Testmanager 4 CarMaker
Tailored Concepts and Solutions
Thorsten Pendzialek, Mario Kuhn - Karlsruhe, 09/2016
Outline

- Linde Material Handling organisation and products
- Products' common factor
- Testing topics
- Requirements for Testmanagers
- Toolchains
  - Testmanager variant "Testmeister"
  - Testmanager variant "Manövermeister"
- Summary
Kion Group is the parent company of several brands
Global Production – Locations worldwide

- Linde Material Handling North America Corp.
  1 Factory
- Linde Pohony s.r.o.
  2 Factories
- Fenwick-Linde S.A.R.L.
  1 Factory
- Linde Material Handling
  5 Factories
- Linde-Xiamen Forklift Corporation Ltd.
  1 Factory

→ ca. 14,000 Employees
→ ca. 3 Billion € Revenue in 2014
Product Portfolio
There is always one, but never the same…
There is always one, but never the same…

The Central ECU implements:
- Drive Control
- Lift Control
- Tilt Control
- Reach Control
- Electrical Steering Control
- Battery Management
- Driver Assistance Functions
- Safety Functions
- …
Testing Topics

- State diagram based functionalities:
  - test simple logic behaviour
  - procedure depends on function
  - monitor ECU on all its I/O
Testing Topics

- **State diagram based functionalities:**
  - test simple logic behaviour
  - procedure depends on function
  - monitor ECU on all its I/O

- **Electrical failure on I/O**
  - simulate wire failure or short circuit
  - standard procedure
  - monitor ECU on all its I/O
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- Working (Drive/Lift...) Maneuver
  - test vehicle behaviour
  - maneuver depends on function to be tested
  - monitor physical quantities (acceleration, wheel load...)
Testing Topics

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Rating based on ECU I/O

Rating based on model quantities
## Requirements for the Testmanager Tools

### Rating based on ECU I/O

- vast quantity of signals must be rated
- test solution shall display signals and boundarys clearly
- Testmanager must have a good usability, tailored to our needs
- solution must be capable of dealing with all thinkable tests for one ECU configuration
- everything must be documented (ISO29119)

### Rating based on model quantities

- overseeable number of quantities must be rated
- physical quantities, data evaluations and boundarys shall be displayed
- tests shall be comprised of modules:
  - environment definition (surrounding, vehicle, mast, attachment...)
  - test parameter set values (test maneuver parameter: lift height, speed...)
  - testscript (test maneuver)
  - evaluation script (boundary check, data analysis)
- everything must be documented (ISO29119)

→ **Concept "Testmeister"**

GUI based Testmanager to execute tests cripts and to exchange data in a large table

→ **Concept "Manövermeister"**

GUI based Testmanager to select modules, execute and evaluate parameterized test maneuvers
## Requirements for the Testmanager Tools

### Concept "Testmeister"

- **GUI based Testmanager to execute test scripts and to exchange data in a large table**

- **Rating based on ECU I/O**
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- **Concept "Manövermeister"**
  - GUI based Testmanager to select modules, execute and evaluate parameterized test maneuvers

<table>
<thead>
<tr>
<th>Rating based on model quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- overseeable number of quantities must be rated</td>
</tr>
<tr>
<td>- physical quantities, data evaluations and boundarys shall be displayed</td>
</tr>
<tr>
<td>- tests shall be comprised of modules:</td>
</tr>
<tr>
<td>- environment definition (surrounding, vehicle, mast, attachment...)</td>
</tr>
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<td>- test parameter set values (test maneuver parameter: lift height, speed...)</td>
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<tr>
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</tr>
<tr>
<td>- everything must be documented (ISO29119)</td>
</tr>
</tbody>
</table>
"Testmeister" Toolchain, Features and Functionality

Test script generation

Keyword driven test script generator

- create test scripts without coding
- library of fixed and editable keywords
- finding keywords via search function
- insert trigger points for later evaluation
- on save, TCL test script is generated for execution with Car/RealtimeMaker "Script Control"
"Testmeister" Toolchain, Features and Functionality

