# LEAN MBSE IN PROJECT USE

## EXPERIENCES FROM THE INTERNATIONAL MBSE PROJECT FOR THE SPECIFICATION AND RISK MANAGEMENT OF A REMOTE-CONTROLLED, AUTONOMOUS OFFSHARE CRANE

**L. Weik, C. Zingel – PALFINGER AG | M. Greinert, C.Tschirner – Two Pillars GmbH**

Zurich, 15 September 2025

PALFINGER

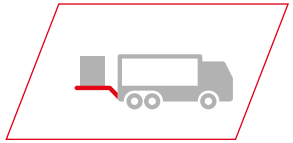
# The international technology and engineering company PALFINGER is the world's leading provider of innovative crane and lifting solutions.

# INNOVATIVE AND POWERFUL PRODUCT PORTFOLIO

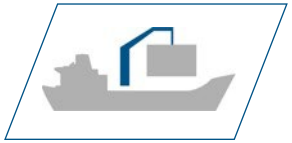
PALFINGER

LADE-
KRANE

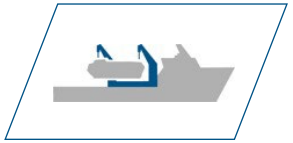
FORST &
RECYCLINGKRANE



LADEBORD-
WÄNDE



MARINE
KRANE



DAVITS

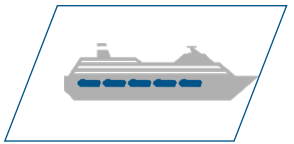
PERSONEN-
EINSTIEGSSYSTEME

HUBARBEITS-
BÜHNEN

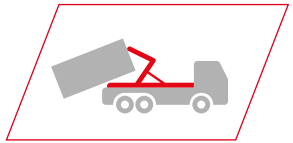
SCHLÜSSELFERTIGE
LÖSUNGEN

DIGITALE
LÖSUNGEN

OFFSHORE-
KRANE

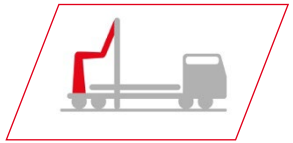


BOOTE



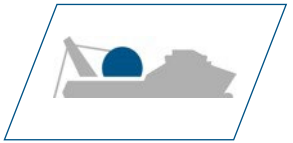
ABROLL- &
ABSETZKIPPER

MITNAHME-
STAPLER



EISENBAHN-
SYSTEME

WIND
KRANE



WINDEN

# WITH OUR VISION AS A FOUNDATION, WE ARE READY TO FACE THE CHALLENGES OF THE FUTURE

PALFINGER

## VISION

LIFTING VALUE – CREATING MOMENTUM


## STRATEGY

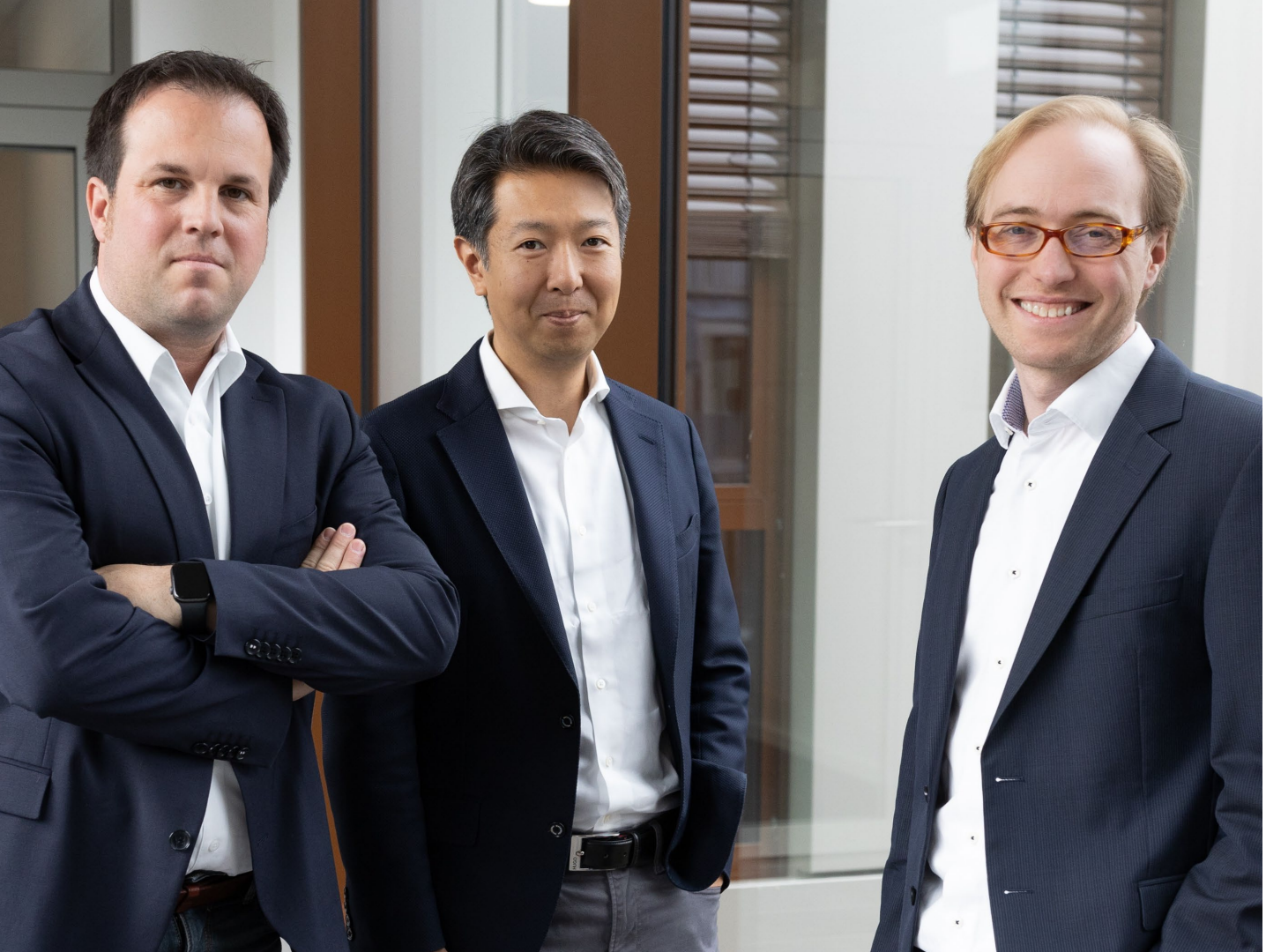
ORGANISATIONAL FRAMEWORK, LEADER-SHIP & SUSTAINABILITY

GO FOR SOLUTIONS

GO DIGITAL

