing their fleet
- DB Netz Germany: major fleet, some renewal, some contracting
- NR UK: aging fleet, decision whether to renew or contract out
- SNCF France: aging fleet, partly renewing and buying into Eurailscout
- Eurailscout Netherlands: ProRail relies on Eurailscout.

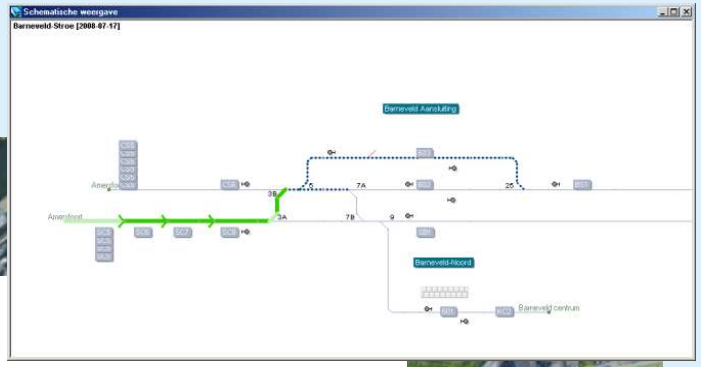
ProRail's view on Asset Management

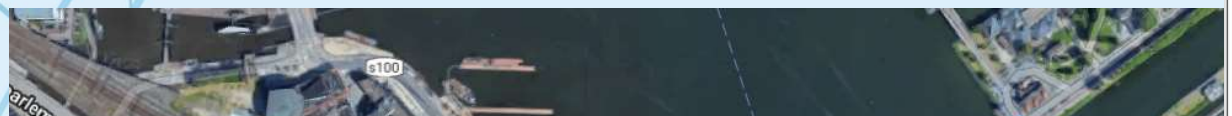
From theory to practice