Execution via CarMaker Script Control Interface

Scripts

Keyword driven test script generator

"Testmeister"
"Testmeister" Toolchain, Features and Functionality

Execution via CarMaker Script Control Interface

<table>
<thead>
<tr>
<th>Ausführung</th>
<th>Testname</th>
<th>Beschreibung</th>
<th>Testlaufbahnen, fahren und Arbeitshydraulik</th>
<th>Kommentar</th>
<th>Bewertung</th>
<th>Start-Zeitpunkt des Schritts</th>
<th>Triggerpunkte</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>F-V_HLB_1_0</td>
<td>HLB mit Schalter 1 und 2</td>
<td>Echte_Akte</td>
<td></td>
<td></td>
<td>13:00:50</td>
<td>13:12:00</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Echte_Akte</td>
<td></td>
<td></td>
<td>13:12:00</td>
<td></td>
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<tr>
<td>x</td>
<td>F-V_HLB_2_0</td>
<td>HLB, Schalter 1 links</td>
<td>Echte_Akte</td>
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<td>13:20:50</td>
<td>13:30:00</td>
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<tr>
<td></td>
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<td></td>
<td>Echte_Akte</td>
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<td></td>
<td>13:30:00</td>
<td></td>
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<tr>
<td>x</td>
<td>F-V_HLB_3_0</td>
<td>HLB, Schalter 2 links</td>
<td>Echte_Akte</td>
<td></td>
<td></td>
<td>13:50:50</td>
<td>13:59:00</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Echte_Akte</td>
<td></td>
<td></td>
<td>13:59:00</td>
<td></td>
</tr>
</tbody>
</table>

**signals to be rated**

**test scripts to be executed**

**boundary values and timeslots**

**evaluation results**
Execution via CarMaker Script Control Interface

- get Information from Excel sheet:
  - test scripts to be executed
  - signals to be rated
  - boundary values and timeslots
  - write evaluation results to Excel
- specify read/write paths
- choose execution Mode:
  - step by step
  - event triggered
  - not triggered (record only, not evaluated)
  - offline evaluation (of prerecorded data)
- archive function (stores all input and output data as package)
- uses CLI and various TCL packages
"Testmeister" Evaluation Window

Execution via CarMaker Script Control Interface

Excel database

test script name

rated Signal

time slot for rated signal

evaluation mode

valid area for signal

red Area: below Min, above Max

test script steps with marked triggers and comments

decision options

multiple signals to analyse causality

open .erg in IPG Control
"Testmeister" Evaluation Window

Execution via CarMaker Script Control Interface

- Example for triggered monitoring internal condition codes
- all occurring codes are displayed simultaneously
# Zusammenfassung Test 392-02CR Hubboehenbegrenzung:

<table>
<thead>
<tr>
<th>Bauart: 392 02</th>
<th>Variante: 392 02CR Std</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>PC and Tester</th>
</tr>
</thead>
</table>
PC: pr-H04/2016 |
Username: dke57 |
Testen: Mario Kuhn / ELV 3 |
OS: Windows NT 5.1 |
OS version: 6.1 |

<table>
<thead>
<tr>
<th>CarMaker</th>
</tr>
</thead>
</table>
Loaded GUI: test_392_02CR_6000 TR19544605 |
Testen Time: 16:47:52 |
Testen Date: 01/25/2016 |
Vehicle: 392_0200_6000 TR19544605 |
CarMaker Version: 4.54 |

<table>
<thead>
<tr>
<th>Script versions</th>
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</table>
Repository version LHC_20 project folder: 48 |
Date LHC_20 project folder: 29/0918 12:48:47 |
Repository version script files: 372 |
Date script files: 20/01/20 22:29:59 |

<table>
<thead>
<tr>
<th>ECU IDs</th>
</tr>
</thead>
</table>
ECU part number: 9003739073 |
ECU HWID: 9003739073 |
Trac SWID: 302328190437 |
Lrt SWID: 292350116536 |
Trac SW Version: 4.013 |
Lrt SW Version: 4.020 |

### Parameter List:

| File: l_report/ExcelReport/Einsteltparameter/392_02_394_32/392_02_3_1_USP_LRA_trac_diagnostic.Helpsv/Einsteltparameter.xml |

### Ergebnis:

<table>
<thead>
<tr>
<th>Bedeutung</th>
<th>Bedeutung</th>
<th>Bedeutung</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>k</td>
<td>k</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dr. Info</th>
</tr>
</thead>
</table>
Ergebnis wurde bewertet und akzeptiert. Prüfresultat wird gespeichert. |
| Elv, Eel |

<table>
<thead>
<tr>
<th>Fac</th>
</tr>
</thead>
</table>
Beliebigstufungslösungen |
| Eel |

<table>
<thead>
<tr>
<th>Erste Folge</th>
</tr>
</thead>
</table>
Sakrifikationslösungen: Ergebnis wurde bewertet und verworfen. |
| Eel |

<table>
<thead>
<tr>
<th>Dr. Bestätigung</th>
</tr>
</thead>
</table>
Sakrifikationslösungen: Ergebnis wurde bewertet und verworfen. |
| Eel |

| 2016 Tailored Testmanager Concepts 4 CarMaker | Thorsten Pendzialek, Mario Kuhn | September 2016 |
## Testmeister Documentation in MS Excel

### Signals with Desired Value Ranges

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Description</th>
<th>Test Object</th>
<th>Comment (optional)</th>
<th>Execution Results, Information about File</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-V_HMB_1.0</td>
<td>HMB mit Schalter 1 und 2 ohne Achse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-V_HMB_2.0</td>
<td>HMB, Schalter 1 fehlt ohne Achse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-V_HMB_2.1</td>
<td>HMB, Schalter 2 fehlt ohne Achse</td>
<td>Stromföhrer als beim vorherigen Test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Testscript Name**

**Short Description**

**Comment (Optional)**

---

**Testmeister**

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Rating based on Model Quantities
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→ Concept "Manövermeister"
GUI based Testmanager to select modules, execute and evaluate parameterized test maneuvers
"Manövermeister" Toolchain, Features and Functionality

Testsuite and Testsetup Concept

What do you want to do today...

