# Punctuality and maintenance

# Infrastructure and rolling stock

## Paris 2017-03-02

**Trafikverket**
**Swedish transport administration**

**Rikard Granström, PhD**
**Project manager Maintenance**
**Southern iron ore line and Haparanda line**

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**Iron ore line Riksgränsen - Luleå**

- Most beautiful railway in Sweden
- Core network
- Single line (arctic circle)
- Traffic: Iron ore, cupper ore, steel-slabs, goods, timber and passenger traffic
- Produce 25-30 MGT/year

- Operational since 1887
- Electrified since 1915
- 53 stations
- 750 m trains
- 30 - 32,5 tons axel load
- 120 - 130 ton per wagon
- 68 wagons per train
- IORE Locomotive 15.000 Hp

**Haparanda line Boden - Haparanda**

- New ERTMS line

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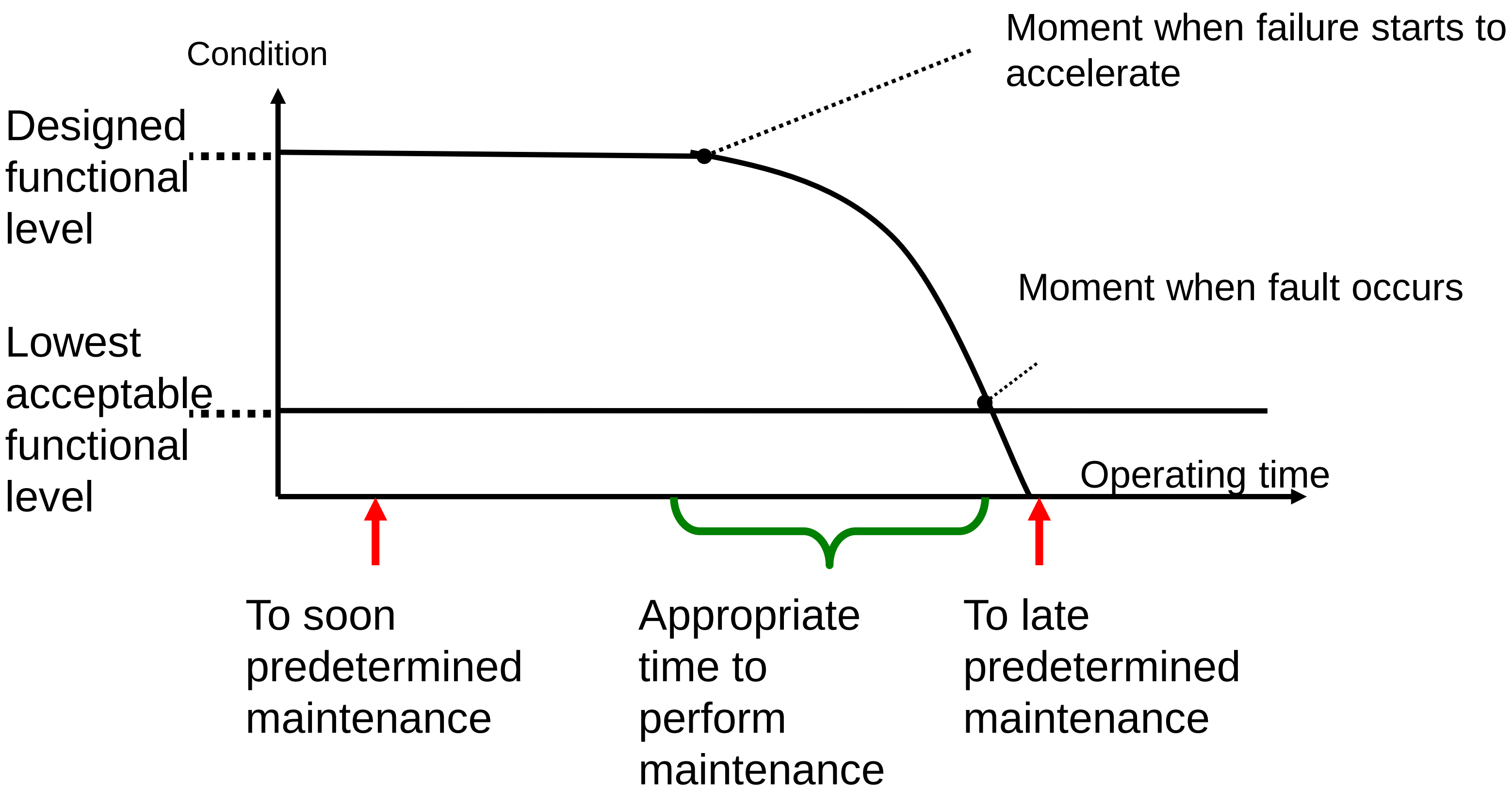
**Availability**