# MODEL-BASED SYSTEMS ENGINEERING PAVES THE WAY FOR “GOING DIGITAL”

- **Systems engineering principles:** Application- and customer-centred analysis, holistic function-oriented development methodology
- **Systems engineering methodology:** Structured product line engineering and modular system architecture development
- **Systems engineering data structure:** Unique data model with clear semantics and domain-specific structuring system
- **Systems engineering organisation:** Empowering stakeholders in product management & development as well as IT, QM, etc.
- **Systems engineering tools:** Needs-based adaptation and establishment of model-based systems engineering tools
- **Systems engineering tool landscape:** Continuously growing integration depth of MBSE tools into the IT enterprise architecture



# Two Pillars GmbH

## Lean Software for Systems Engineering

founded in 2018

- by DENTSU SOKEN and Fraunhofer IEM

Fraunhofer IEM

*~200 emp | ~20 Mio. EUR research budget*

電通総研 DENTSU SOKEN INC.

*~4.000 emp | ~1 Mrd. EUR turnover*

- Registerd office in Paderborn
- Development + distribution of systems engineering software and consulting services

two pillars
MODEL-BASED SYSTEMS ENGINEERING

# THE PROJECT CONTEXT – DEVELOPMENT OF REMOTE-CONTROLLED AND FULLY AUTONOMOUS OFFSHORE CRANES

PALFINGER

**The System**

- 4 different fully electric crane variants, 7 crane instances
- Use on manned or unmanned offshore installations
- Designed for use in harsh environments

