AkerSolutions™

Preferred partner

Reduction Of Late Design Changes Through Early Phase Need Analysis

Las Vegas 02.07.2014

Eldar Tranøy | Systems Engineer

Agenda

- Introduction
- Motivation For Research
- Systems Engineering – How to do it
- Aker Solutions – How are we doing it
- Need analysis
- Summary and Conclusion

AkerSolutions™

Motivation For Research

- Large cost overruns on EPC projects on the Norwegian continental shelf
  - Skarv
  - Snøhvit LNG
  - Yme
- 10 large EPC projects totaled a $16 Bn cost overrun
- Large media exposure and highlighted in the Norwegian national budget

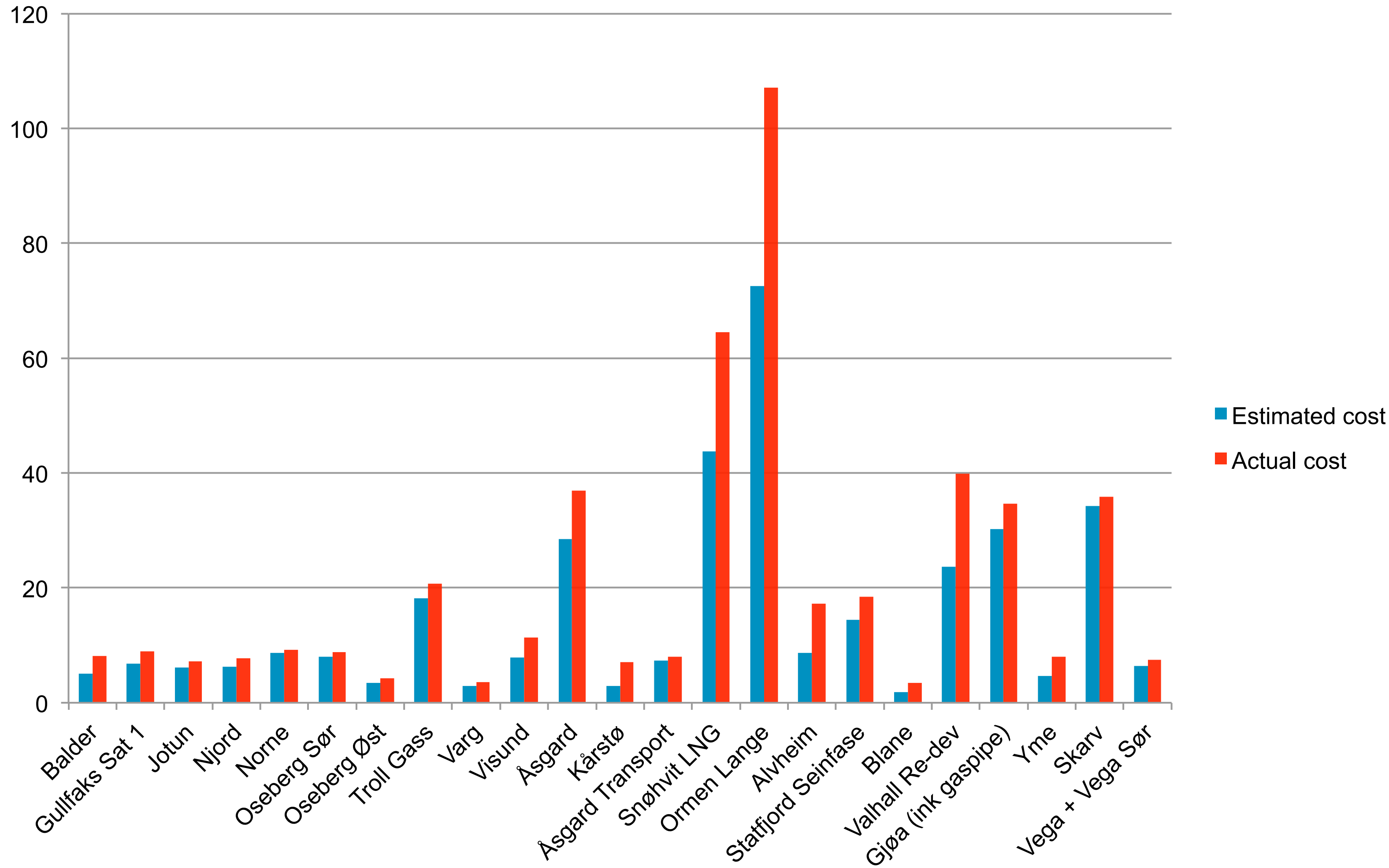
AkerSolutions™

Motivation For Research

- Cost overruns on EPC projects is not a new phenomenon
- The investment Committees report – «Analysis of the development of investments on the Norwegian continental shelf»
  - Government initiated report released in 1999
  - Documents cost overruns similar to media reported cost overruns for 2004- 2008
- Consistent trend with cost overruns from 1994 through 2008