**Reliability**

**Maintainability**

**Maintenance support performance**


# Predetermined maintenance



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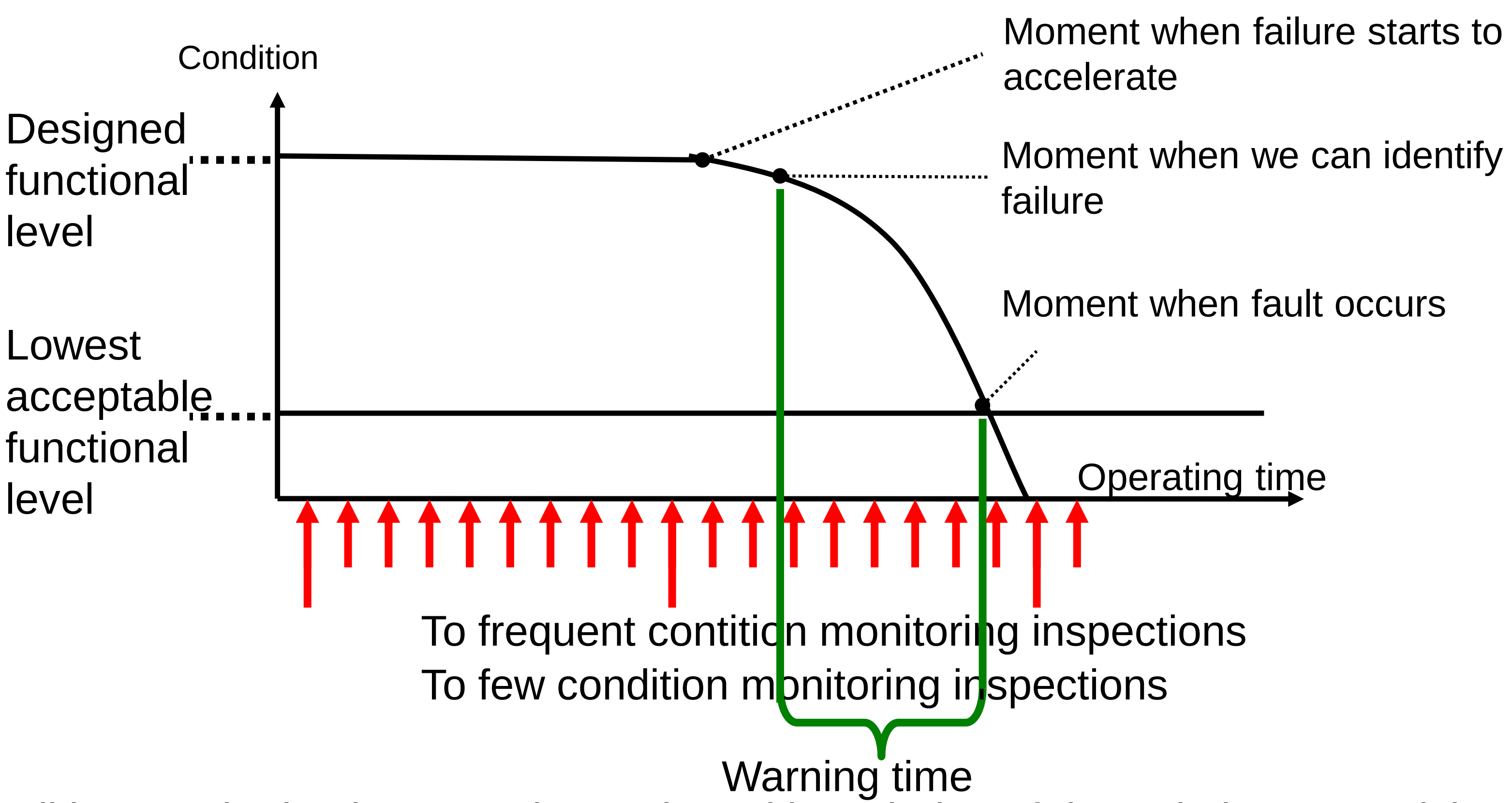
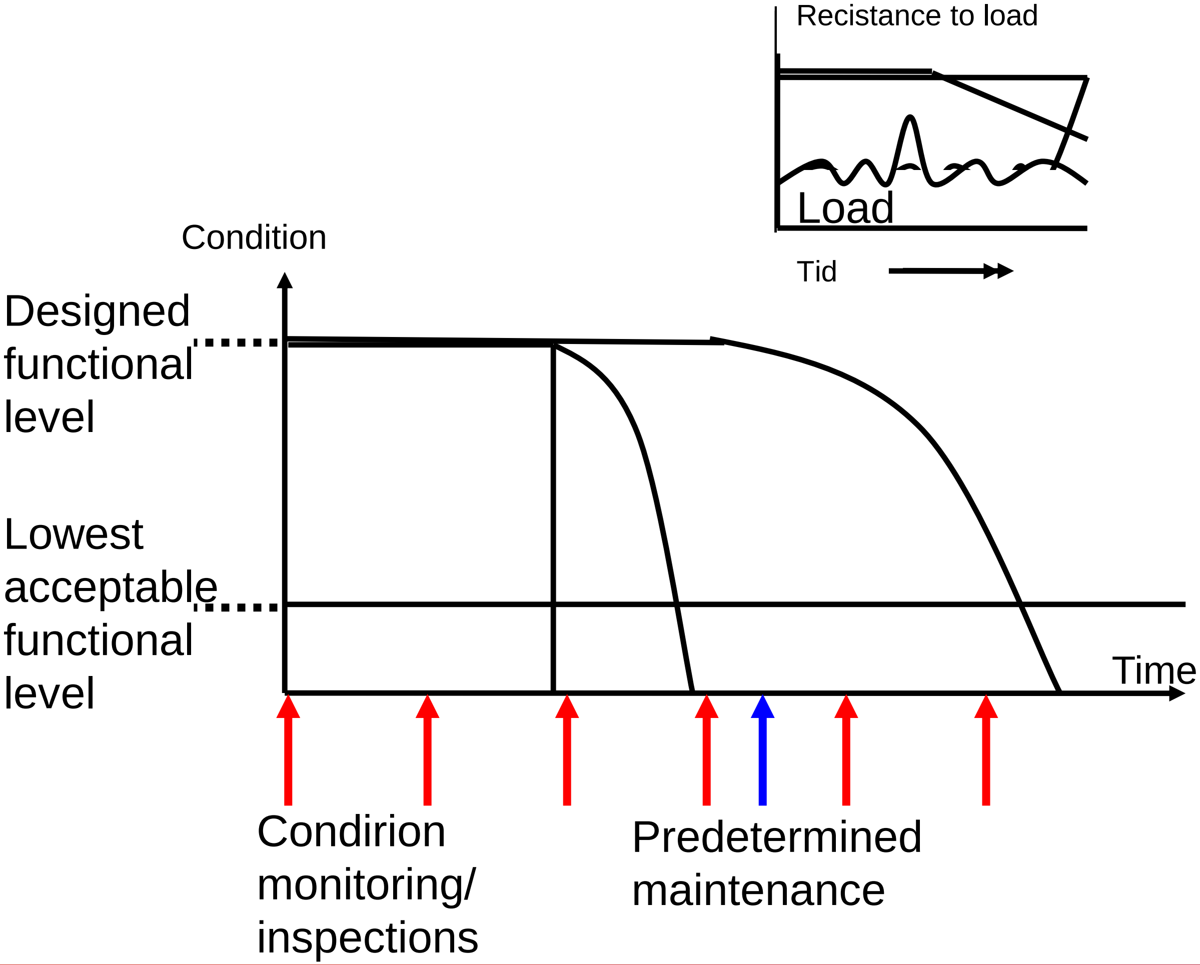
# Condition based maintenance