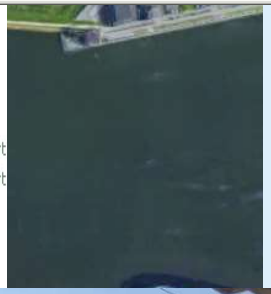


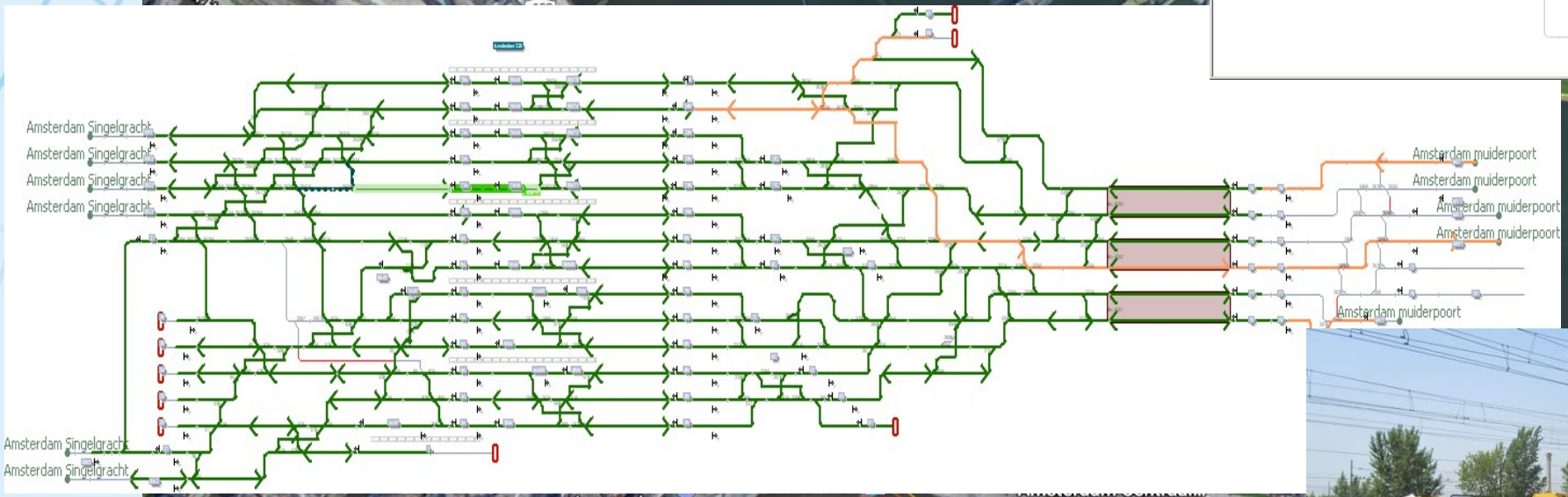


Step 1a Model acquisition & use example: Amsterdam







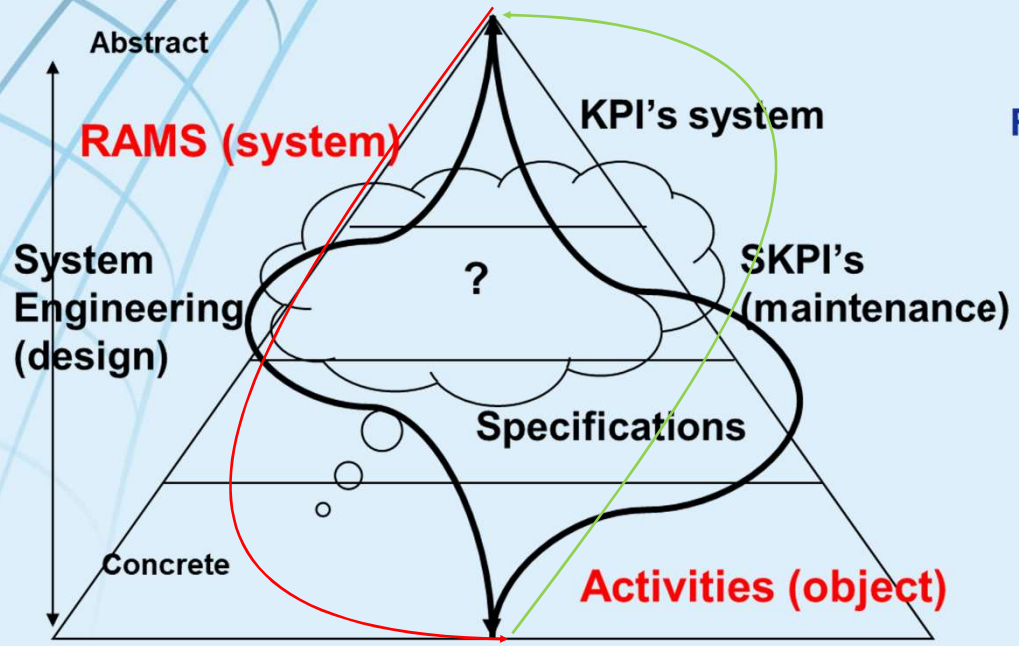


Routing:

Map-matching, based on: gps, odometer, IMU, and recognition of the switch frog, RFID

Step 1b. Budgeting RAMS requirements: R+M=A

Non-A = 1%?



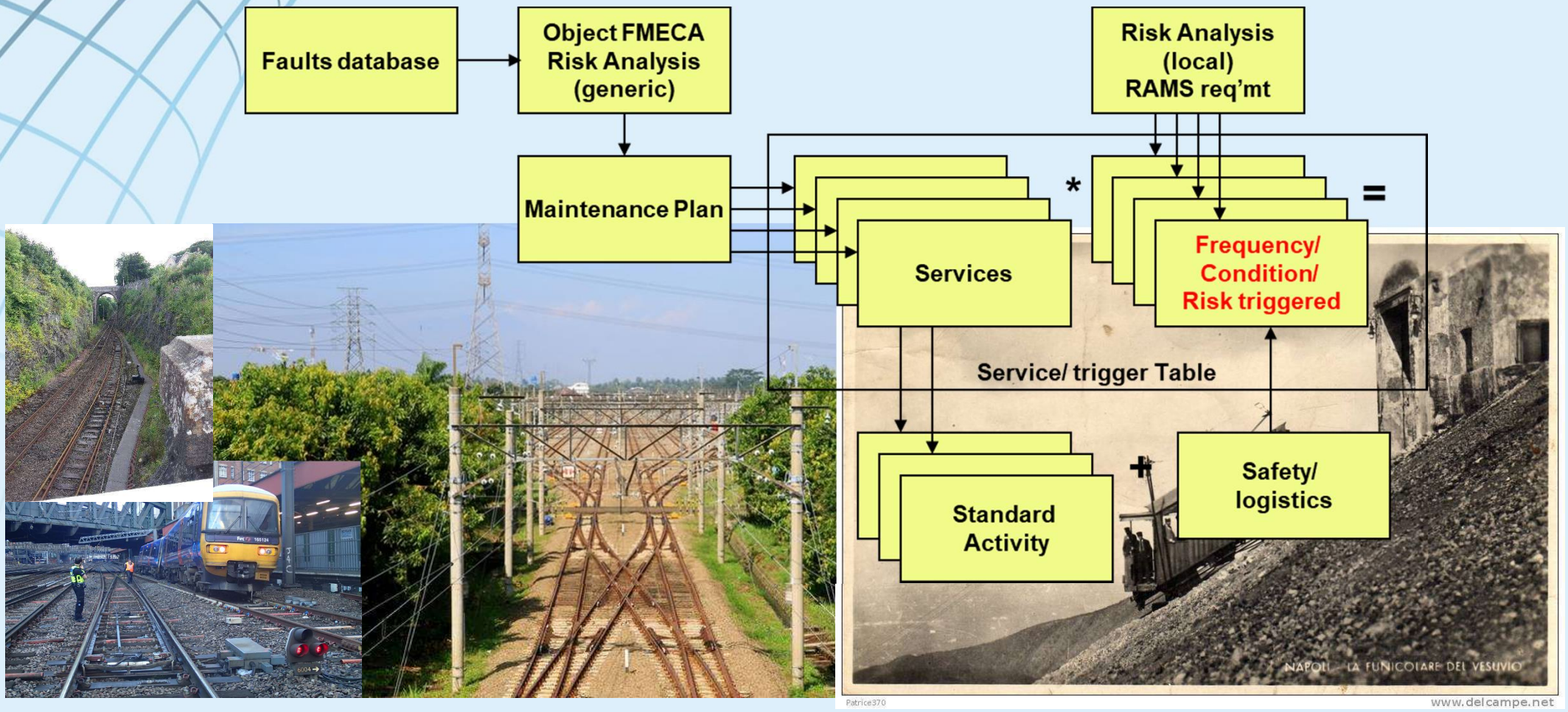
R = Non dependability ~ 0.1%
= Unplanned downtime