**The development goals**

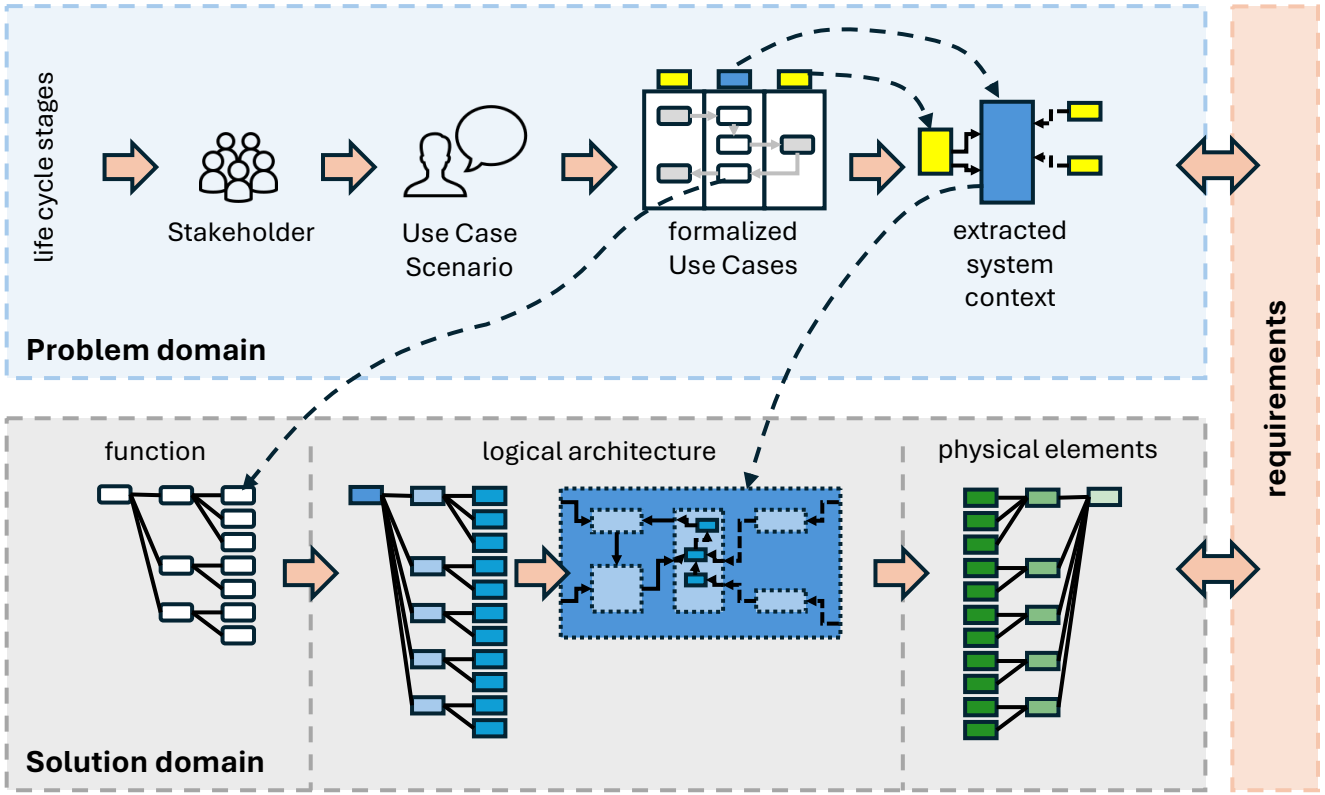
- Complete remote control from a control location on land, including commissioning, operation, diagnostics, support and logistics functions
- Option of fully autonomous loading and unloading of cargo from supply ships

Oben: Offshore Schwenkkran
Rechts: Fernsteuerzentrale

**The approach: lean MBSE**

- Use of systematic analysis of the problem area and synthesis of a suitable system architecture
- Consistent modelling of all aspects based on a lean, needs-based SPES methodology
- Supplementing the system architecture model with variant creation (autonomous levels and crane variants)
- Model-based documentation of failure mode, effect, and criticality analyses (FMECA)

