26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

Applying A3 problem resolution to new system design to improve performance and reduce rework

A study performed by Alexander S. Svendsen on behalf of Aker Solutions AS
Master Project, Systems Engineering University College of Southeast Norway
Academic Supervisor: Dr. Cecilia Haskins

Introduction

- Alexander Svendsen, Oslo Norway
- Bachelor's degree in Mechanical Engineering
- Master's degree in Systems Engineering
- 4 years experience in the Oil & Gas industry

From school to work

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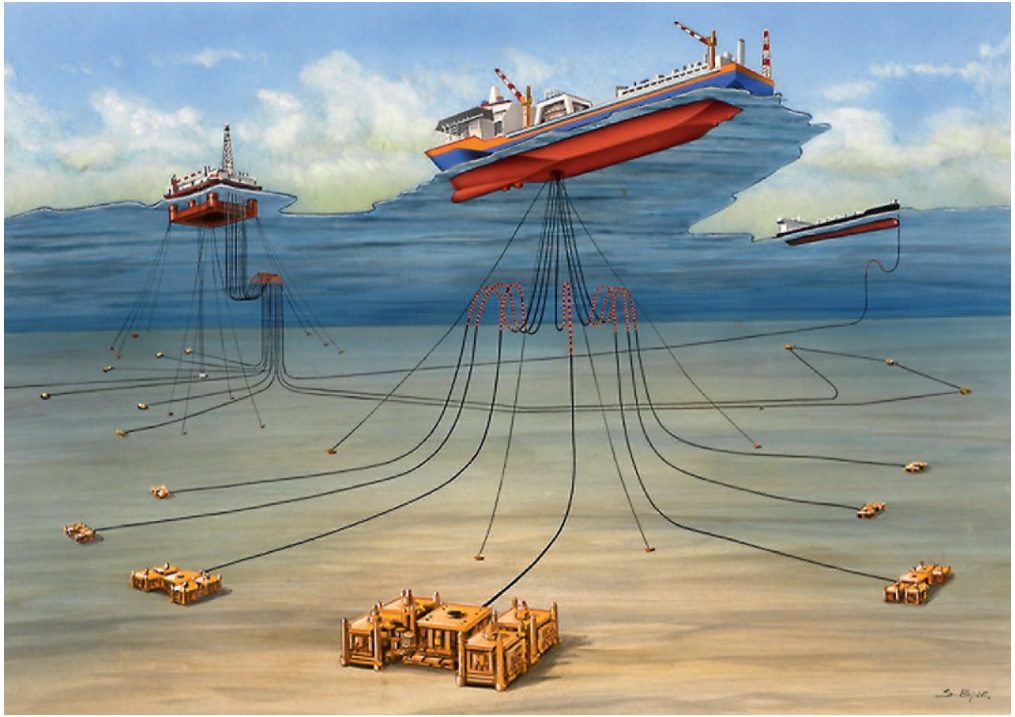
- 3 years industrial master program at the Systems Engineering University College of Southeast Norway.
- Employed in Aker Solutions a Norwegian based company delivering products, systems and service for the oil and gas industry.
- Working in the company's new product development project (Subsea Gas Compression) as a systems test engineer.

AkerSolutions™

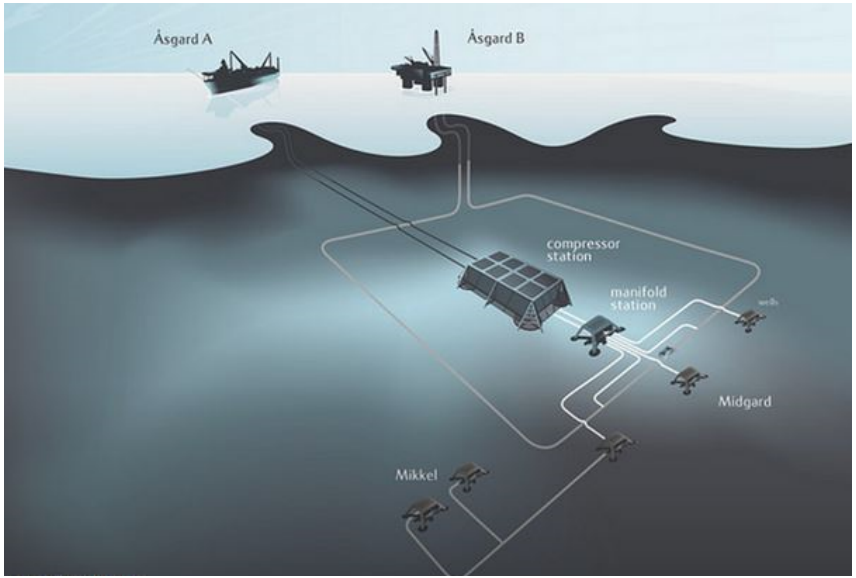
- Norwegian based Company
- A global provider to Oil & Gas industry
- 50+ years of experience within Subsea Systems
- 15.000 employees in 20 countries