M = Planned downtime for maintenance ~ 0.8%

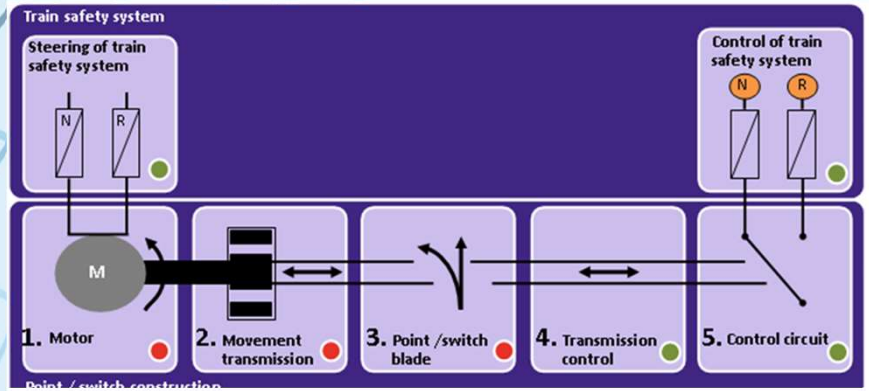
# Faults x Recovery time = MTBSeF x MTTRSe	Recurring possessions
	Incidental possessions
Possession return delays	Temporary Speed Restrictions

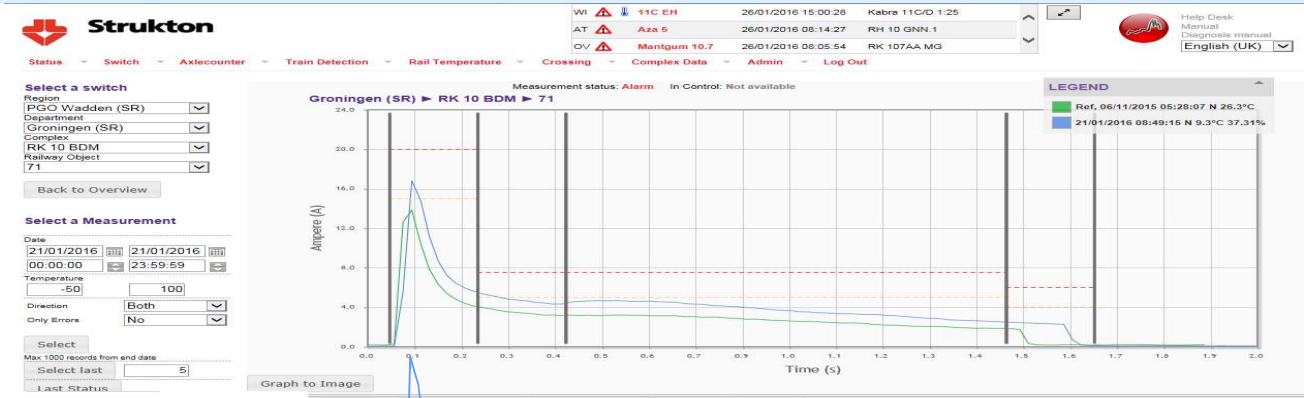
T = Tegelberg's number = **8760 hrs/yr**

Step 1c. Maintenance concept building



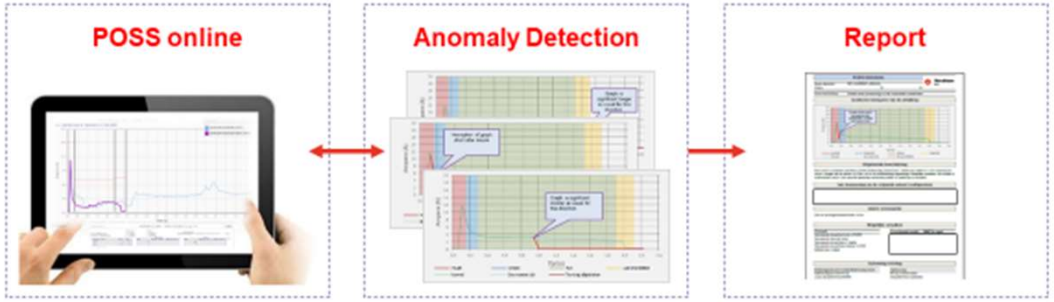
Step 2 Switch system approach: what can we influence, what do we need to measure