Condition monitoring in proper intervals and knowledge of degradation -> Decision support for maintenance planning and maintenance execution  (remaining time to fault)

# Operating environment




Dewirement
http://www.youtube.com/watch?v=m09W479sqhQ&feature=related

Pantograph damage
http://www.youtube.com/watch?v=XgCPPeYmyKw

Bad track
https://www.youtube.com/watch?v=JuP2ZDMh9I8 1:25



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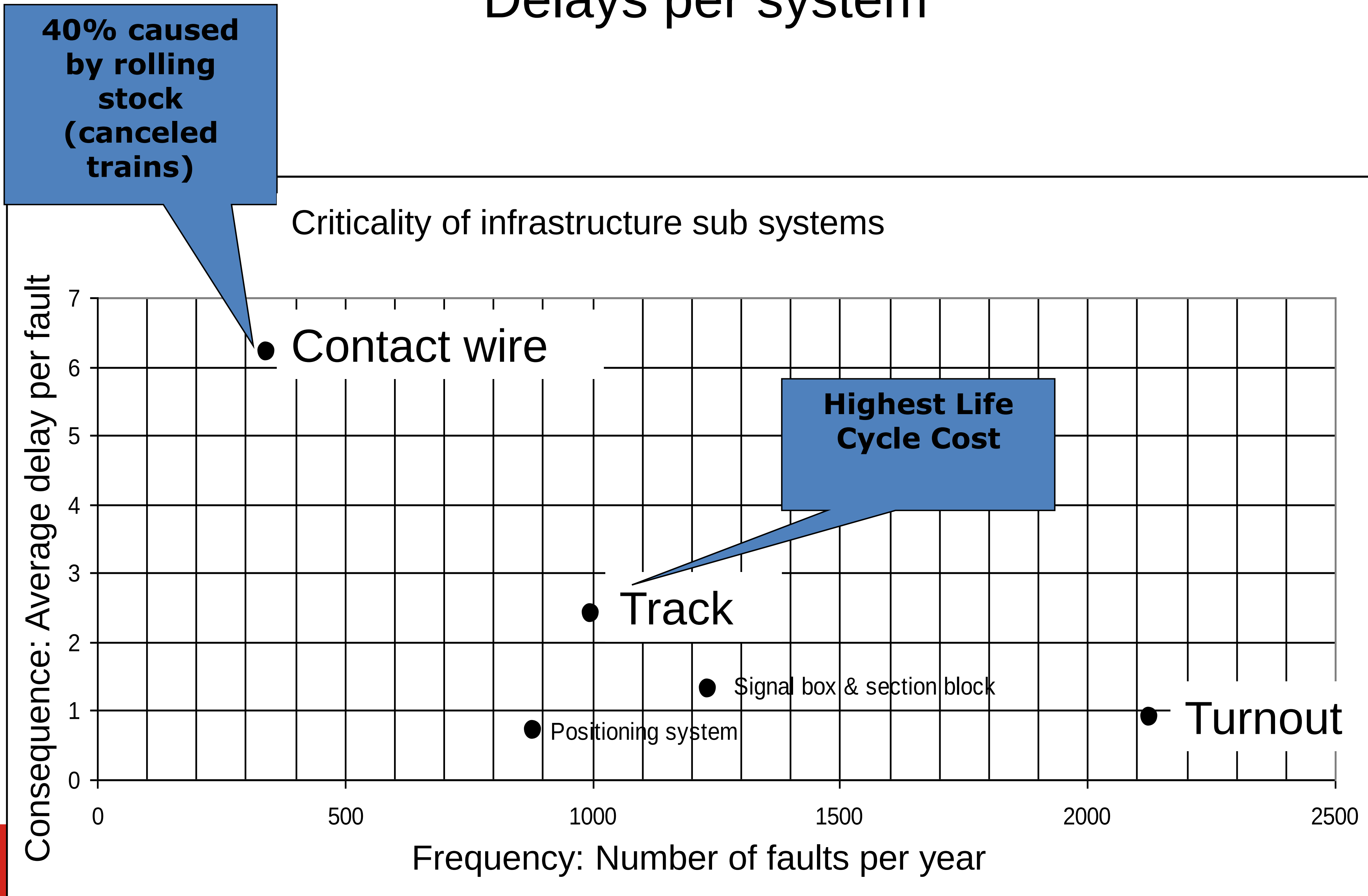
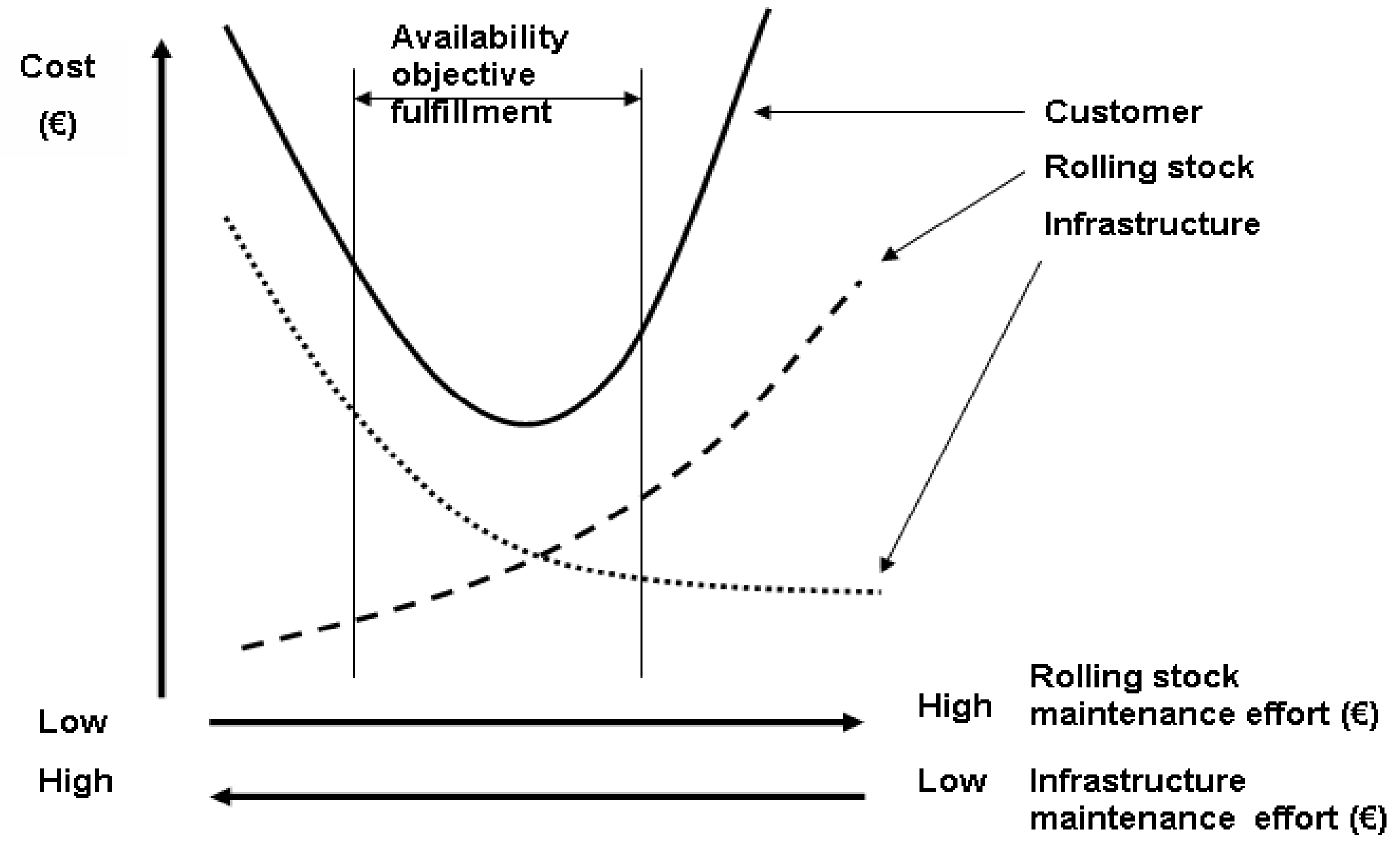
# Delays per system