AkerSolutions™

Planned vs Actual Cost - BNoK



Motivation for research - Cost To Society

- Strong tax incentives for oil companies to invest on the Norwegian Continental Shelf
- 78% of the investment cost is tax reimbursable
- This also applies to the cost overruns
- Total amount of cost overruns:
  - 1994-1998: 5,5 Billion Dollars (documented)
  - 1998-2008: 18 Billion Dollars (estimated)
- Continuous and increased media focus expected.

"In reality, The Norwegian government covers 93% of the cost overruns"

K.I. Røkke in his letter to the shareholders

Main Cost Drivers

- Scope changes and late design changes are considered to be the main drivers
  - Has potential to add schedule delay
- Imposes a project risk
  - Oil companies need means to mitigate these risks
- The risk is transferred to the contractors
- Methods and tools to reduce the amount of late design changes might yield a competitive advantage

Project	PUD year	Estimated cost	Change in %
Balder	1998	5	**62**
Gullfaks Sat 1	1998	6,86	31
Njord	1998	6,31	23
Oseberg Øst	1998	3,49	23
Varg	1998	2,94	24
Visund	1998	7,85	45
Åsgard	1998	28,52	30
Kårstø	1998	2,94	**141**
Snøhvit LNG	2002	43,8	47
Ormen Lange	2004	72,5	48
Alvheim	2004	8,7	**98**
Statfjord Seinfase	2005	14,5	28
Blane	2005	1,8	**94**
Valhall Re-dev	2007	23,7	68
Gjøa (ink gaspipe)	2007	30,2	15
Yme	2007	4,7	**70**
Vega + Vega Sør	2007	6,4	17

AkerSolutions™

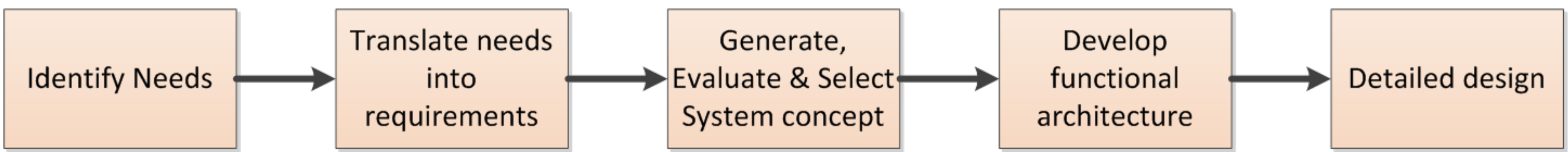
Systems Engineering

- SE have proven valuable to reduce the amount of scope changes and late design changes
- We therefore initially assumed that using SE would prove effective, and help reduce scope changes and late design changes.
- The Oil&Gas (O&G) industry is already using SE
- Despite the use of SE, O&G EPC projects continue to see large cost overruns

Systems Engineering - Benchmarking

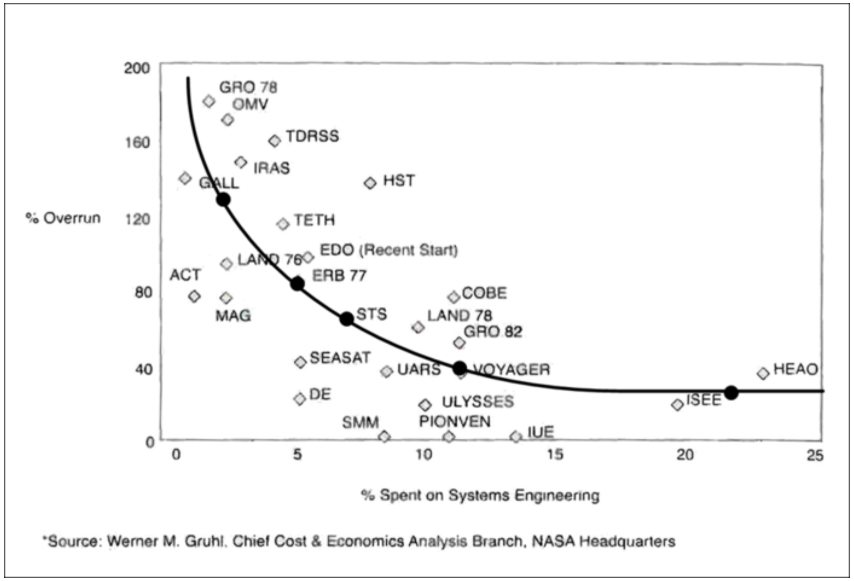
- Systems Engineering Body of Knowledge (SEBoK)