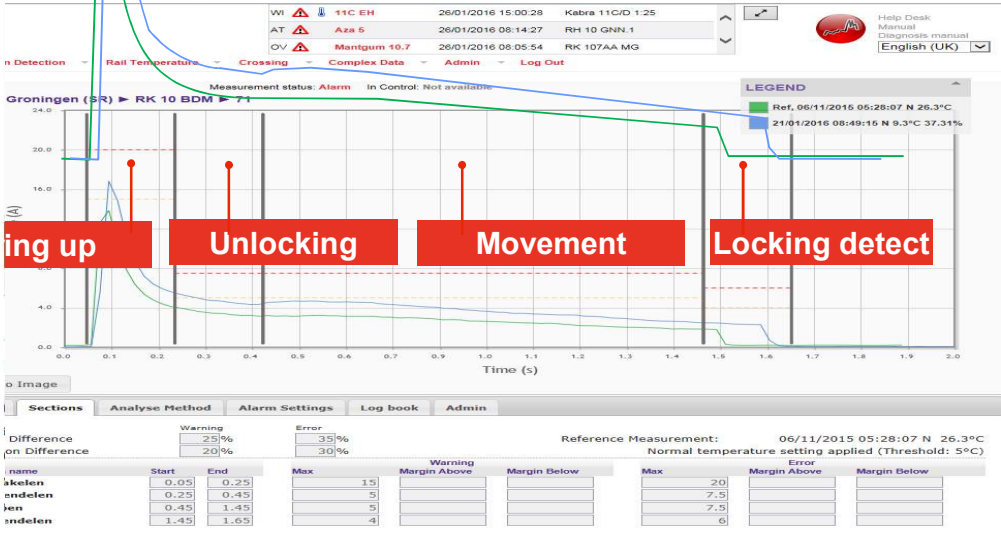
Maintenance Support Algorithm

Concept of a virtual assistant

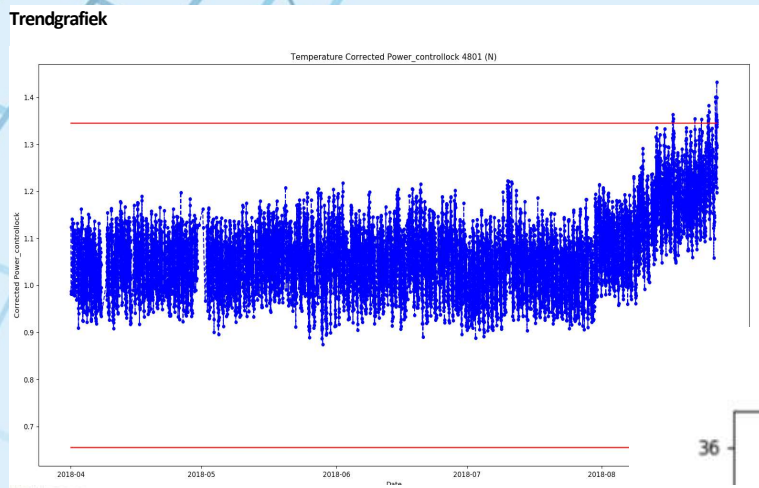


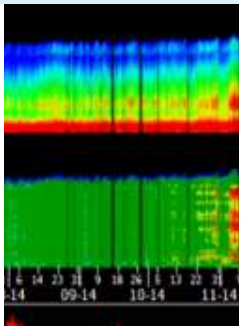
The algorithm compares POSS graphs with the library 24/7.
Minor deviations which are related to characteristic of known failure's are detected.
A notification is issued to the control center, where a root cause report is generated.
The maintenance crew is informed by reported instructions.

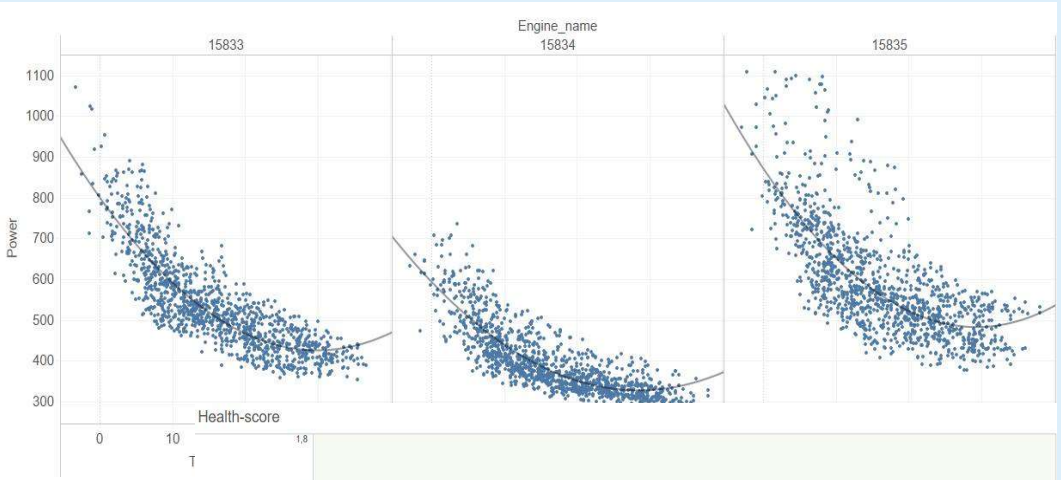
SMART Maintenance Technologies

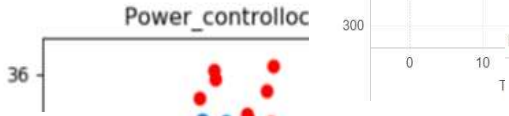


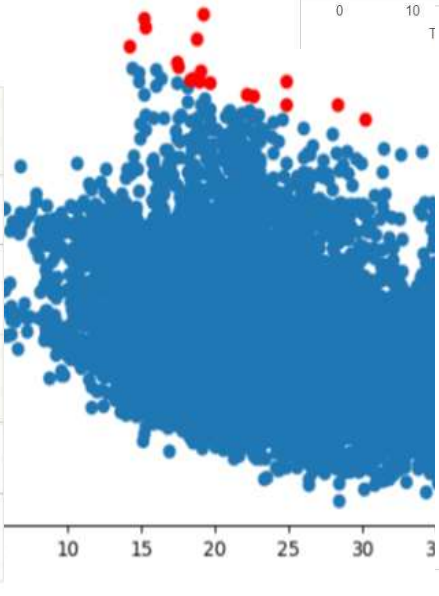
Step 2 Switch system approach: what can we learn, what can we do: health scores