# Systems and stakeholders' interrelations A combined maintenance process



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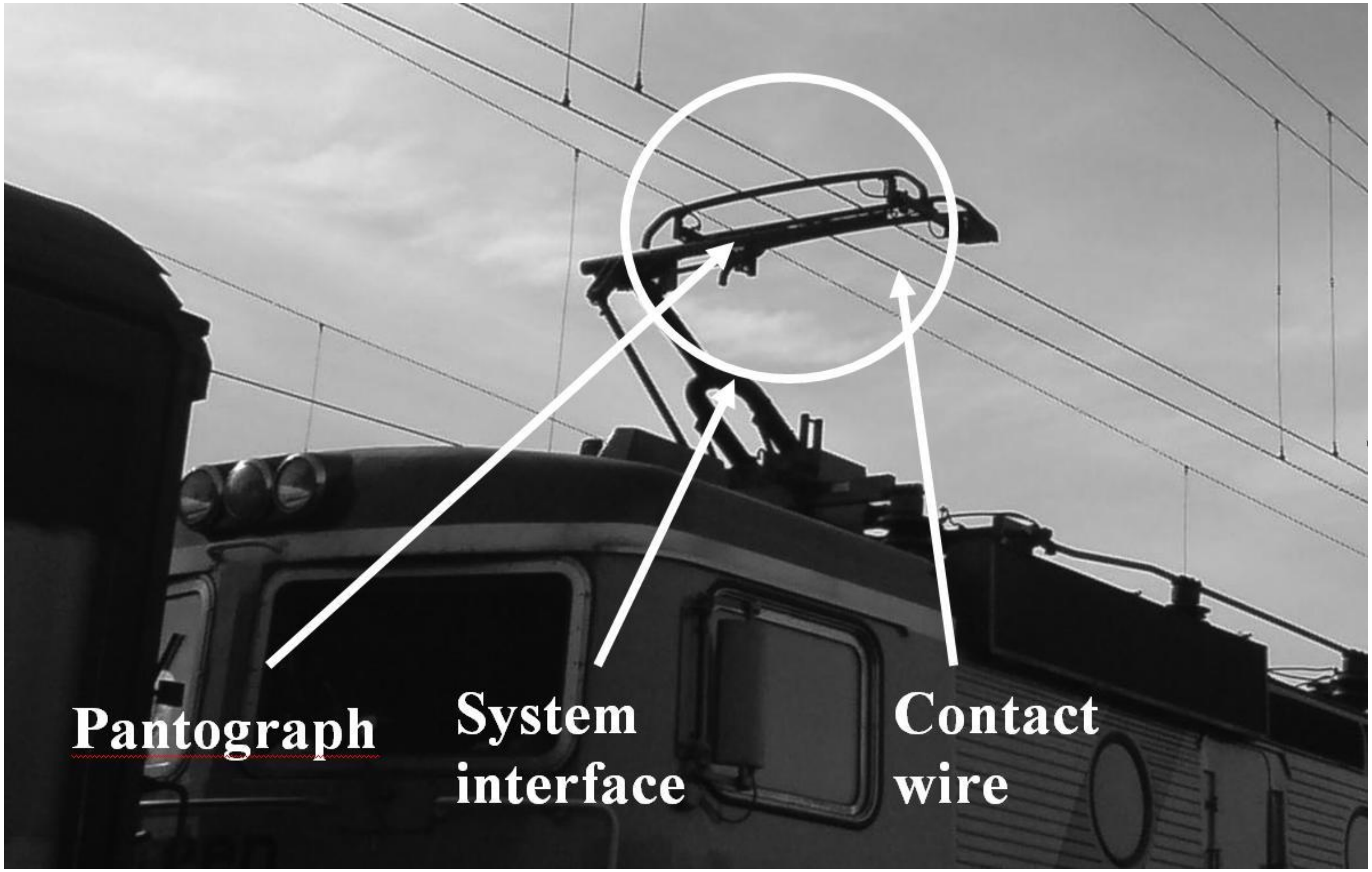
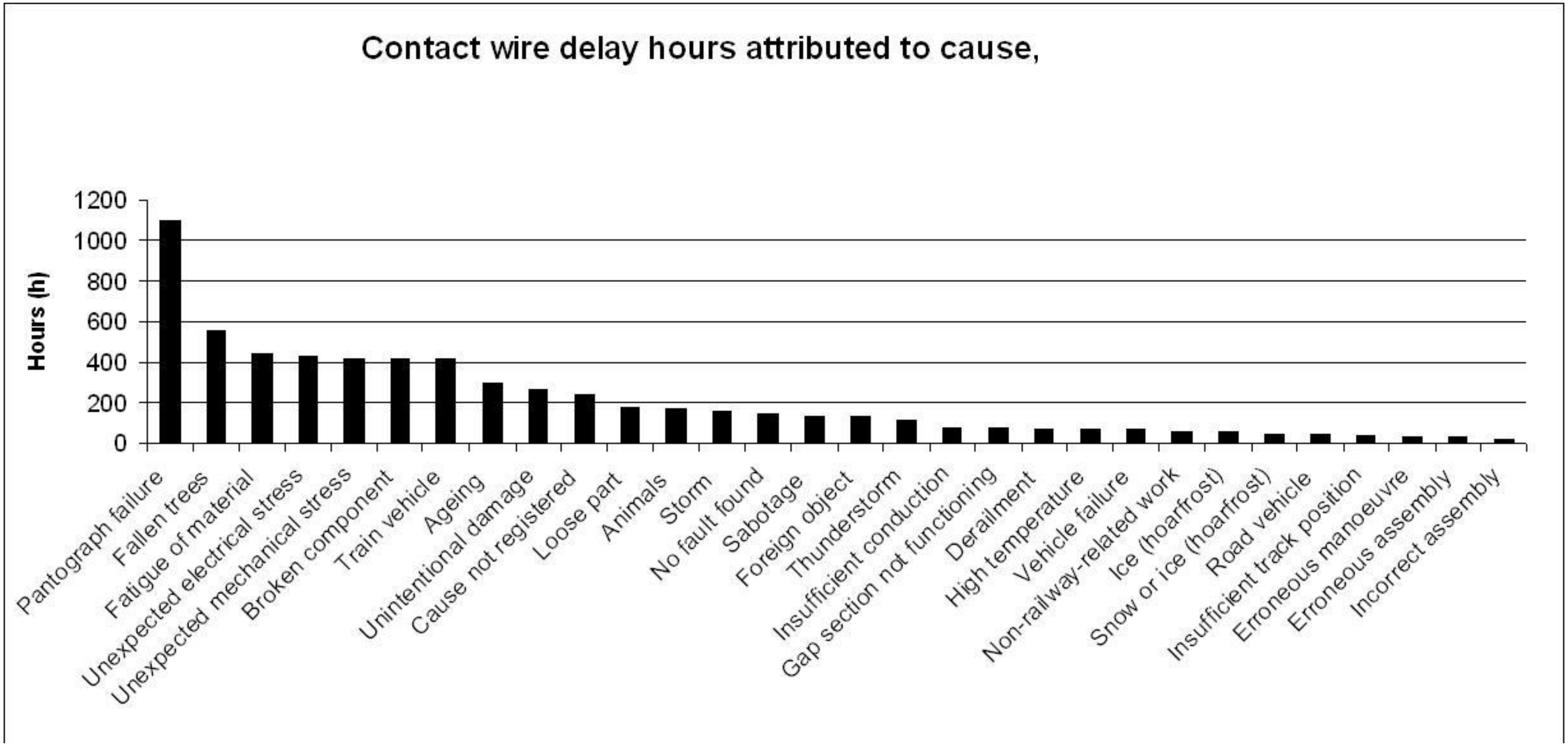
# Study of contact wire/pantograph interface