- Fundamental SE process:



Systems Engineering – Benchmarking

- Eric Honour (2004) – Value of Systems engineering
- Gruhl (1992) – NASA research
  - Less cost overruns with early phase effort
- Barker (2003) – IBM research
  - Productivity improvement, cost savings and increased quality of design



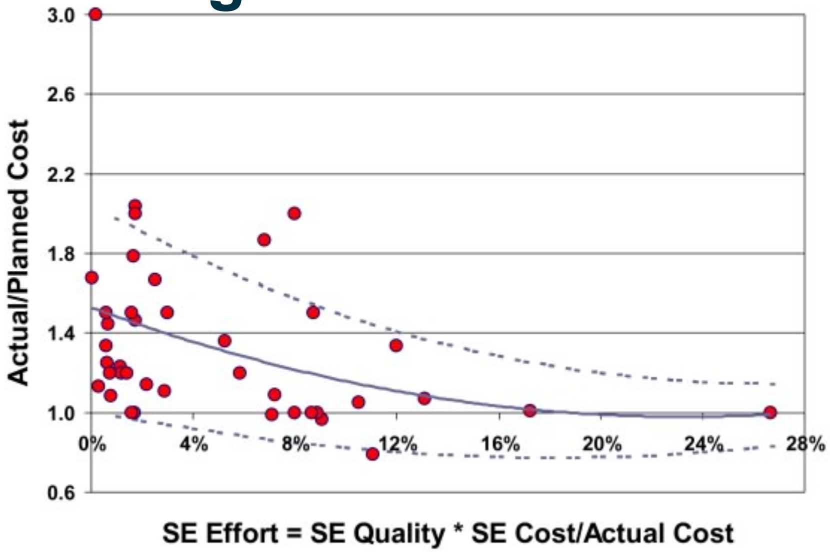
Systems Engineering - Benchmarking

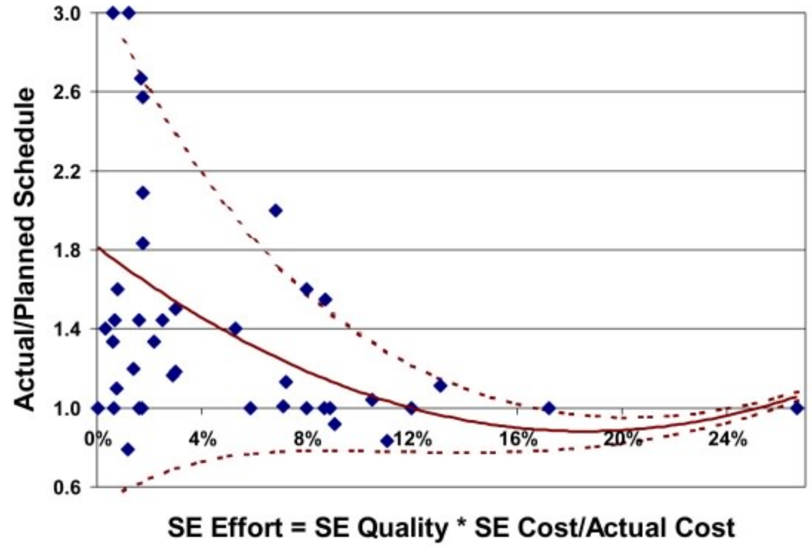
- Systems Engineering Effort (SEE)

$SEE = SE\ Quality * SE\ Cost/Project\ Cost$

- Optimum SEE at 15-20 %

- This implies that contractors are either doing too little SE or performing SE with too low quality