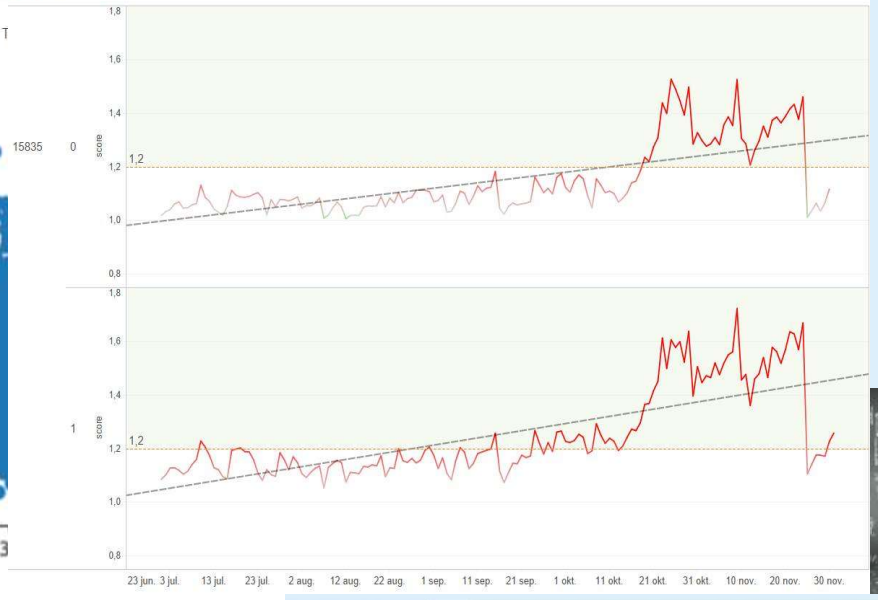








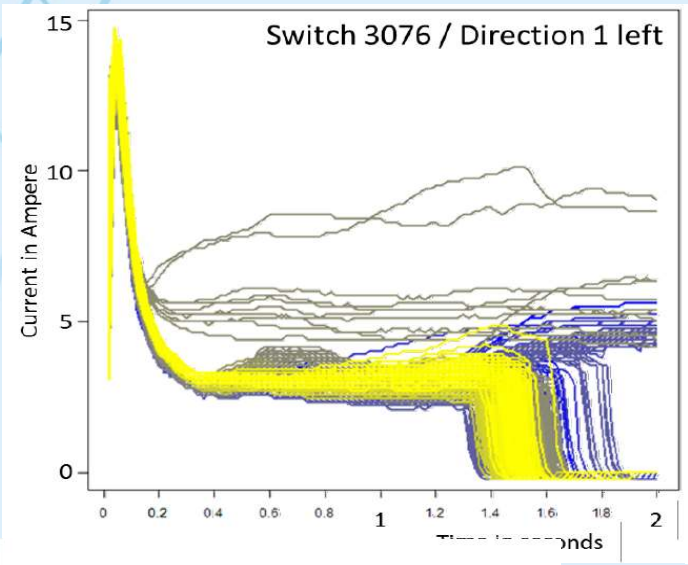


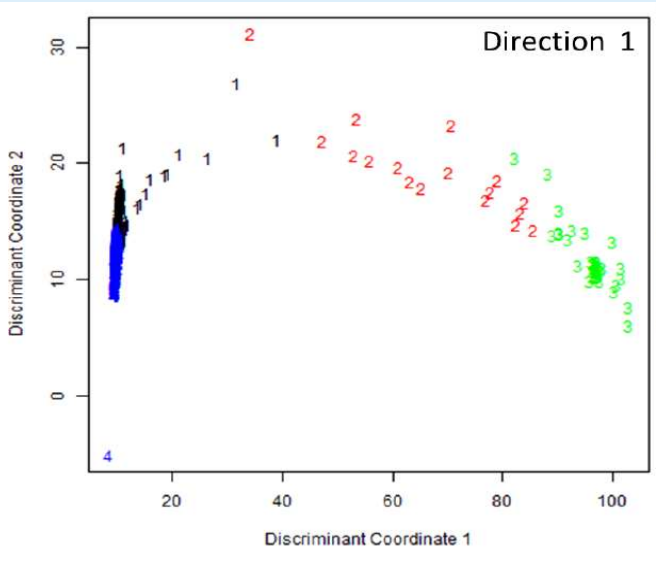


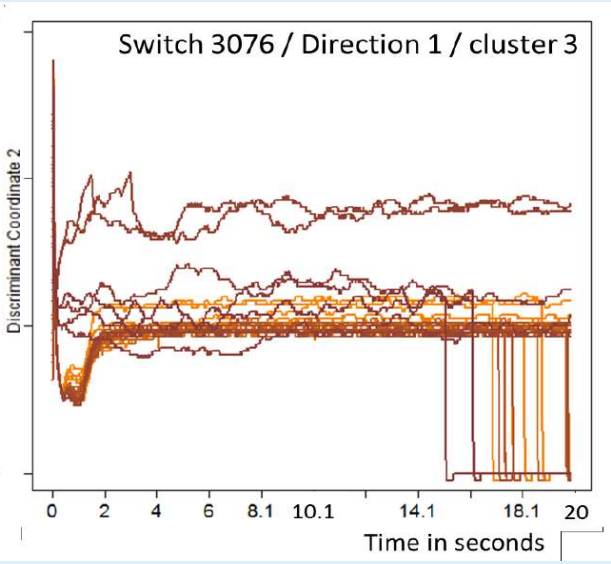
Step 2 Switch system approach: what can we learn, what can we do: anomaly detection

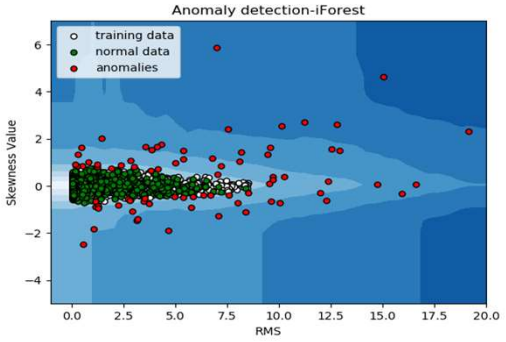
'Anomaly is defined as a deviation of normal'

- Clustering









in: Proceedings of WCCM 2017 congress, London, 13.-16.06.2017.