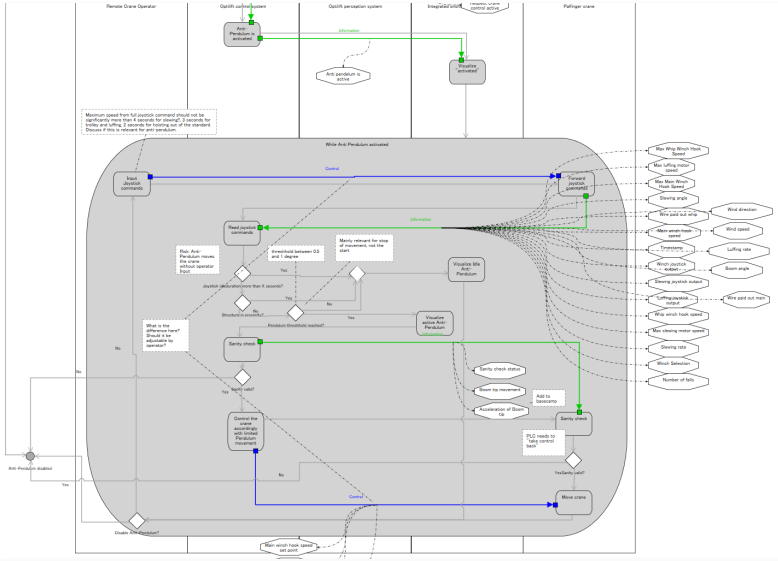
# THE MODELLING APPROACH

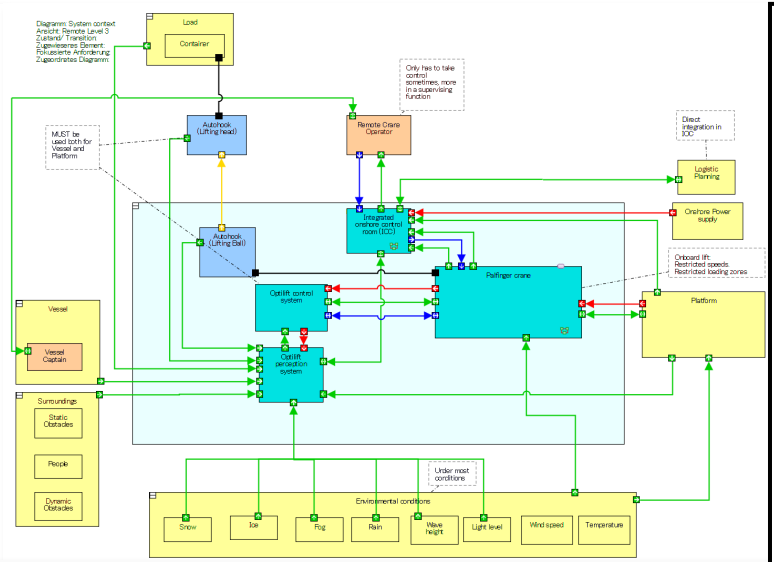


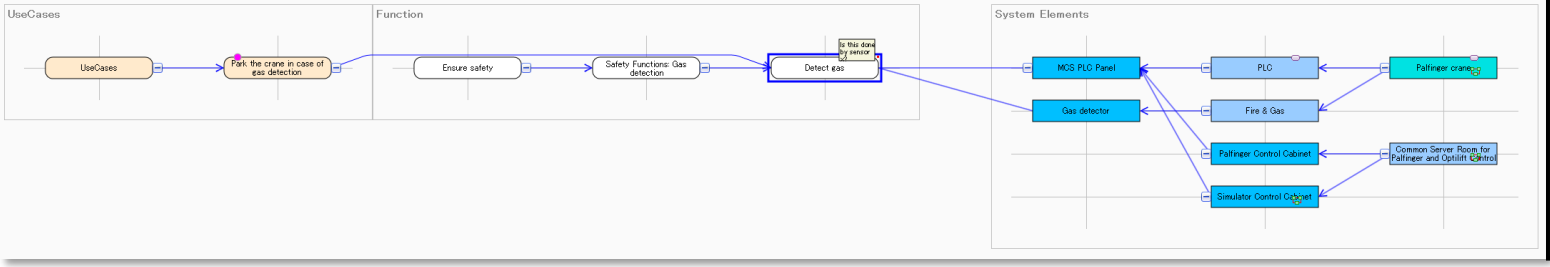

Traceable modelling of the system architecture from use cases and system context to functional and logical to physical architecture variants, linked to (non-)functional requirements

- Environment
- System
- System module
- System element
- Product
- Product module
- Component
- Function
- External function