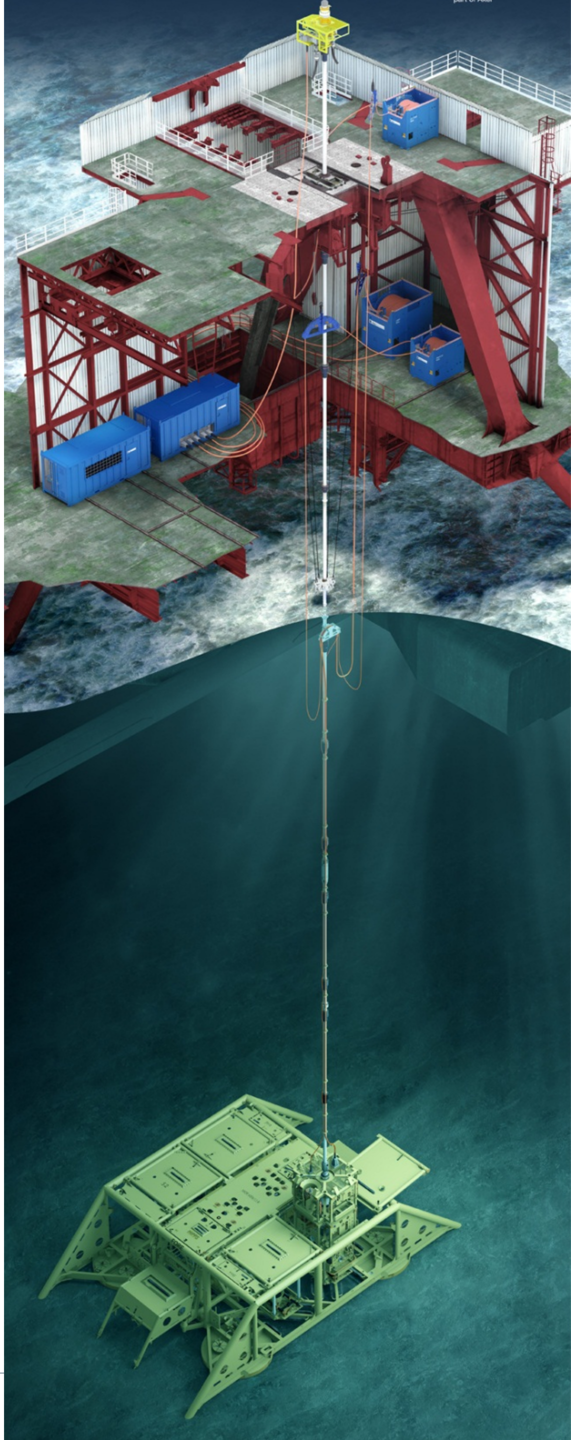




AkerSolutions™

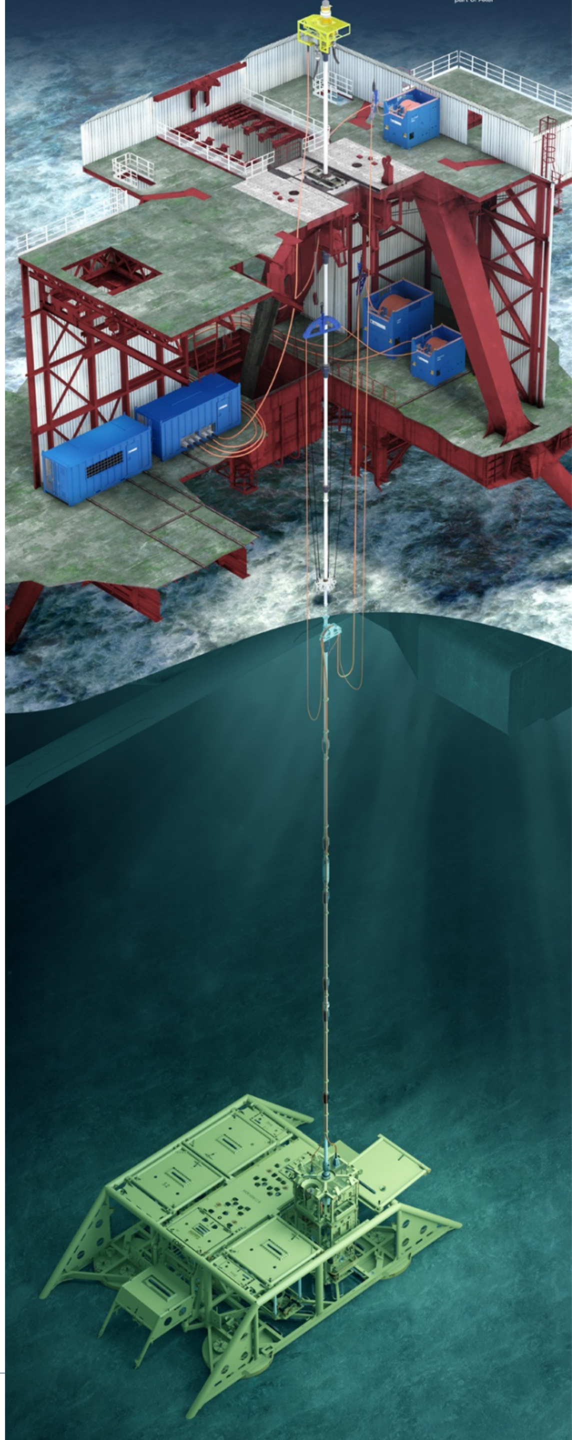
Example Project – Vigdis NE WOS

- Workover Systems / Light Well Intervention Equipment
- System delivery comprise of:
  - EDP/LRP
  - Riser System
  - multiWOCS
- Interfaces XMTs/Wells from multiple vendors
- Interfaces multiple offshore vessels / rigs
- Follows the “FastTrack” delivery scheme