# Statistics input to analysis



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# Failure modes and detectability

| Priority | Contact wire failure modes | Detectability |
|---|---|---|
| 1 | Pantograph motion path obstructed | 2 |
| 2 | Horizontal displacement from working point | 5 |
| 3 | Rapid change of contact wire height | 2 |
| 4 | Hoarfrost | 3 |
| 5 | Too thin contact wire | 8 |
| 6 | Vertical displacement from working point | 3 |
| 7 | Contact wire tension is either too high or too low | 6 |

| Priority | Pantograph failure modes | Detectability |
|---|---|---|
| 1 | Lift pressure too high | 4 |
| 2 | Damaged carbon slipper | 3 |
| 3 | Lift pressure too low | 4 |
| 4 | Incorrect dynamic motion | 9 |

# Failure mode effect and criticality analysis FMECA

**FMEA**

End item:
Operating period:

Item:
Revision:

Prepared by:
Date:

| Item ref. | Item description and function | Failure mode | Failure mode code | Possible failure causes | Local effect | Final effect | Detection method | Compensating provision against failure | Severity class | Frequency or probability of occurrence | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

- Systemize the degradation of the system
- Assess criticality of failure modes
- Assess the maintenance concept for the system
- Define the information profile (what information do we need to make the right decisions). **Decision support**

**Figure A.1 – Example of the format of an FMEA worksheet**

IEC 2643/05



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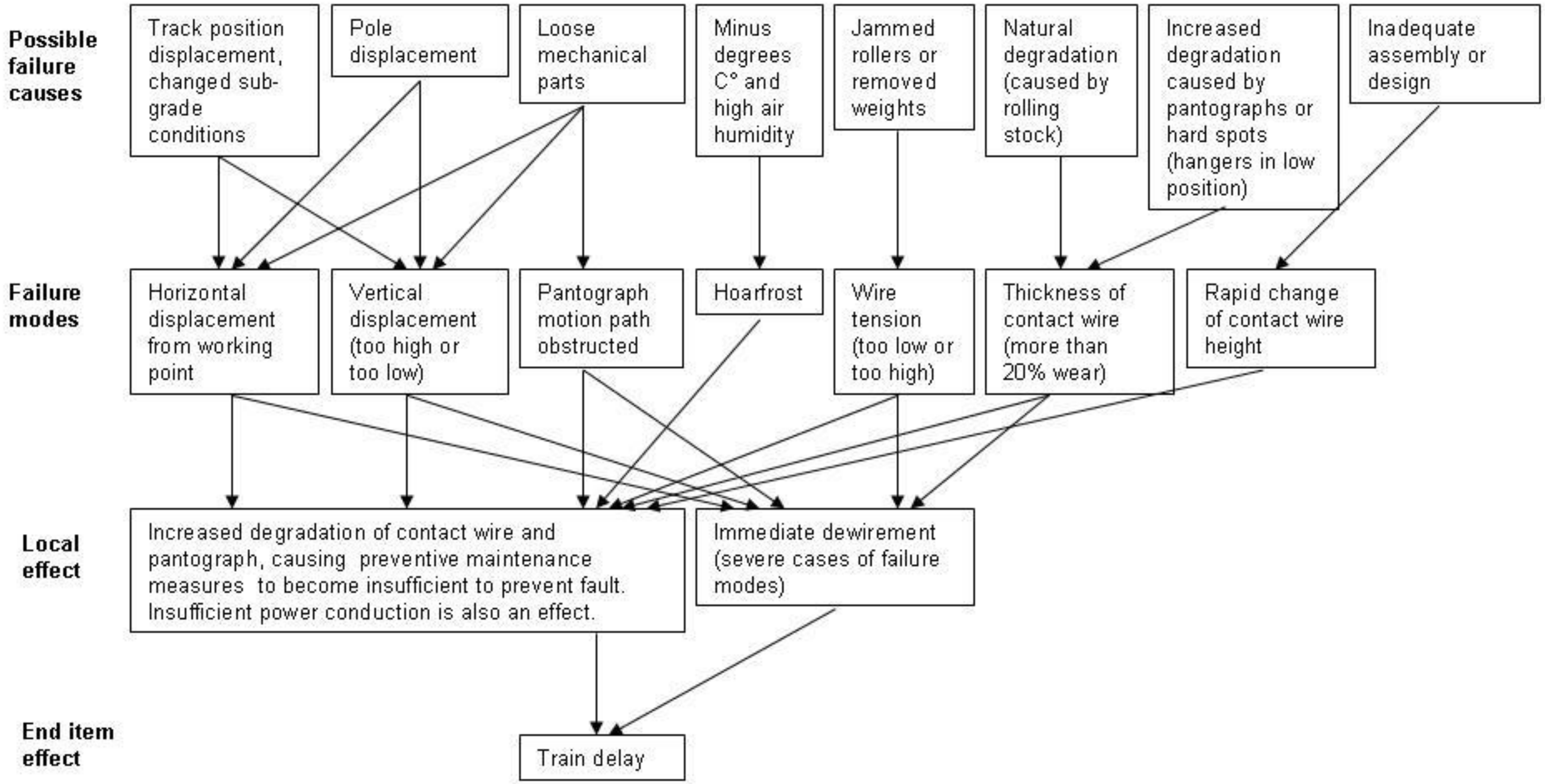
# Contact wire failure modes