# ‘A LOOK AT THE PROJECT MODELS’





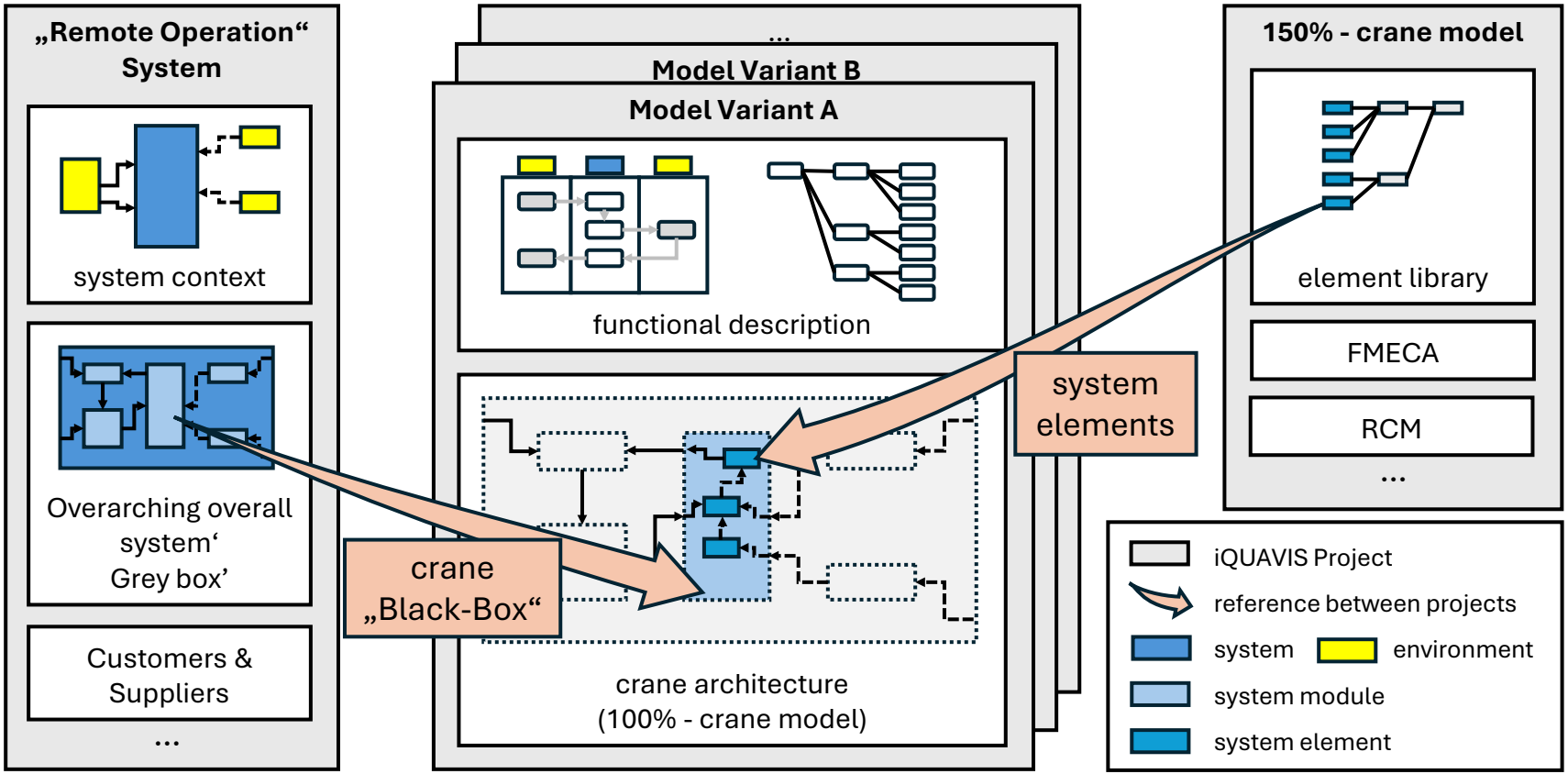




**Left:** Flow chart of a complex assistance function

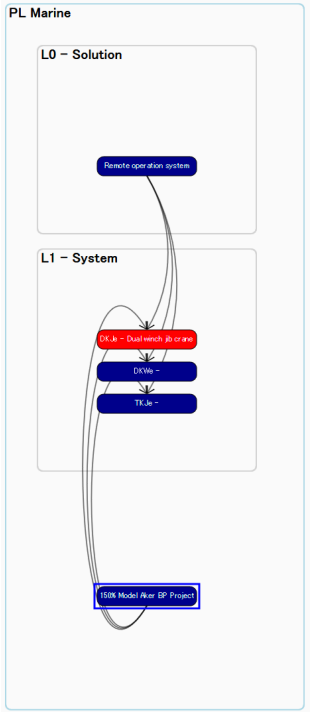
**Below:**
Tree structures with traceability from use cases to functions to the system elements that implement them