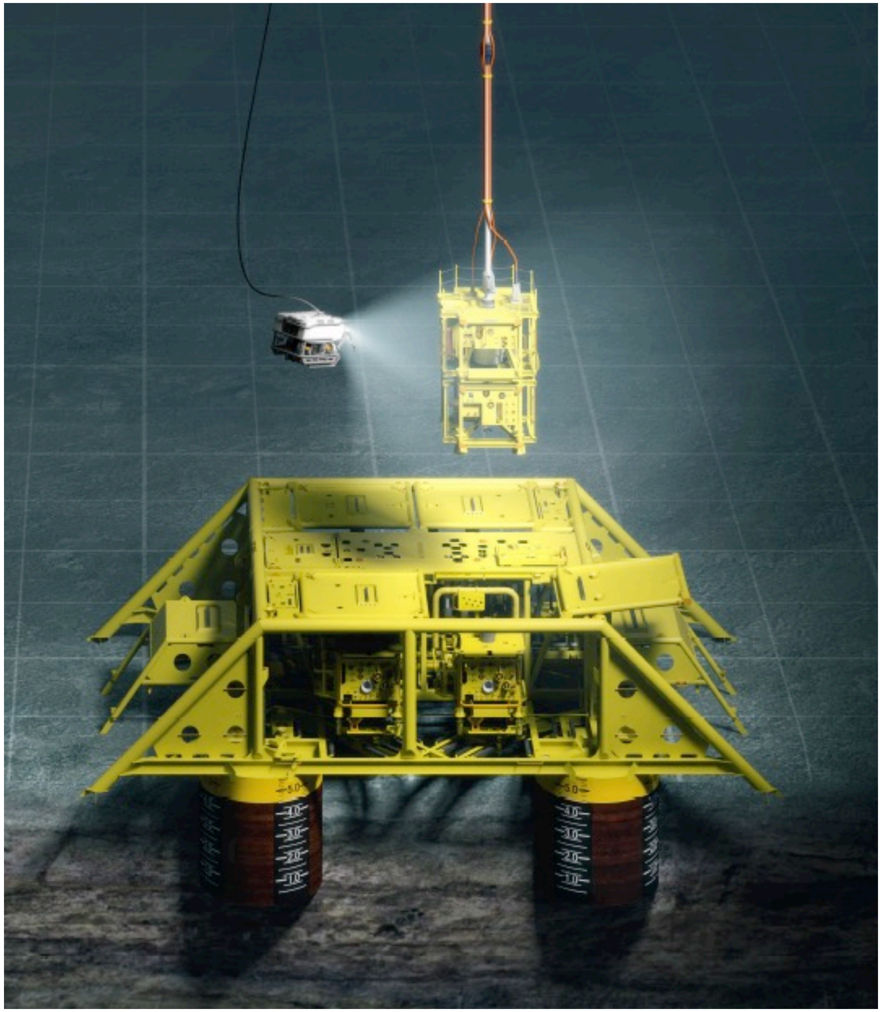
Identifying Root Causes

- We needed to benchmark SE performance in Vigdis NE WOS
- Amount of SE:
  - 8,5% of total project cost
  - Too low for optimum SEE
  - High enough to expect good results
- Startup of SE activities:
  - Initiated at project startup
  - Confirmed by project timeline
- Performed a comparison of internal SE activities compared to SE fundamental processes



Capturing the Customer Perspective

- Assess if the initial system design covered the operational need of the customer
- Establish a basis to evaluate the initial need analysis done in the project
- Performed through in-depth interview with customers' technical lead
- Three main root causes were identified



