

RAM Analyses – do we expect too little?

ESRA Seminar “Praktisk bruk av RAM og produksjonstilgjengelighetsanalyser”

Siegfried Eisinger, DNV GL
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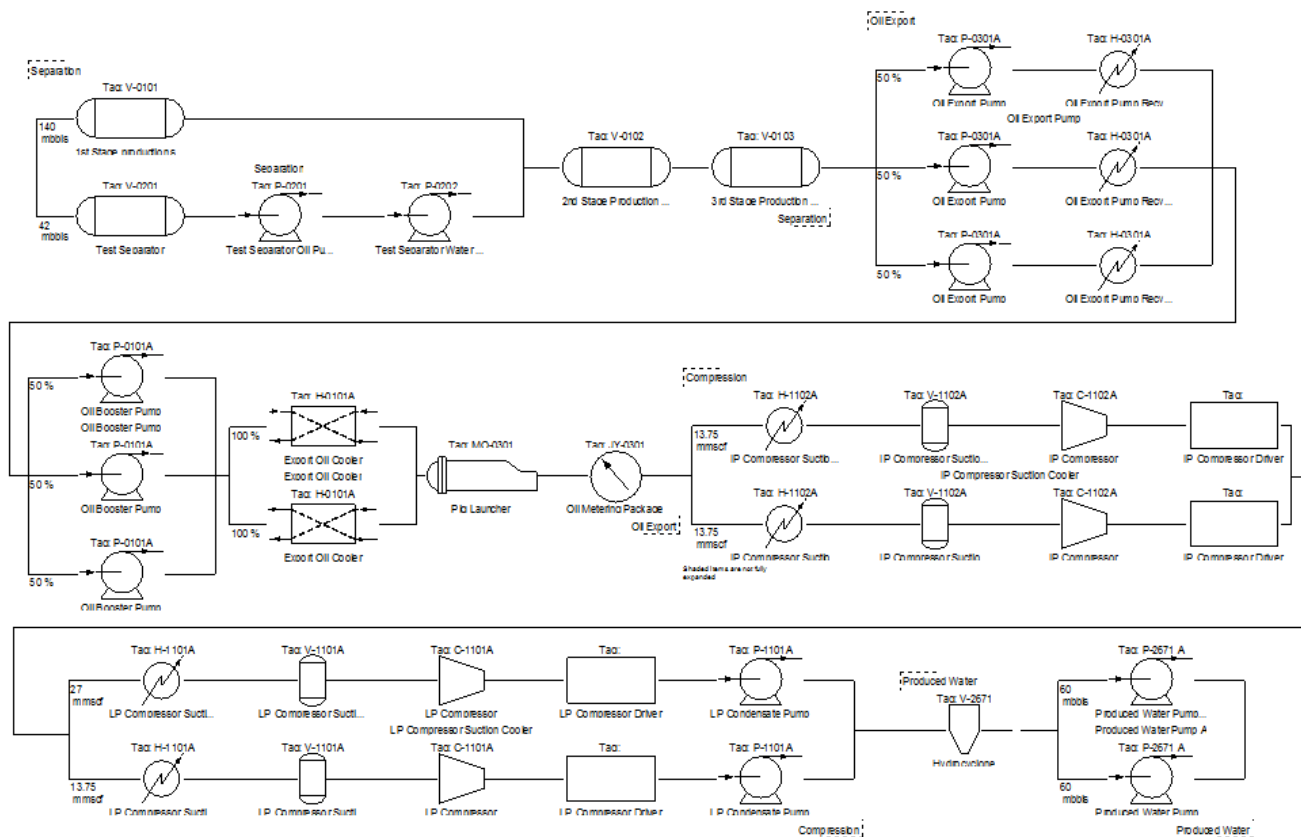
RAMS – Definitions [EN 50126]

Reliability	probability that a system can perform a required function under given conditions for a given time interval (t_1 , t_2) [IEC 60050(191)]
Availability	ability of a system to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided
Maintainability	probability that a given active maintenance action, for a system under given conditions of use can be carried out within a stated time interval when the maintenance is performed under stated conditions and using stated procedures and resources [IEC 60050(191)]
Safety	freedom from unacceptable risk of harm

RAMS contains everything, but a new word might still help

– e.g. Performance Forecasting

Availability = Reliability Block Diagram?