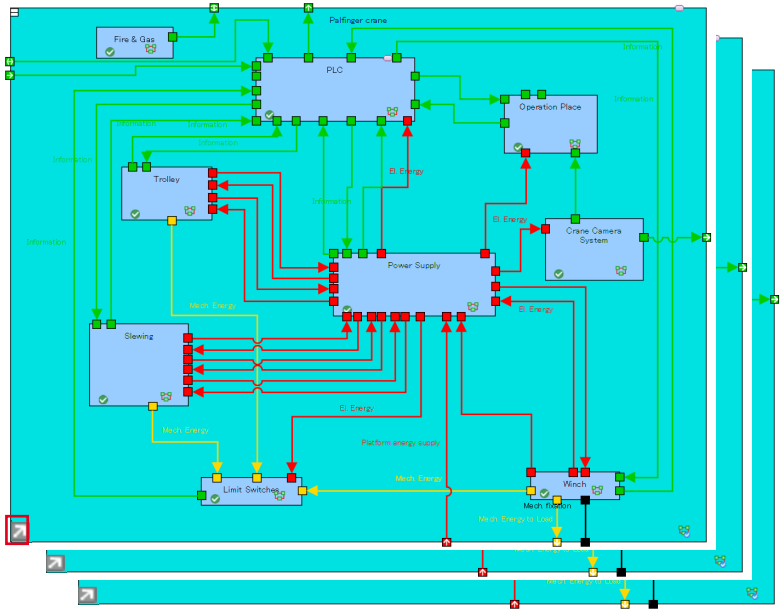
**Right:** Resulting structure diagram with system elements and interfaces