- Focus is on Maneuvers
- Each Test consists of a Setup of Modules
- A Test Maneuver is executed and evaluated for a defined Set of Parameters
- Testsetups can independently be grouped in Testsuites
"Manövermeister" Toolchain, Features and Functionality

Testsuite and Testsetup Concept

Testsetup "A"

Environment Parameter

Maneuver Parameter

Test Maneuver

Maneuver Evaluation

Setup Evaluation
"Manövermeister" Toolchain, Features and Functionality

Testsuite and Testsetup Concept

Testsuite

Testsetup "A"
- Environment Parameter
  - Maneuver Parameter
    - Test Maneuver
      - Maneuver Evaluation
        - Setup Evaluation

Testsetup "B"
- Environment Parameter
  - Maneuver Parameter
    - Test Maneuver
      - Maneuver Evaluation
        - Setup Evaluation

Testsetup "C"
- Environment Parameter
  - Maneuver Parameter
    - Test Maneuver
      - Maneuver Evaluation
        - Setup Evaluation

...
"Manövermeister" Toolchain, Features and Functionality

Execution via CarMaker Script Control Interface

- modular concept:
  - environment definition (surrounding, vehicle, mast, attachment...)
  - test maneuver parameter: lift height, speed...
  - testscript (test maneuver)
  - evaluation script, boundary check, data analysis
  - offline evaluation (prerecorded data)
  - archive function (stores all input and output data as package)
  - uses CLI and various TCL packages

- specify write paths
Execution via CarMaker Script Control Interface

- Algorithm for automated generation of test data combinations
- Predefined parameters
- User-definable parameters
"Manövermeister" Toolchain, Features and Functionality

Documentation as html

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TestID</td>
<td>ID1450369448</td>
</tr>
<tr>
<td>Date, Time</td>
<td>17.12.2015 17:24</td>
</tr>
<tr>
<td>Tester</td>
<td>Thorsten Pendzialek</td>
</tr>
<tr>
<td>PC Name</td>
<td>PC-D0220032</td>
</tr>
<tr>
<td>OS description</td>
<td>Windows NT</td>
</tr>
<tr>
<td>OS version</td>
<td>6.1</td>
</tr>
<tr>
<td>CarMaker Version</td>
<td>4.54</td>
</tr>
<tr>
<td>Testrun</td>
<td>Allgemein</td>
</tr>
<tr>
<td>Vehicle</td>
<td>336_E20PH</td>
</tr>
<tr>
<td>Mast</td>
<td>TR1T1606625.1cl</td>
</tr>
<tr>
<td>Ambauten</td>
<td>TR1T1_LindeSTES_G645x100</td>
</tr>
<tr>
<td>ECU part number</td>
<td>3905700218</td>
</tr>
<tr>
<td>ECU MID</td>
<td>3905702031</td>
</tr>
<tr>
<td>Trac SWD</td>
<td>151926196313</td>
</tr>
<tr>
<td>Lift SWD</td>
<td>151926101424</td>
</tr>
<tr>
<td>Trac SW Version</td>
<td>4.300</td>
</tr>
<tr>
<td>Lift SW Version</td>
<td>4.300</td>
</tr>
<tr>
<td>Realtime Source Repository Version</td>
<td>193</td>
</tr>
<tr>
<td>Script Software Repository Version</td>
<td>MKskripte 266</td>
</tr>
<tr>
<td>Kombination</td>
<td>0</td>
</tr>
</tbody>
</table>

### Test specific evaluation

Using an archive function all input and output data (parameter files, scripts, protocol, erg files...) is zipped.
Summary

- Different test topics demand for tailored solutions
- 2 approaches have been shown
  - "Testmeister" for the test of logical functions and electrical failures, monitoring signals
  - "Manövermeister" for maneuver based testing, monitoring physical quantities
- Both approaches
  - use TCL GUIs for user Interaction
  - use the same proprietary keyword driven test script generator to minimize manual coding
  - are called from the CarMaker Script Control Interface, thus fully integrated in CarMaker
- Signal Monitoring is table based, enhanced by a guided rating process
- Maneuver based testing is handled in a strictly modular manner