- ..it may be an element in the whole picture
- Evidently, the *ability, conditions, time, resources, procedures, ..* cannot easily be projected onto True/False

..therefore..

1. Define the goal
 - If there is no more goal than 'we do it because one does it': **don't do it**
 - If there is no more goal than 'authorities require it': **try a good qualitative analysis**
 - **But:** there is at least one good goal: How can I earn (more) money with this?
2. Establish a good understanding of the system and the major contributors to 'ability' – brainstorming with experts
3. Is the system complex?
 - No:** a qualitative analysis with suitable experts should do
 - Yes:** a suitable model including all relevant 'ability effects' is recommended
4. Use suitable modelling paradigm and tool to get a suitable model
 - *All models are wrong – some models are useful*
 - ! It is not necessary any longer to give up making a useful model
5. Keep in touch with the experts/owners throughout the analysis

Concept Selection Studies – OrmenLange

Critical Issues

- Select the best concept for the OrmenLange development project
- Optimise System design (in later phase)

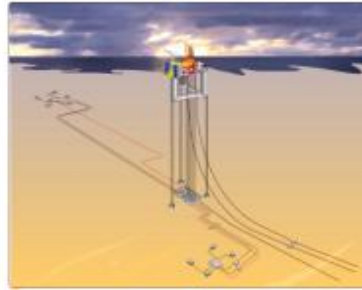
Decision Support

- Availability and *cost-benefit* for the possible concepts
- Improvement suggestions

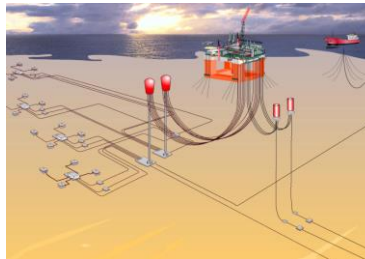
Value Delivered

- (advanced) RAMS integrated in project design

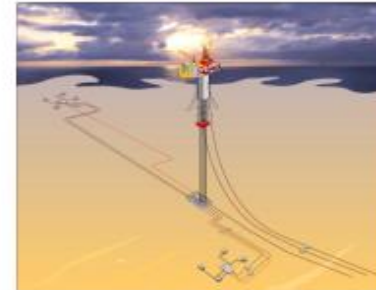
TLP



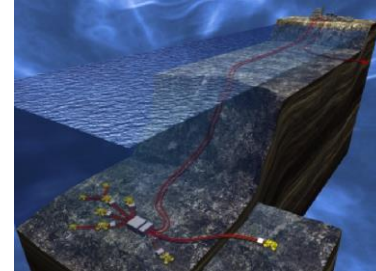
Semi



SPAR



SSL



Technical Issues

- Growing number of components in model
- Huge number of What-If cases
- Reporting of uncertainty important