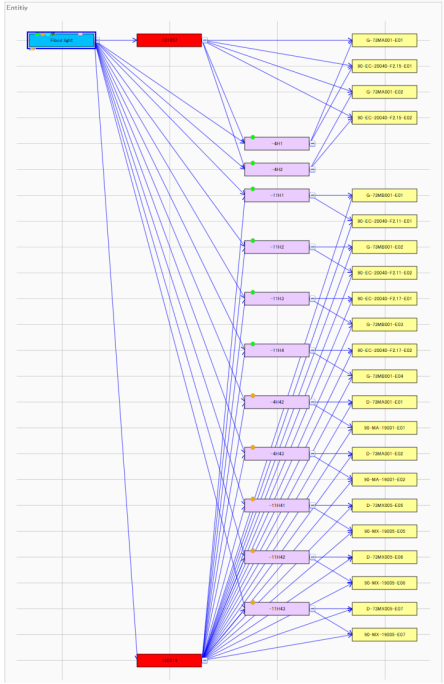
# PROJECT STRUCTURE IN VARIANT MODELLING



# EXAMPLE: SYSTEM ARCHITECTURE OF THREE CRANE VARIANTS



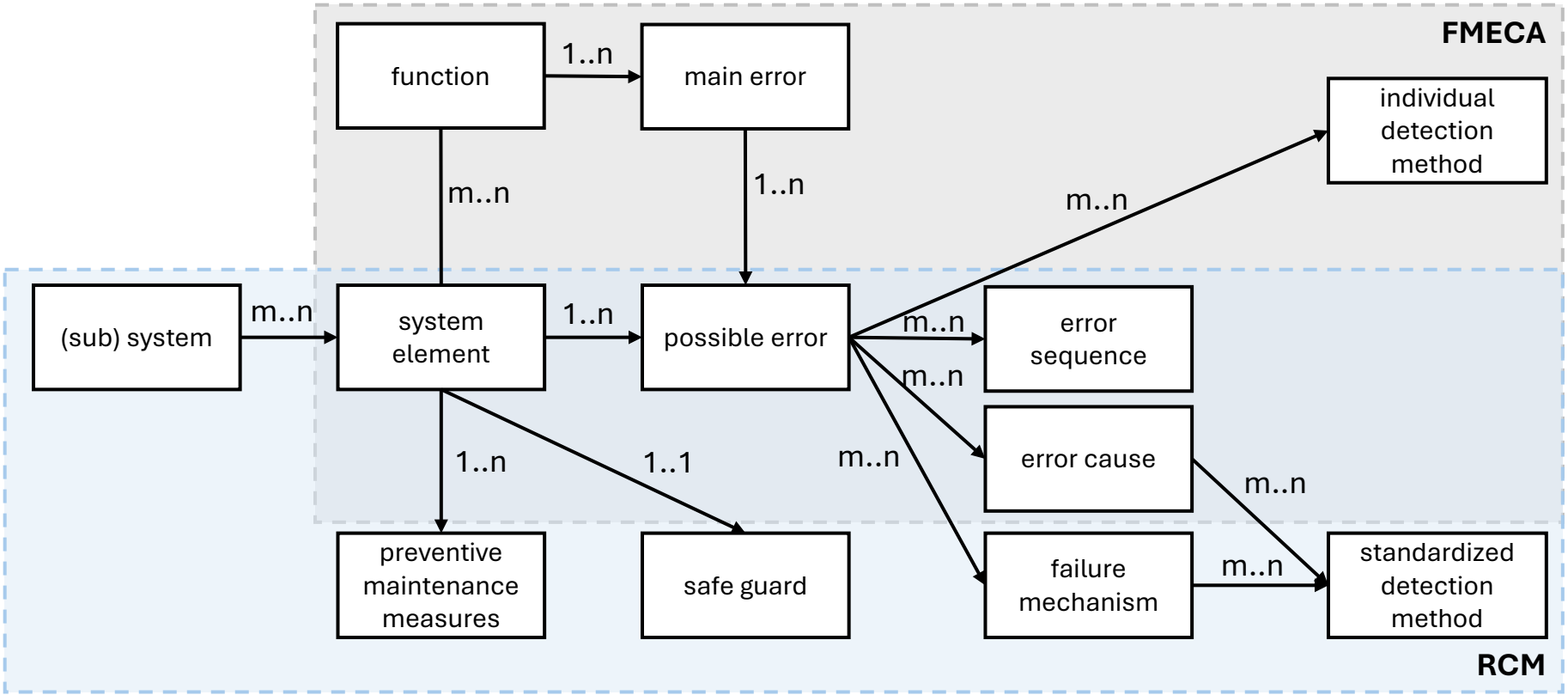



**Left:** Project references between the iQuavis models

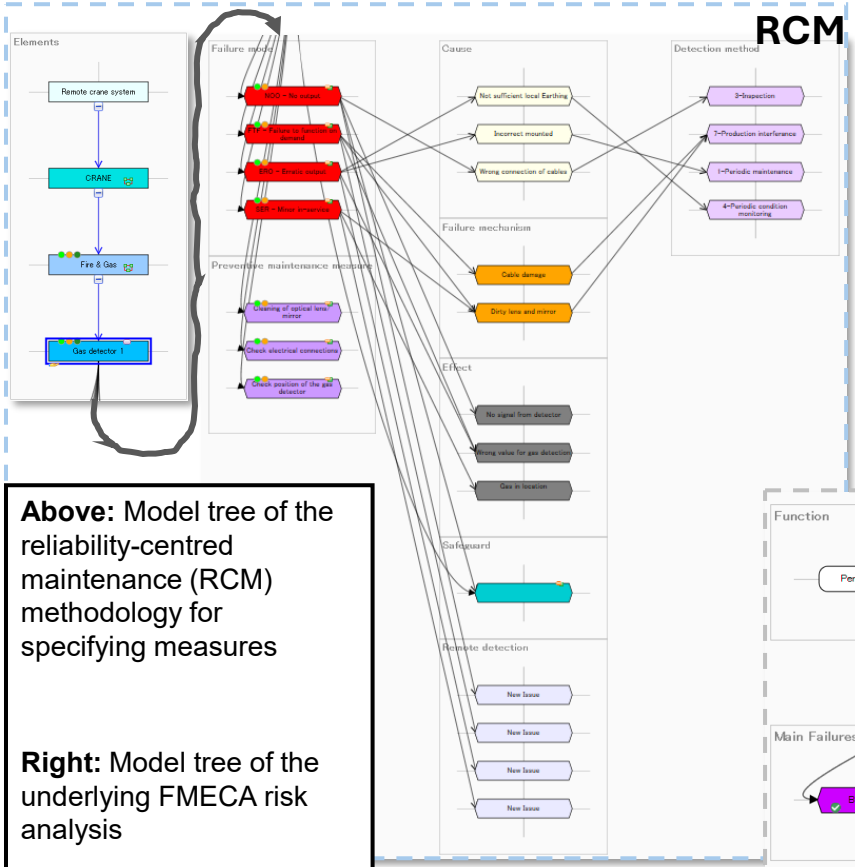
**Centre:** System architecture(s) of the individual crane variants based on the same reference element