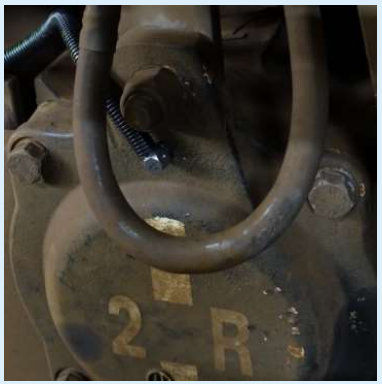
erospace Centre (DLR)

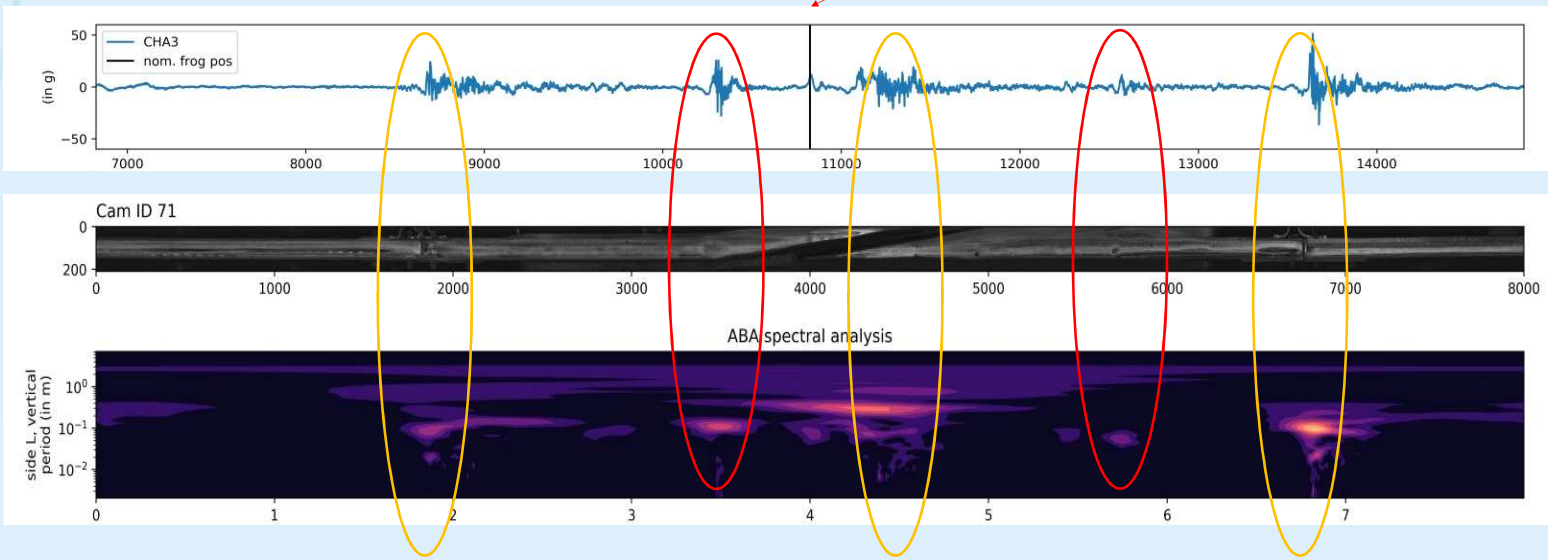
Step 2 Switch system approach: what can we learn, what can we do: prediction