Concept Selection Studies – Borouge II

Critical Issues

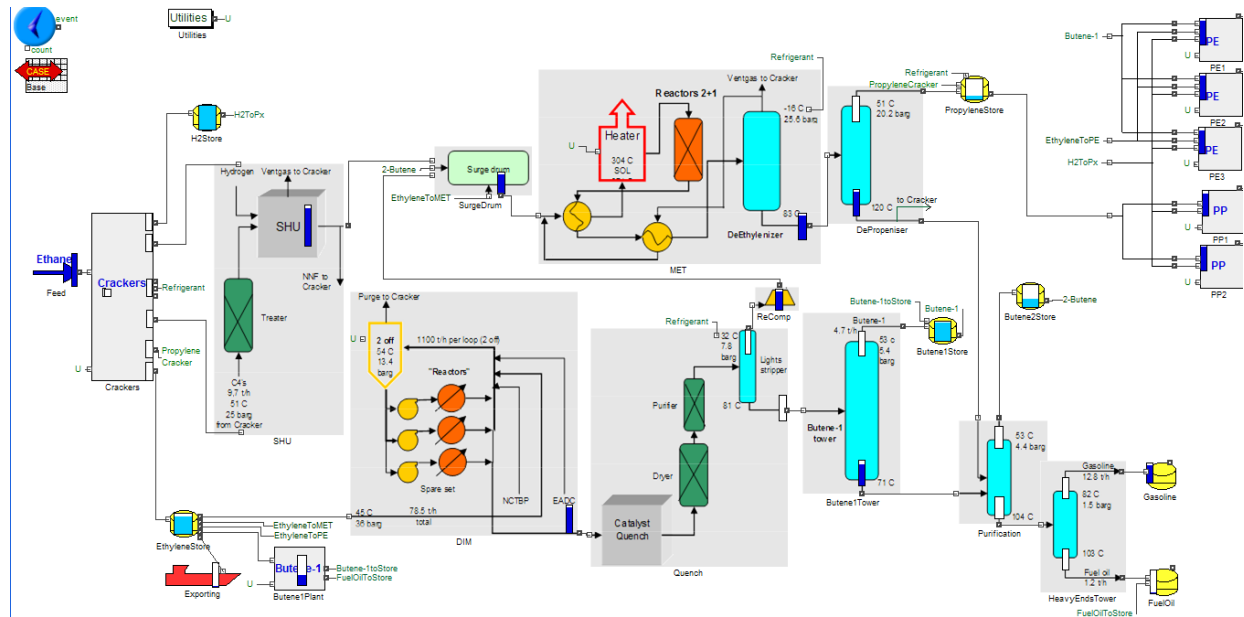
- Convince Shareholders that Borouge II is a good project and that investment will pay back
- Optimise System design

Decision Support

- Yes, the project is good.
- Optimisation of buffer storage (cost-benefit)
- Uncertainty estimation

Value Delivered

- Convinced Shareholders



Technical Issues

- Rather complicated flow model with complex rules for running plant in case of component failures.
- Short time frame \Rightarrow pre-assessment and main project

Emergency Preparedness – Tug boat availability

Critical Issues

- How to distribute tug boats along the Norwegian Coast?

Decision Support

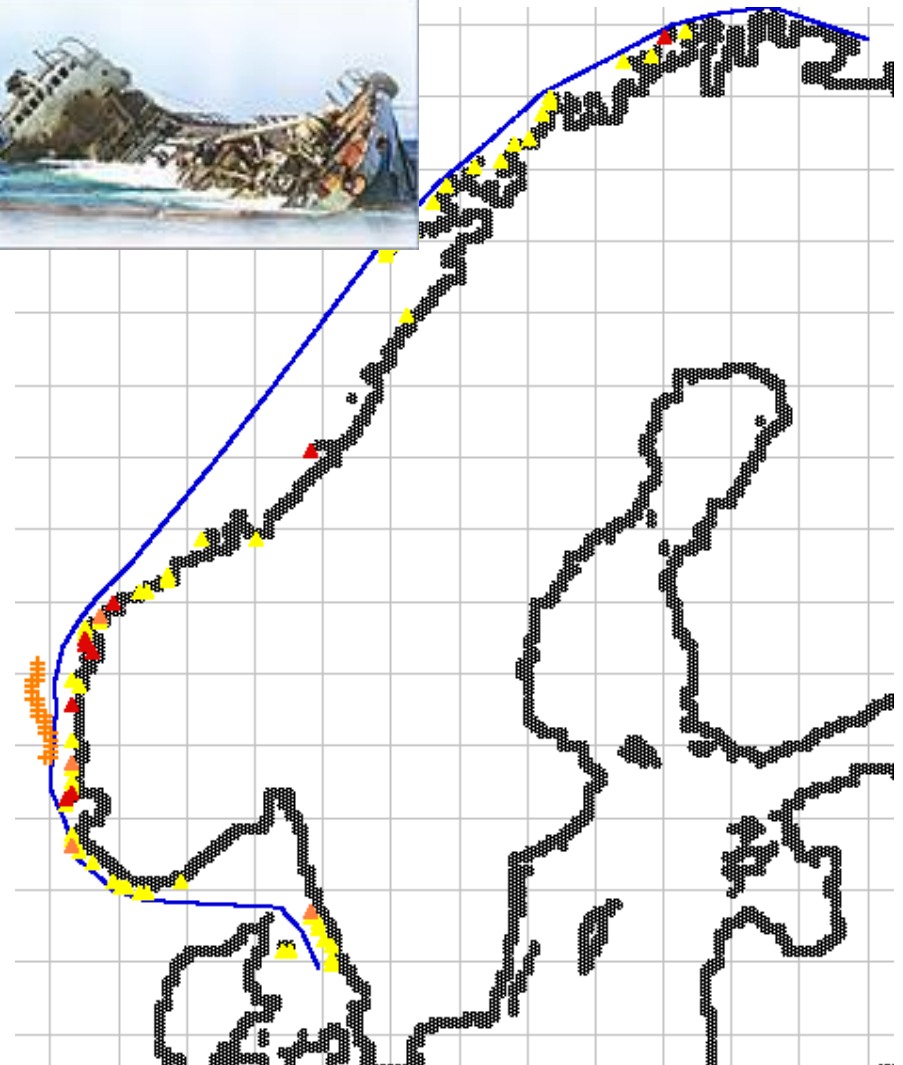
- Critical regions along the coast
- Recommended distribution of tug boats