AkerSolutions™

Capturing the Customer Perspective

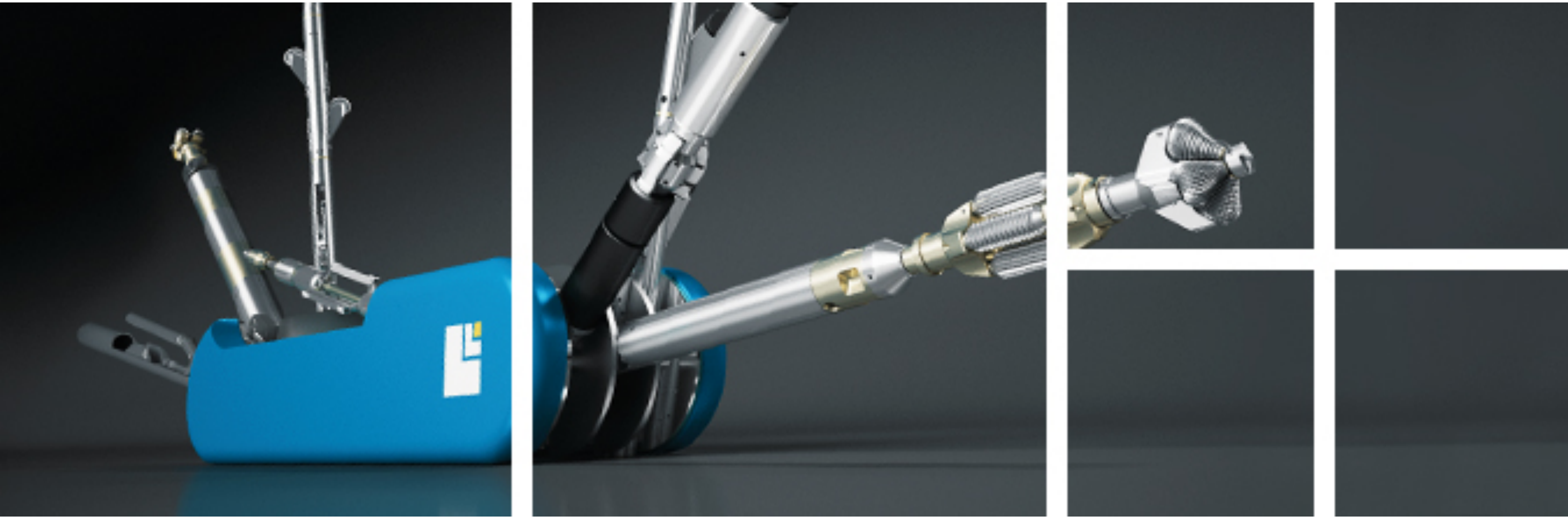
- Cross vendor interfaces
  - Not evaluated in the research

- Mismatch between tendered design and operational needs
  - Requirements derived from the tender phase were generic, not application specific
  - Leads to over-dimensioning of subsystems

- Mismatch between requirements in governing documents and operational needs and physical limitations of interfacing systems and stakeholders
  - The needs of the operational vessels not covered by governing documents
  - This will in turn affect how the requirements interact
  - Governing documents define the system and impose weight restrictions
  - These restrictions exceed the lifting capacity of the operational vessels

Capturing the Customer Perspective

- This effectively means that the design that won the tender is not suitable for the actual operational needs of the customer



Aker Solutions – Are we doing it right?

- In-depth interview revealed that the projects SE processes had been unsuccessful in capturing the customers' operational needs

- SEBoK states that:
  - SE shall perform the initial capturing of needs before system design
  - Derive system requirements from the needs

- Are our internal procedures in accordance with SEBoK?

AkerSolutions™

Aker Solutions – Are we doing it right?

- PEM
- High level model which governs the overall processes in all AkSo projects
- The PEM defines how to systematically move from a concept, to win a tender and how to execute a complete project
- Does the PEM model cause limitations in SE Effort?

AkerSolutions™

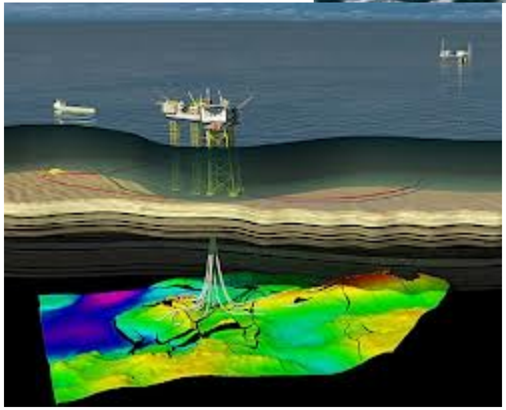
Tender Phase

Aker Solutions – Tender Phase

- How does the tender phase define a system and it's requirements?
  - No need analysis
  - No requirements definition
- This is due to the tender process being a public process.
  - This implies that all communication towards company is in principle public communication.
  - Little or no communication takes place during the tender, due to the risk of SE efforts being revealed to competitors
- As earlier described, this results in tendered system design being different from the system design the customer actually needs
- This finding is supported by the investment committee's report
  - The report also address the problem with little to no communication during the tender and the subsequent consequences of the current tendering regime