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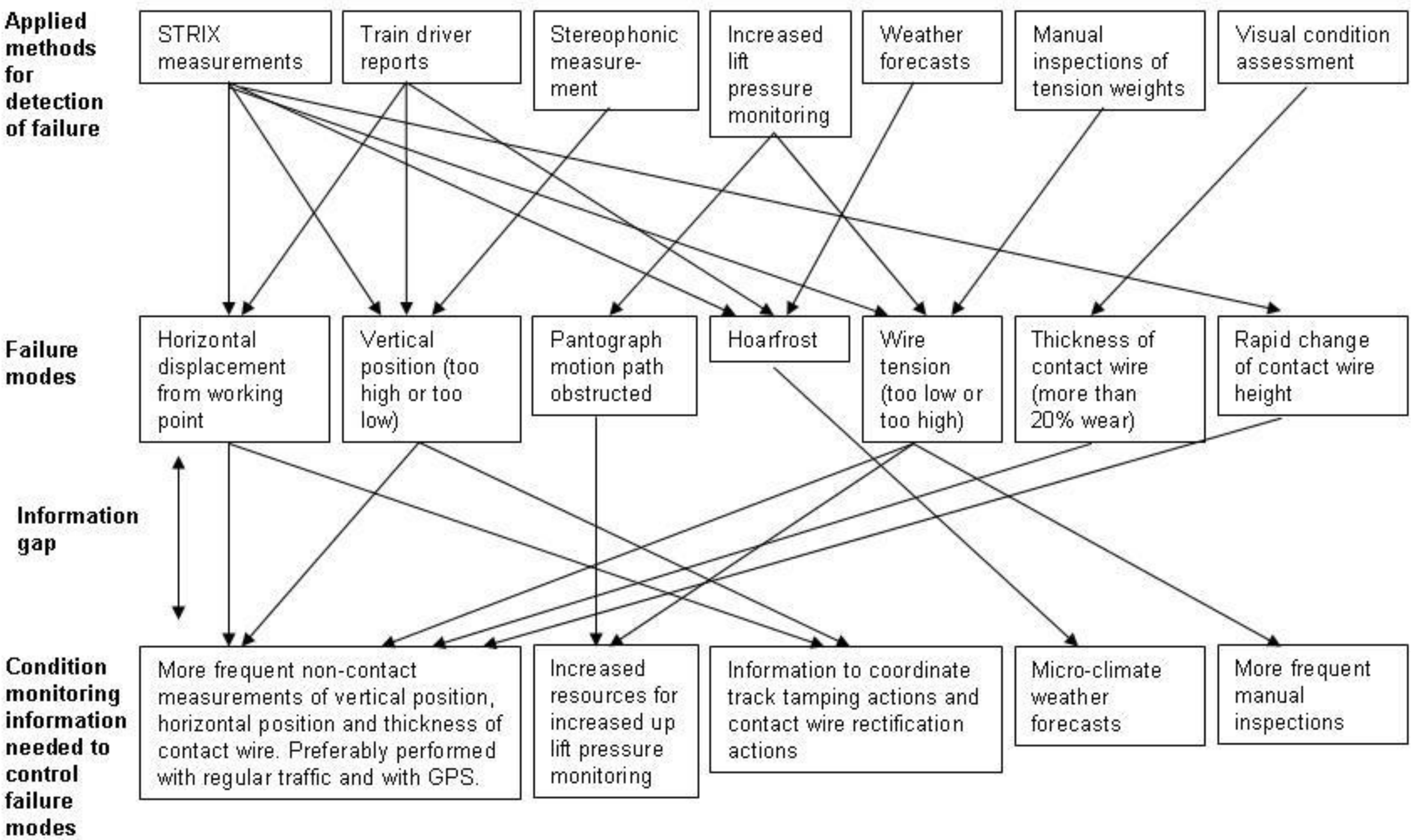
# Applied contact wire detection methods VS need for information