Value Delivered

- Improved Risk Management wrt. oil pollution along the (long) coast

Technical Issues

- Link to external program to calculate ship drift
- Results visualisation as map
- GIS integration
- Integration of AIS data



Including Flow Assurance Issues

Critical Issues

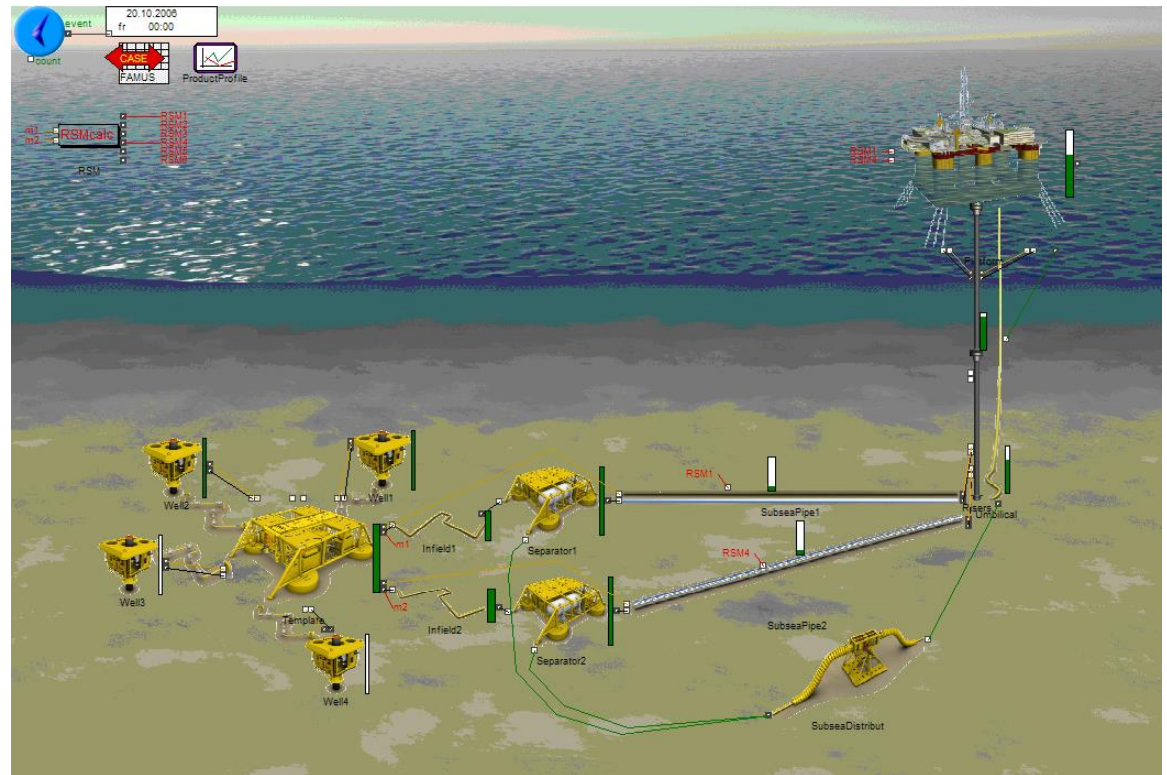
- Concept selection of Oil&Gas field including Flow Assurance issues.