AkerSolutions™

Aker Solutions – Tender Phase



- When contractors enter into a tender, it is not unusual that essential operational data is missing.
- This finding also correlates with the investment committee's report
- Examples of typical missing data:
  - Meteorological and oceanographic data
  - Field data
  - Soil data
  - Fluid data
  - Installation vessel data

Feasibility & Concept Phase

Aker Solutions – F&C

- F&C offers more degrees of freedom for design
- No single concept is chosen at startup
- Both contractor and customer has the freedom to tailor the design
- Communication between participants are more open
  - This allows for more customer interaction and identification of underlying needs
- AkSo assumes that the generic customer requirements are sufficient
- Requirements definition activity exists
- No need analysis takes place

AkerSolutions™

Potential Impact of Need Analysis During F&C

- The research into the tender procedures revealed that tenders often are clearly influenced by the company performing the initial study
- A contractor that uses need analysis during the F&C phase will have the opportunity to tailor the study to the customer needs, and adapt it to the contractors available technology
- If need analysis is used during F&C to identify needs not stated in the customers F&C documentation or ITT, the contractor can potentially gain a competitive advantage to win the contract and execute the work with less design changes
- Less design changes will increase the profitability potential of the project and gives the customer a more predictable project cost

Analysis of Cost and Potential Impact

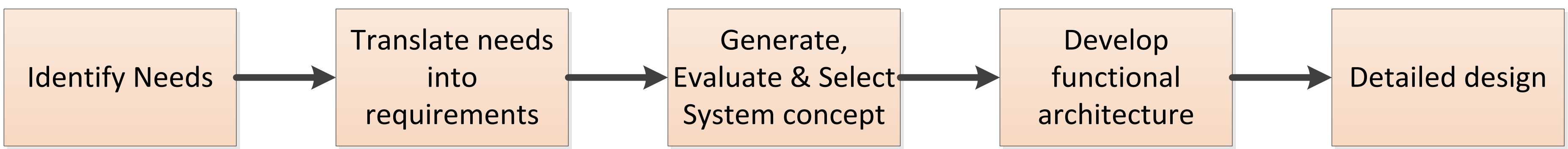
- Analysis of VO registry
  - Changes to design or scope normally results in a variation order (VO)
  - Cost of change is normally carried by customer
  - Review of 23 VO's

- Findings
  - 74% of the VO's were preventable by need analysis
  - 92% of the cost incurred by late design changes, were preventable

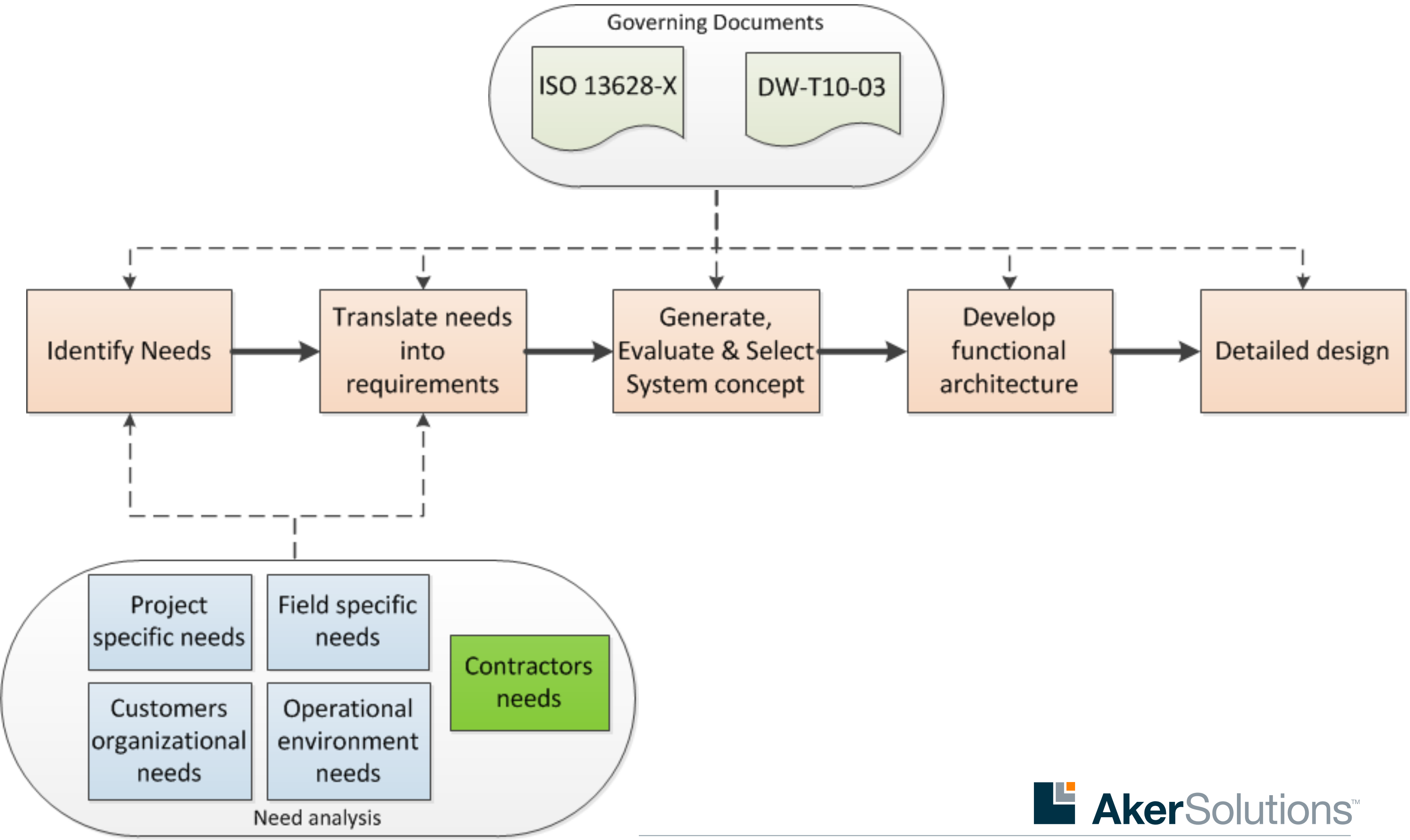
- Root cause analysis of the preventable VO's
  - Changes to product design
  - Mismatches between project requirements and operational needs