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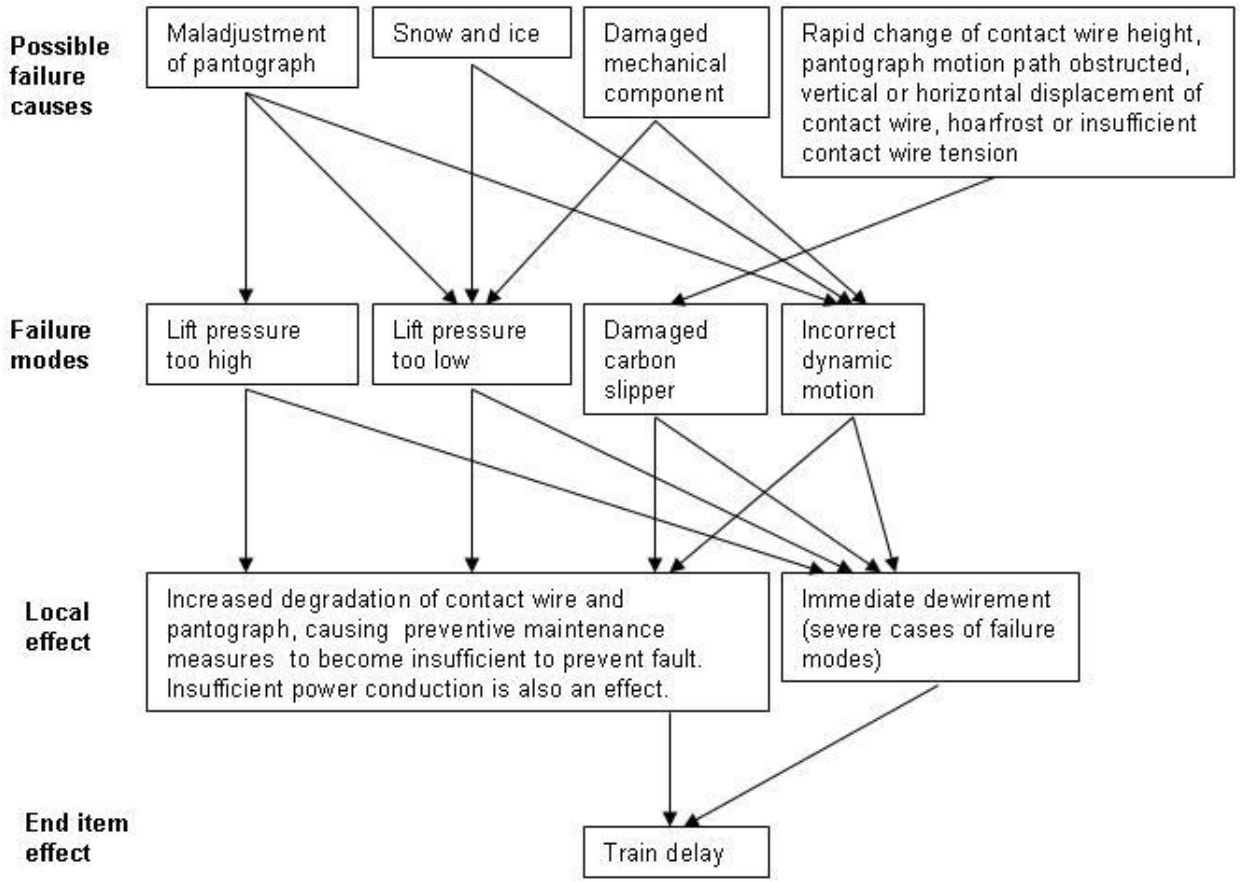
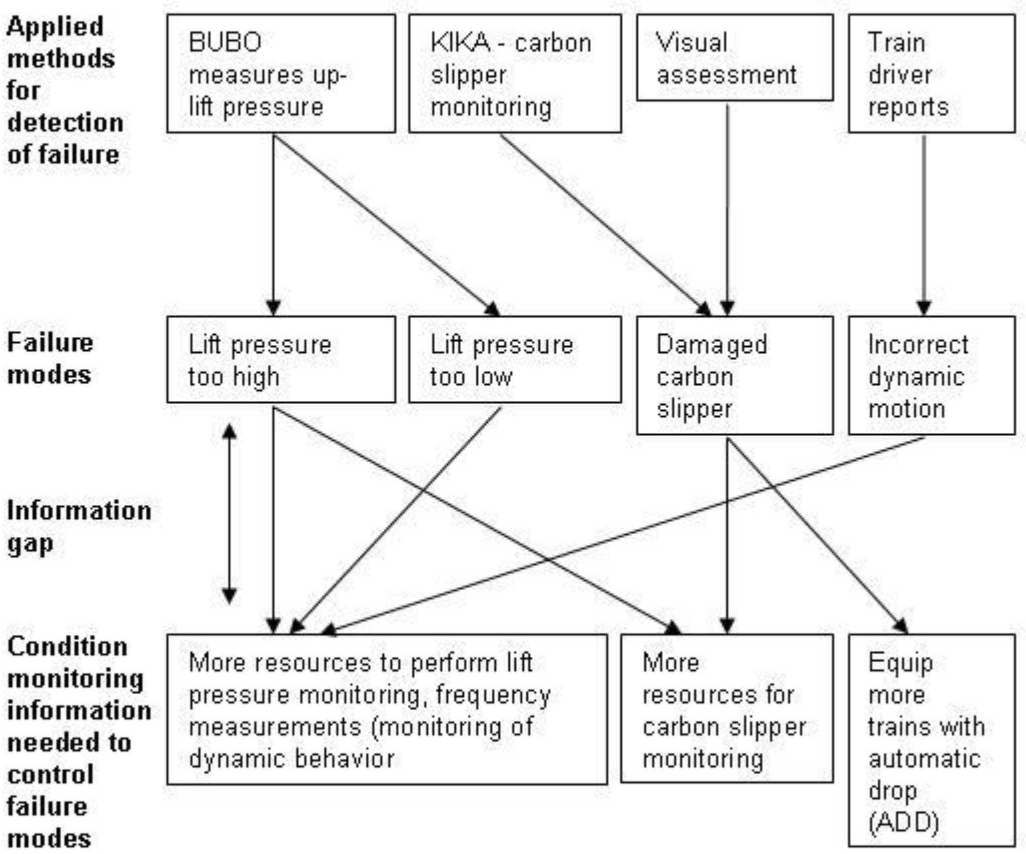
# Pantograph failure modes



# Applied pantograph detection methods VS need for information



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# Results from implementation of results from FMECA on level crossings in 2012


## All faults

| Anläggningsindivid (vf) | (Alla) |
|---|---|
| Antal av Felrapport Id | |
| Year | Summa |
| 2008 | 90 |
| 2009 | 95 |
| 2010 | 97 |
| 2011 | 75 |
| 2012 | 50 |
| 2013 | 50 |
| 2014 | 38 |
| 2015 | 44 |
| 2016 | 48 |
| Totalsumma | 587 |

## Signaling faults

| Anläggningsdel (vf) | (flera objekt) |
|---|---|
| Orsak + | (flera objekt) |
| Anläggningsindivid (vf) | (Alla) |
| Antal av Felrapport Id | |
| Year | Summa |
| 2008 | 70 |
| 2009 | 74 |
| 2010 | 65 |
| 2011 | 54 |
| 2012 | 39 |
| 2013 | 35 |
| 2014 | 28 |
| 2015 | 31 |
| 2016 | 42 |
| Totalsumma | 438 |

## No fault found

| Anläggningsdel (vf) | (flera objekt) |
|---|---|
| Orsak + | (flera objekt) |
| Anläggningsindivid (vf) | (Alla) |
| Antal av Felrapport Id | |
| Year | Summa |
| 2008 | 39 |
| 2009 | 42 |
| 2010 | 33 |
| 2011 | 31 |
| 2012 | 18 |
| 2013 | 16 |
| 2014 | 14 |
| 2015 | 13 |
| 2016 | 19 |
| Totalsumma | 225 |

# Questions ☺

# Thank you!

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