Decision Support

- Optimised field development based on analysis of possible component failures and flow assurance issues (e.g. hydrate formation, wax deposits and sand erosion) which might arise
- Analysis of uncertainty
- Analysis of involved cost

Value Delivered

- Optimised field development



Technical Issues

- Complex Thermo-Hydraulic Flow Vector instead of simple flow rate
- Modelling of Flow assurance through Response Surface models

Emergency Preparedness – TAPS

Critical Issues

- Emergency Response Time wrt. Pipeline Leakage

Decision Support

- Analysis of Response Time for
 - >200 Containment Sites
 - all required resources
 - transport from Response Base through road network or helicopter
- What-if analysis wrt. helicopter placement and type

Value Delivered

- Decision Support wrt. helicopter bases and type
- Possibility to optimise Response Time



Technical Issues

- Huge road network (>30 000 nodes)
- Advanced Mixed Integer Linear Programming problem
- Integration of Extend with LP solver and database

Airport Security Check

Critical Issues

- Operation of airport at capacity limit

Decision Support

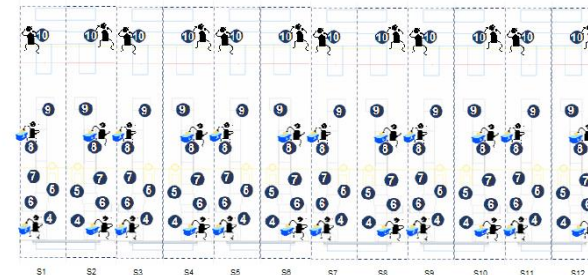
- Find bottlenecks in security system
- Propose solutions for increased capacity
- Check solution in test system

Value Delivered

- Improvement of security system based on knowledge of bottlenecks and solutions which are tried out both in simulation model and in test system

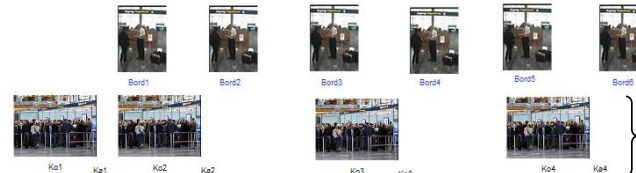


Passengers leaving the security check



Maximum 12 security check systems

6 preparation tables



4 queues dedicated to preparation tables



Arrival of passengers with given rate

Technical Issues

- Input data acquirement through video and analysis
- Simulated solution is also tested in test system