AkerSolutions™

Recommended Process Change



Recommended Process Change



What's New?

- Vigdis NE Project:
  - Now have 110 approved VO's
  - Cost is increasing, margin is falling
- Goliat FPSO Project
  - On schedule to become one of the largest cost overruns in Norwegian O&G history
    - Planned cost $5 Bn
    - Estimated cost: $7,5 Bn

AkerSolutions™

Summary

- The research shows strong incentives for contractors to use structured need analysis
- Using structured need analysis can help contractors to:
  - Deliver more tailored solutions to each customer
  - Avoid costly late design changes and schedule delays
- Less late design changes increases both actual and perceived quality
- More predictable project cost for our customers
- Reduce the cost to society

AkerSolutions™

Academic Background for the Reasearch

Industry Documents

- ISO 13628-X
- DW-T10-03
- AkSo PEM
- Contract – Vigdis NØ C/WO
- Vigdis NØ VO registry

Independent Research

- Systems Engineering Body of Knowledge
- Eric Honour – «understanding the value of systems engineering»
- The investment committee – «Analysis of the development of investments on the Norwegian continental shelf»

Copyright and disclaimer

Disclaimer

This Presentation includes and is based, inter alia, on forward-looking information and statements that are subject to risks and uncertainties that could cause actual results to differ. These statements and this Presentation are based on current expectations, estimates and projections about global economic conditions, the economic conditions of the regions and industries that are major markets for Aker Solutions ASA and Aker Solutions ASA's (including subsidiaries and affiliates) lines of business. These expectations, estimates and projections are generally identifiable by statements containing words such as "expects", "believes", "estimates" or similar expressions. Important factors that could cause actual results to differ materially from those expectations include, among others, economic and market conditions in the geographic areas and industries that are or will be major markets for Aker Solutions' businesses, oil prices, market acceptance of new products and services, changes in governmental regulations, interest rates, fluctuations in currency exchange rates and such other factors as may be discussed from time to time in the Presentation. Although Aker Solutions ASA believes that its expectations and the Presentation are based upon reasonable assumptions, it can give no assurance that those expectations will be achieved or that the actual results will be as set out in the Presentation. Aker Solutions ASA is making no representation or warranty, expressed or implied, as to the accuracy, reliability or completeness of the Presentation, and neither Aker Solutions ASA nor any of its directors, officers or employees will have any liability to you or any other persons resulting from your use.

Aker Solutions consists of many legally independent entities, constituting their own separate identities. Aker Solutions is used as the common brand or trade mark for most of these entities. In this presentation we may sometimes use "Aker Solutions", "we" or "us" when we refer to Aker Solutions companies in general or where no useful purpose is served by identifying any particular Aker Solutions company.

AkerSolutions™