Step 3 Transform data into information

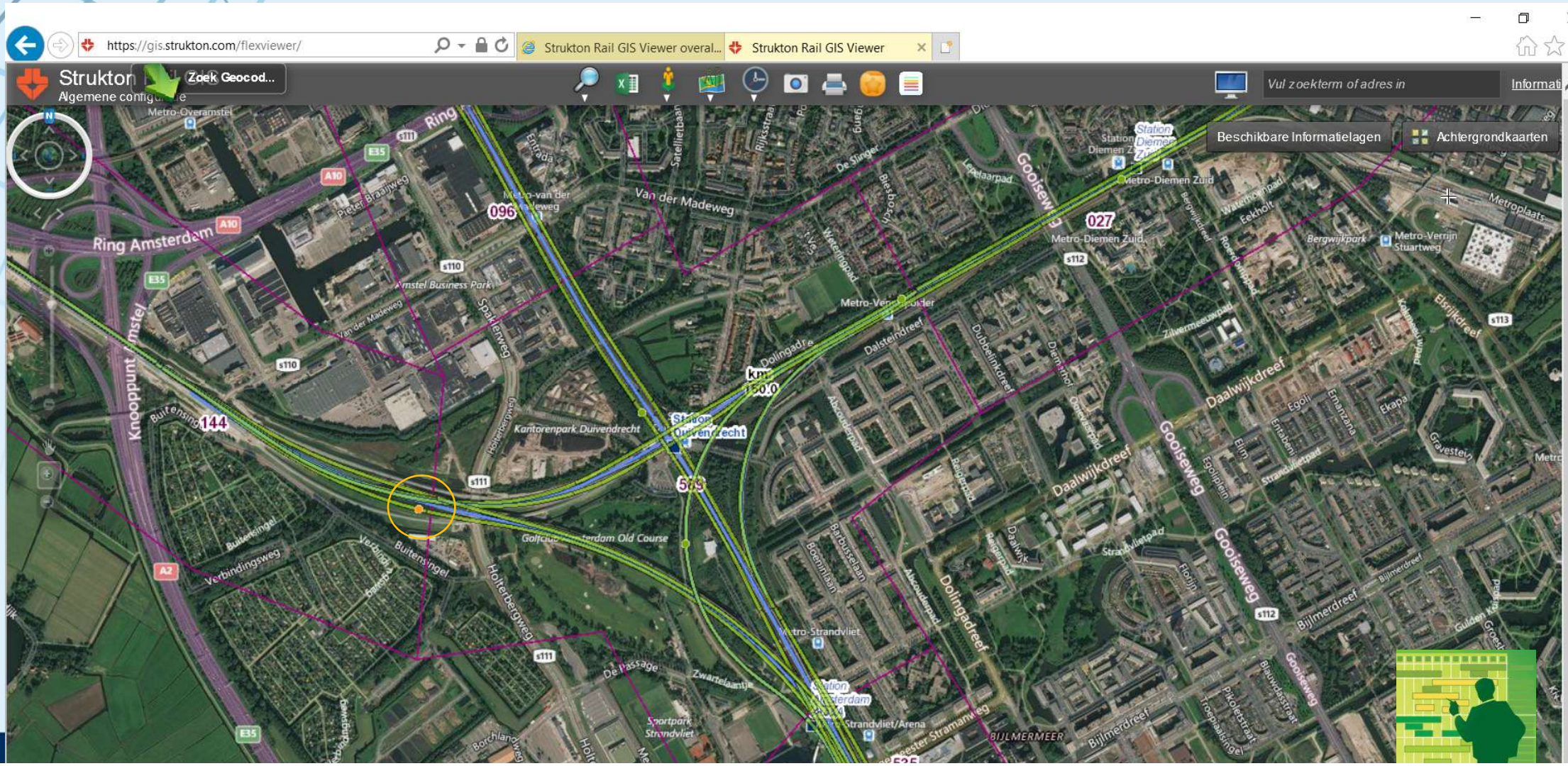
Step 4 Analyse and interpret

- From the Shift2Rail programme!
- Monitoring of (degeneration of) rail surface defects
- Datasets: 3D-axle box accelerations + video



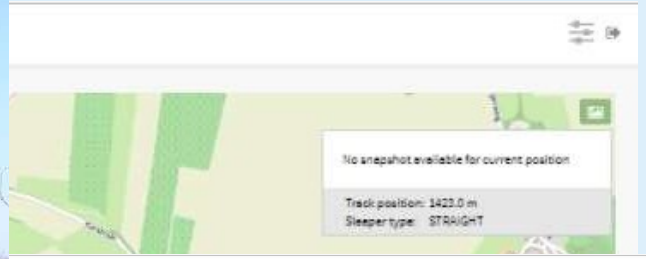


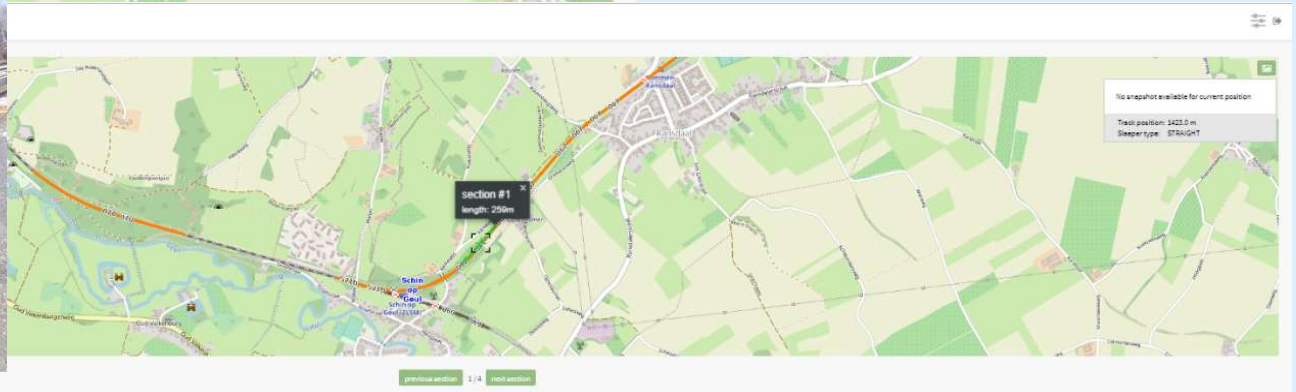
Step 5 Geolocationing and GIS positioning of defects & work



Step 6 Maintain & feedback

System 7 tamping machine





A final word on Digital Twins

As an Asset Register
- To hold and develop static data
- To hold and develop physical models and FMECA's

As a Faults Database
- To hold faults data and performance KPI's

As a Data Warehouse
- To hold and develop dynamic data
- Linear and point databases
- To localise and mesh datasets

As an Analysis Tool
- To clean and prepare dynamic data
- To analyse and merge datasets
- To deliver information
- To predict the near-time future in physical models
- To action work