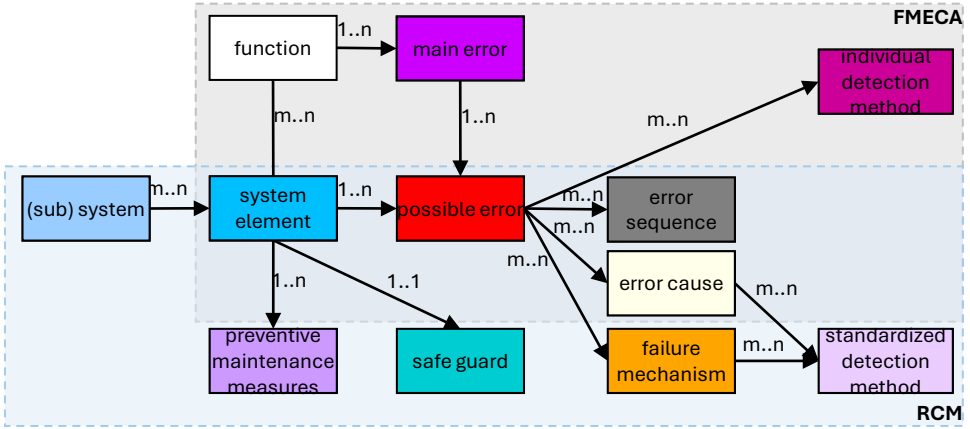
**Right:** Mapping structure of elements with article numbers and descriptions of crane instances (part of EBOM)

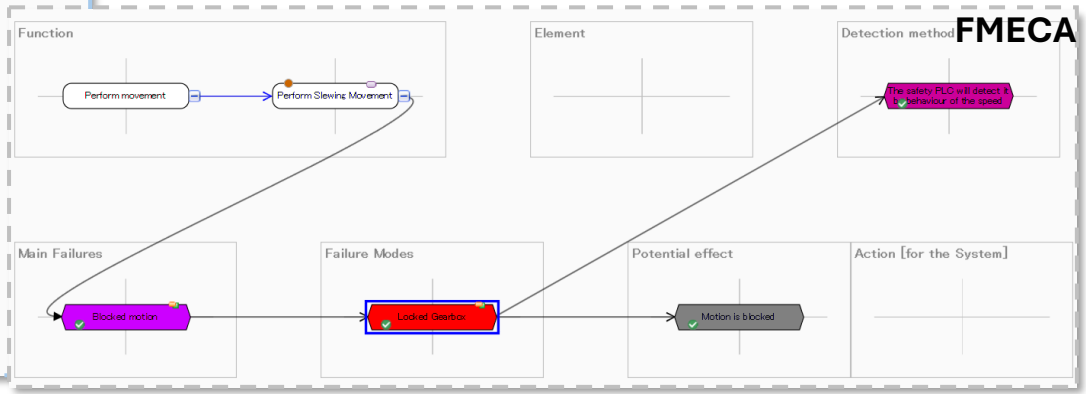
# DATA MODEL FOR RISK ANALYSES



# ‘A LOOK AT THE RISK MODELS’




**Above:** Model tree of the reliability-centred maintenance (RCM) methodology for specifying measures

**Right:** Model tree of the underlying FMECA risk analysis

# SUMMARY & OUTLOOK

Feedback: ‘The use of MBSE results in consolidated documentation for the seven crane variant models, which has reduced the documentation effort by approximately 60%.’

Feedback: ‘The functional modelling of the entire system enabled clear functional responsibilities to be agreed upon for cross-company collaboration.’

Given the large scope of the system aspects covered, the lean modelling methodology is actively modelled by only four people for dozens of information users.

The modelling methodology is to be used as standard in all large and complex marine projects at PALFINGER in future.

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