Concept Selection - Gas Field Development and supply chain study

Critical Issues

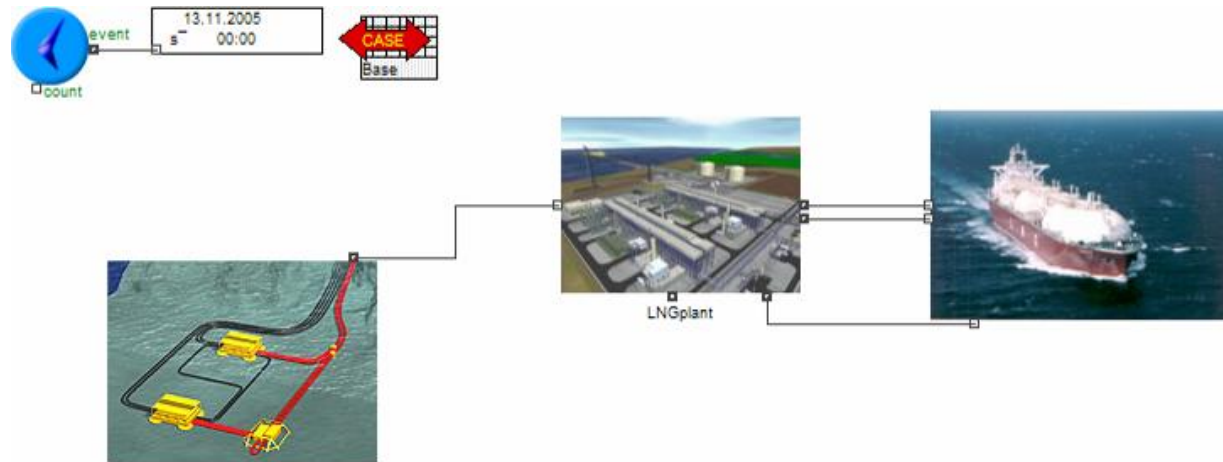
- Concept selection wrt. shipping solution

Decision Support

- Net Present Value
Optimisation of Transport Chain wrt. export market, number and type of ships.
- Availability of offshore installation (incl. mobilisation of vessels), LNG onshore plant and, shipping and re-gassification

Value Delivered

- Project feasibility



Technical Issues

- Modelling of whole supply chain (gas→LNG →ship load→gas market)
- Complex Case Study

Shipping Models – Ferry Regularity

Critical Issues

- How to convince authorities that competitor will ruin regularity?

Decision Support

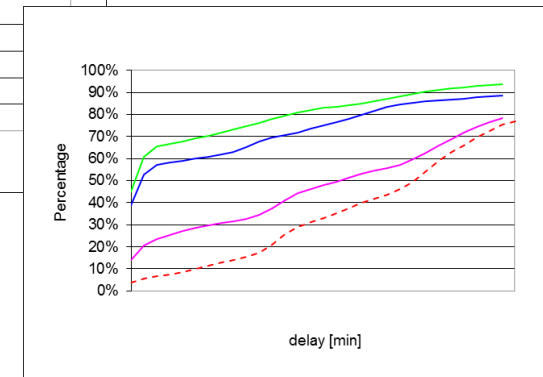
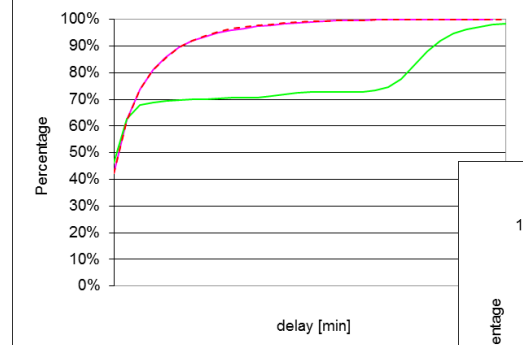
- Regularity change if competitor opens ferry link
- Acceptable rule setting for harbour entrance

Value Delivered

- Avert business threat

Technical Issues

- Resource Slot Management
- Goal-based sailing time with uncertainty
- Short project response time