Take home messages

Questions and answers

KIVI departments

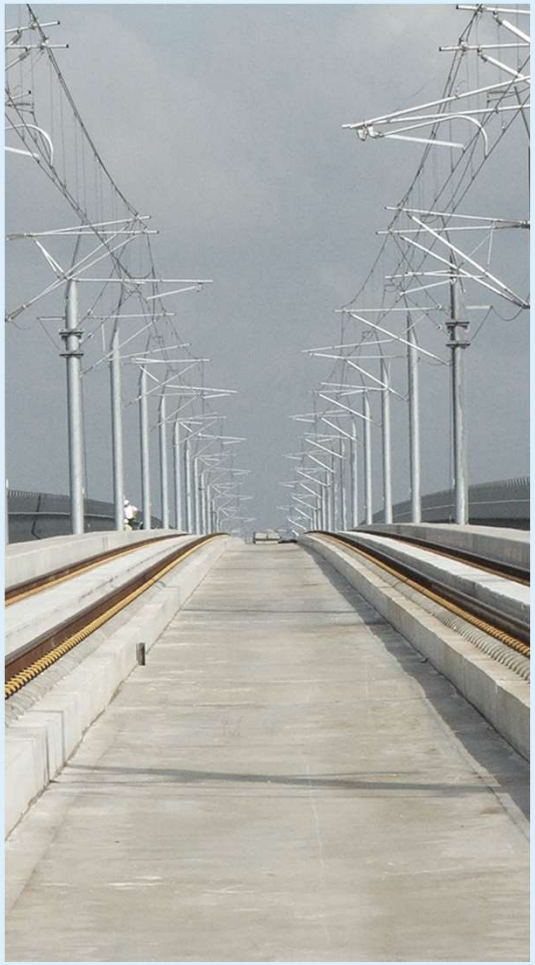
Aerospace Engineering	Landgebruik en Watermanagement
Asset Management & Maintenance	Maritieme Techniek
Bedrijfskunde	Mechanica
Bouw	Medische Technologie
Bouw- en Waterbouwkunde	Meet-, Regel- en Besturingstechnologie
Chartered Engineering	Mijnbouw
Commercieel Ingenieur	Nederlandse Procestechnologen
Defensie en Veiligheid	Netwerk Vrouwelijke Ingenieurs
Duurzame Technologie	Offshore Techniek
Elektrotechniek	Rail
Energie- en Warmtetechnologie	RisicoBeheer en Techniek
Filosofie & Techniek	Techniek, Maatschappij & Economie
Geotechniek	Technische Fysica
Geschiedenis der Techniek	Telecommunicatie
Hydrocarbon Technologies & Energy Transition	Transportkunde en Logistiek
Industrieel Ontwerpen	Tunneltechniek en Ondergrondse Werken
Informatica	Verkeer en Vervoer
Kerntechniek	Voertuigtechniek
KIVI International Engineers	Werktuigbouwkunde

KIVI afdeling Rail: **in het kort**

Techniek promotie
- De rol van techniekvelden
- Versterken van beroepsprofielen
- Promotie op universiteiten en hogescholen

Leden service
- Collegiaal contact en verbinden
- Kennisopbouw en kennisuitwisseling
- Aantrekkelijk programma van lezingen en excursies

Onze vakafdeling
- Opgericht in 2007
- Actief en breed vertegenwoordigd bestuur
- Rond 200 actieve leden in de railsector



KIVI afdeling Rail: **thema's**

- ERTMS
- BB21
- 3 kV, 25 kV
- FRMCS, GSMR
- Spoorsystemen en –constructies
- Lightrail
- Systems engineering
- Veiligheid
- Nieuwe contractvormen (prestatiegericht onderhoud)
- Ontwerp en bouw
- Onderhoud
- Spoorspattingen
- Stations en stationsvoorzieningen
- Info-plus (onderdeel Post 21)

KIVI afdeling Rail: **activiteiten**

Activiteit
Chartered Engineer: kwaliteitsmerk voor topingenieurs

Webinar
Technische ontwikkelingen spoorsystemen in Europa

Webinar
Vernieuwing spoorbeveiliging in Sri Lanka

Webinar
Raakvlakken FRMCS, 5G en IoT en toepassingen

Webinar
Datascience in het Spoor: Via data, experimenten met sectorpartners

Activiteit
Spoorpubquiz 2021

Bijeenkomst
Trans Europe Express 2.0

Webinar
Automatisch rijden in metro's en treinen

Webinar
Project Noord-Zuidlijn Amsterdam

Webinar
De Uithoflijn – Klaar! Maar wat hebben wij ervan geleerd?

KIVI afdeling Rail: **onze vakafdeling**

Doelgroep

- De jonge en toekomstige ingenieurs
- De professional die kennis wil vergaren en delen
- De professional die wil netwerken

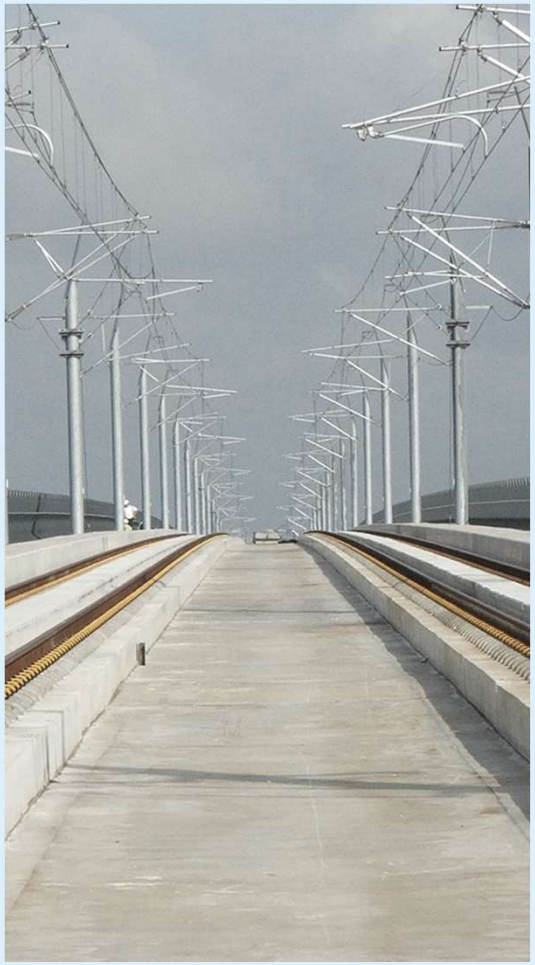
Geïnteresseerd? Word lid!|

→www.kivi.nl/afdelingen/railsystemen

- 2 afdelingen (toegang bijeenkomsten, updates en netwerk)
- Tijdschrift 'de Ingenieur' (12x/jaar)
- Exclusief, gereduceerd tarief of gratis toegang tot activiteiten

Opkomende lezingen en excursies

- Excursie Onderhoudswerkplaats Zutphen
- Excursie Onderhoudswerkplaats Stadler Rail
- Klimaat adapatie / Baanlichamen
- Ervaringen uit Australië
- Overwegveiligheid
- ProRail 5D
- BONS



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