Functional specifications
Functional specification – methodology

When talking about functional requirements it is important to note that

- there is a lot of confusion about ‘what is functional’
- there are several levels of functionality and requirements
Methodology – types of requirements

When is a requirement a functional requirement?

• often all requirements that do not specify a technical solution are called ‘functional’

• however as a functional requirement is a specification of the functionality for which the object or system is created (e.g. carrying traffic), many solution – free requirements appear to be non – functional

• so the environmental requirement that the pavement materials should not pollute the ground water is non - functional (it is a constraint rather than a functional requirement) because this is not a functionality for which we would create a pavement
Methodology – types of requirements

- so we never have only functional specifications

- there always are (usually much more) non–functional specifications which describe how the system or object must function or be. These requirements can concern many aspects

- as the term ‘non–functional’ does not sound too attractive, these requirements are called ‘aspect requirements’ in the Netherlands

- furthermore there are requirements that are imposed by surroundings; these are called ‘interface requirements’.

- these can overlap aspect requirements (e.g. noise requirements)
Methodology – types of requirements

In the Systems Engineering approach used in the Netherlands, distinction is made between the following requirements:

• Functional requirements (what should the system do)

• Aspect requirements (how should the system do it)
  – reliability  - availability
  – maintainability - safety
  – sustainability  - health
  – ergonomics   - aesthetics
  – environment - demolition
  – future proofness

• Interface requirements
Methodology – generating requirements

Functional requirements follow from function analysis (what should the system do)

• why do we make pavements?

• because we invented the wheel

• a very useful invention

• however it had one bad habit

• it tended to ‘dig in’

• this called for a next invention
Methodology – generating requirements

- so the functional requirement which a pavement fulfils is
  - a ‘provision’ over which wheels can roll freely

- therefore the bearing capacity requirements in the contract are the only functional requirements
Methodology – generating requirements

Aspect requirements (how should the system fulfil its function) follow from considering the various aspects and related possible issues

- availability  -> without frequent maintenance
- safety        -> with a certain level of skid resistance
- sustainability -> without polluting subsoil and ground water
- sustainability -> with minimum CO₂ emission at construction
- health        -> without producing too much noise
- etc

...
Methodology – generating requirements

Interface requirements (what requirements follow from interfaces with other objects) follow from an inventory of project interfaces and possible problems arising from these

- bridges -> pavements under them may not be too high
Functional specification – methodology
Functional specification – methodology

Interface requirements (what requirements follow from interfaces with other objects) follow from an inventory of project interfaces and possible problems arising from these

- bridges -> pavements under them may not be too high
- bridges - > pavements over them may not be too heavy
Functional specification – methodology
Functional specification – methodology

Interface requirements follow from an inventory of project interfaces and possible problems arising at these interfaces

• bridges -> pavements under them may not be too high

• bridges - > pavements over them may not be too heavy

• bridges - > pavements should protect these from salt e.d.

• existing pavements -> new pavements must connect to them without height or slope differences

• etc.
Methodology – requirements decomposition

- requirements have different levels
- low-level requirements can still be functional or function-related

relations between levels are described by models or empirical knowledge
Methodology – requirements decomposition

- requirements on raw materials and building materials
- this was the approach before the introduction of the functional contracts
- was condensed in Standard Contract Requirements
- these were not unilaterally developed, but jointly between public authorities and private sector
Methodology – requirements decomposition

- requirements decomposition by the client should be no deeper than necessary in the contract.

- the contractor should perform further decomposition towards the details of the design.

- decomposing too deep will limit the possible solutions because the decomposition is usually more or less solution dependent.

- however if the decomposition is not deep enough the client may be unable to control his risks.
Methodology – requirements decomposition

Typical risks that remain with the client are

- **Political risks**
  - reliability and availability of road network

- **Social risks**
  - safety
  - health
  - sustainability
  - aesthetics

- **Financial risks**
  - long term maintenance costs
  - demolition costs
Methodology – system decomposition
Methodology – system decomposition

- Road infrastructure system
  - Road
  - Moveable span bridge
  - Rigid bridge
  - Tunnel
  - Noise reducing provision
  - Service area
  - Dynamic Traffic Management
  - Eco passage
Methodology – system decomposition

subsystem

components

Road

- Embankment
  - Lighting system

- Pavement
  - Road and traffic signs

- Road markings
  - Guard rails and barriers
Component specifications

- For each component of the road, DVS has Component Specifications

- These are separate documents that contain the non-project specific requirements

- The requirements are formulated in solution-independent terms as much as possible

- For each requirement a verification method is given

- However, verification methods are often solution specific; e.g. the design verification for asphalt roads is different from that for concrete roads
Component specifications - example

<table>
<thead>
<tr>
<th>BO VH 02 SAFETY - breaking deceleration</th>
<th>Overlying requirements</th>
<th>Underlying requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each wearing course or temporary wearing course must enable a breaking deceleration of 5,2 m/s².</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Verification method**

**Design verification**
Demonstrate according to Protocol G that the proposed wearing course can meet the requirement

**Product verification**
Braking tests according to Annex I
## Component specifications - example

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<th>BO DV 02</th>
<th>Overlying requirements</th>
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<tbody>
<tr>
<td>CARRYING TRAFFIC - bearing capacity of new pavements in continuously reinforced concrete on embankment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New pavements in continuously reinforced concrete must be able to carry the traffic loads according to Appendix A of the Output Specification during the design periods according to Appendix B of the Output Specification.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Verification method

**Design verification**
According to Concrete Pavement Design Specification [4]

**Product verification**
Evidence that the pavement as installed complies with the design, based upon production quality registrations, layer thickness measurements and drilling core information.
Methodology - contract management approach

- System Oriented Contract Management

- Principle of this approach: check if the Quality System of the contractor is effective (contractor has to have a certified quality management system, based on NEN-EN-ISO 9001 Quality Management)

- This is done by a mix of system checks, process checks and product checks
Contract management approach

- System check: check if the integral quality management system of the contractor is correct

- Process check: check during realisation of a project if the contractor follows his own process instruction of a specific process

- Product check: check the reliability of the quality control results of the contractor

- Risk based approach

- Balance in mix of checks adapted if necessary