Safety Analysis from Design Documentation

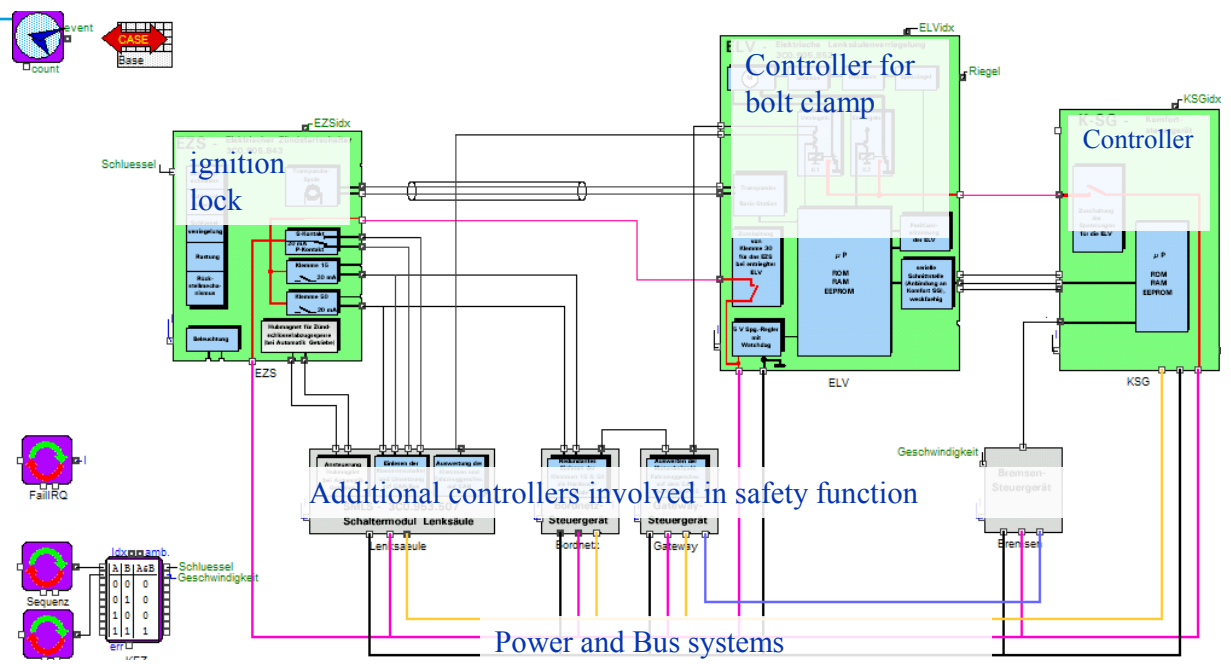
- ### Critical Issues

 - Find all possible root causes for critical system failures directly from design.
- ### Decision Support

 - List of Cut Sets from model of the signal flow. I.e. Fault tree is the result, not the input
- ### Value Delivered

 - More Reliable Safety Analysis (no manual FTA design)
 - Cheaper Safety Analysis
- ### Technical Issues

 - First pilot project of this type of analysis



Components (root causes)

Prozent	Order	crit. Relais	KL3	T_Supply	T_Eable	Verriegelung	Microwi	Hal sensor	V_M_sungl	V_M_sungl	ErrorDet	KL3	V_M_sungl	V_M_sungl	Verriegelung	ErrorDet	Bus Value	Lenksäule	Bordnetz	Gateway
0.04 %	3	x										x					x			
0.02 %	6		x	x		x									x			x		
0.02 %	5	x										x			x		x			
0.02 %	5		x	x	x	x			x											
0.01 %	6		x	x	x	x					x						x			
0.01 %	7		x	x	x	x					x				x					
0.01 %	4	x										x	x				x			
0.01 %	9				x	x					x	x	x			x	x	x		x

Start-up Performance Modelling and Optimisation

Critical Issues

- Commissioning and Start-up sequences for huge projects are difficult to plan and control during the execution in a diverse environment

Decision Support

- Identification of bottlenecks in start-up
- Alternative solutions
- Consequences of changes to the plan
- Traffic light control of commissioning status
- Uncertainties propagation within activities.

Value Delivered

- Improved communication and common understanding between departments
- Consolidation of different commissioning and Start-up plans. More robust plan.
- Start-up on schedule within budget



Technical Issues

- Advanced sequencing, resource planning and rules handling
- Modelling of underlying process details to get a clear performance picture

RAM Analyses – do we expect too little?

Siegfried.Eisinger@dnvgl.com
+47 99 70 62 37

www.dnvgl.com

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