



Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

ITA-COSUF Workshop

Balancing Operational
Needs and Safety Research
Developments

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How to balance
regulations & conformity
with research results?

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Content

The Dutch situation:

- EU-guide line tunnel safety
- Tunnels safety
 - 5 layers of protection
 - Responsibility of owner
 - Role of technology
 - Stage of development
- New technologies: paradox
- Research needs





European directive on tunnel safety

European Directive 2004/54/EC:

DEFINES MINIMUM REQUIREMENTS FOR TUNNEL SAFETY

- Technical
- Organization

Translation in national law in the Netherlands:

Warvw (2006), evaluated & renewed in 2013.

Two important aspects:

- 1- Dutch law is more strict than EU law
- 2- The renewed Dutch law gives a detailed description of technical installations for highway tunnels



Tunnel safety: 5 layers of protection

The safety concept of a tunnel.

In the Netherlands tunnel safety is based on five layers:

- 1- Civil design
- 2- Integral design of 3 top functions;
 - Facilitate self reliance
 - Prevention of escalation of an accident
 - Facilitate emergency services
- 3- Functionality of the IA to manage the installations
- 4- Human intervention (procedures)
- 5- Emergency services



Role of TSO (principle advisor on tunnel safety to the owner)

- New tunnels:
 - Safety is sum of installations (hard-ware), controle system (software) and organisation (people)
 - Software Validation & Verification is crucial (predictable response to various operational states and conditions)
 - Installation technology requires an other approach compared to civil structures (culture, process steps and testing)





Tunnel safety: responsibilities of the owner

The tunnel owner has to balance between:



In the Netherlands the following hierarchy is used:

- 1- Safety
- 2- Reliability
- 3- Availability

But



Tunnel safety: role of technology

- Tunnels are no longer autonomous objects but form a part of a traffic network
- The Dutch highway network is more and more subject to traffic management:
 - Specified use of lanes (speed, availability)
 - Rush hour lanes (adaptation of capacity)
 - Diversions (instructions)
 - Accident management (availability)
 - Traffic information
 - Access control



Observation

Technology:

- Increasing role of IT (Industrial Automatisatation I/A)
- Increase of demands regarding safety and availability
- Every single tunnel is seen as an unique project



Increasing number of systems in tunnels

Tunnel = civil structure + limited number of installations
(light, ventilation, drainage etc.)

Tunnel = civil structure
+ tunnel installations (light, ventilation etc.)
+ traffic management installations
+ systems for operating, control & security
(+ new: water mist systems)



New tunnels have > 50 systems



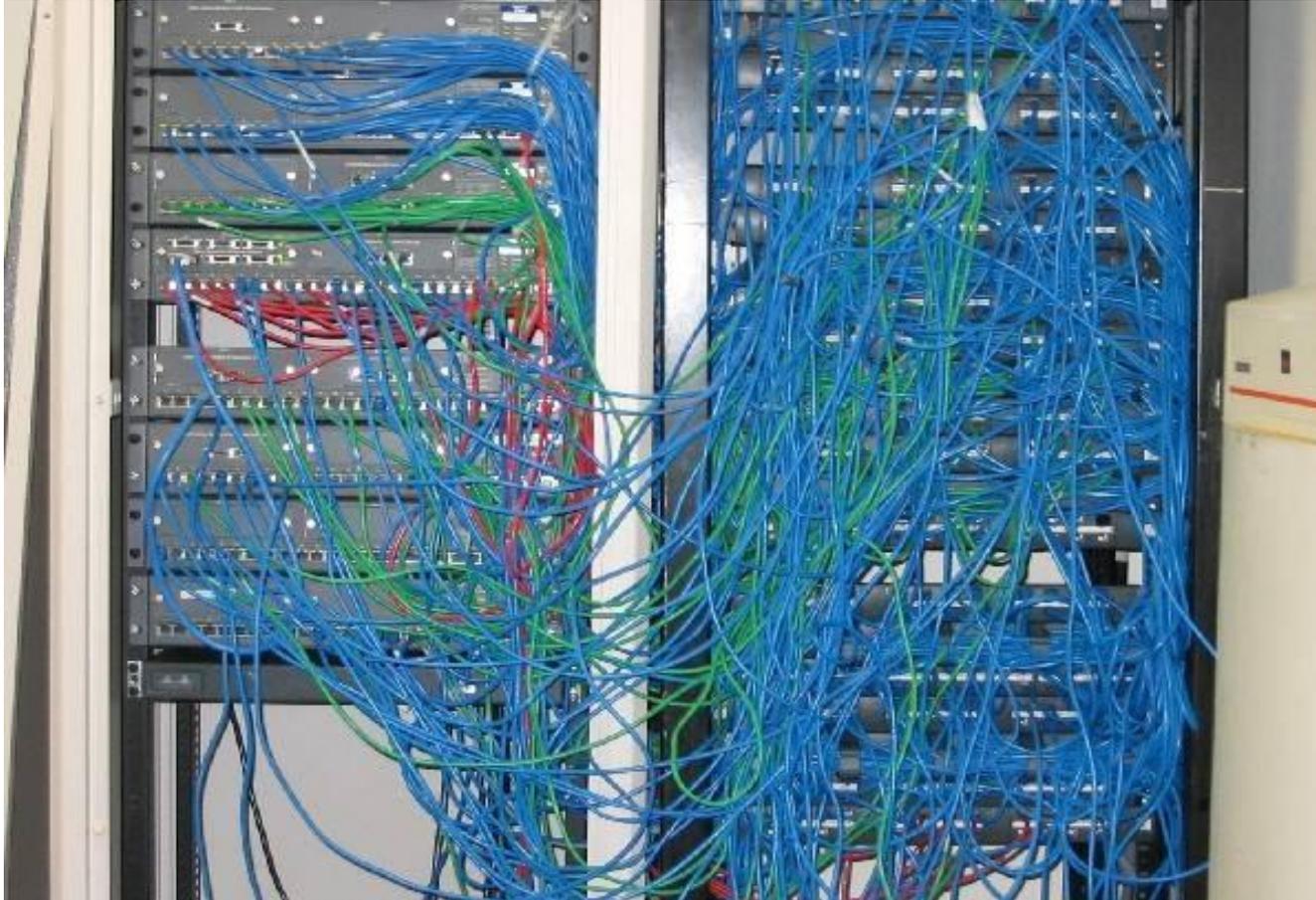
Technical Installations of Tunnel: issues

- High complexity > underestimated/not understood (three main functions have to be integrated through cooperation of over 50 different installations)
- Describing the processes involved in creating software is complex
- No working system without **system integration**

Tunnel generation 1.0  **generation 2.0**



Software is complex (4500 I/Os)





Stage of development

- In the Netherlands a new generation of tunnels is becoming operational (Generation 2.0: tunnels with a high dependency on I/A)
- Existing tunnels have to be upgraded

Main challenges for the owner:

- To increase the **reliability** and **availability** of the tunnels
- To **refurbish** existing tunnels in a safe way maintaining maximum availability



New technologies: paradox

(New) technologies for road tunnels:

- Fixed Fire Fighting Systems (PIARC TC 3.3 – WG4)
- Monitoring system for maintenance
- Road management systems
-

Main question:

Are this new systems increasing the availability & reliability of a tunnel ?



Research needs

A tunnel owner is looking for systems/solutions that :

- 1- Are reliable and have low risk of failure
- 2- Increase the knowledge of the tunnel performance
- 3- Are economical feasible

Main purpose: to increase availability and decrease operational costs