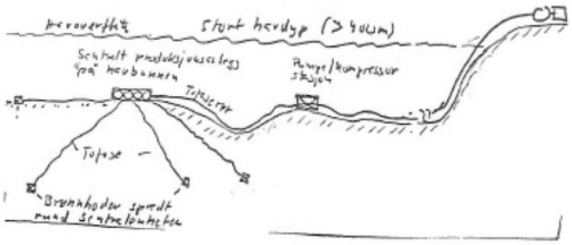
Aker Solutions Headquarters, Fornebu, Norway

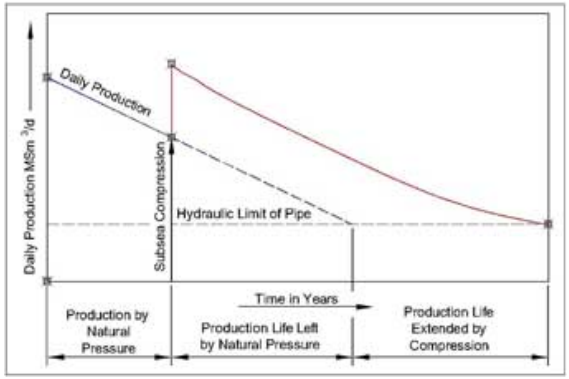
Storyline



From a vision to realization

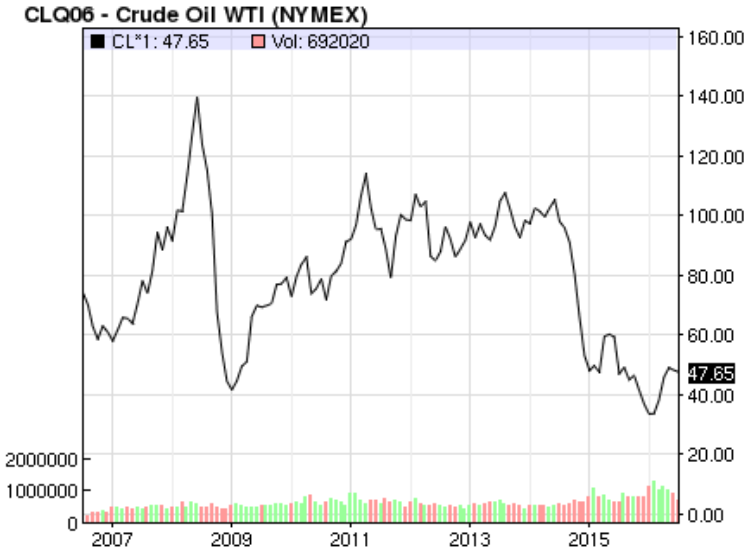






Business environment

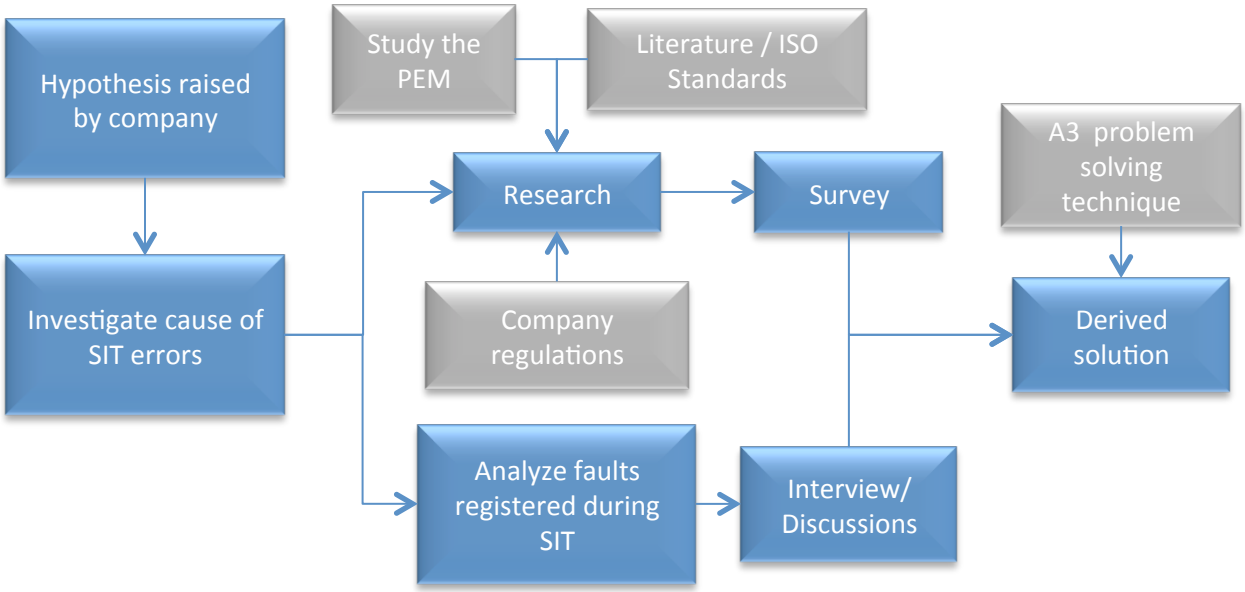
- Galloping oil price through the last 10 years
- Project cost increases over time
- Poor standardization
- Advanced technology
- Enhanced oil recovery (EOR)



Foundation of the thesis

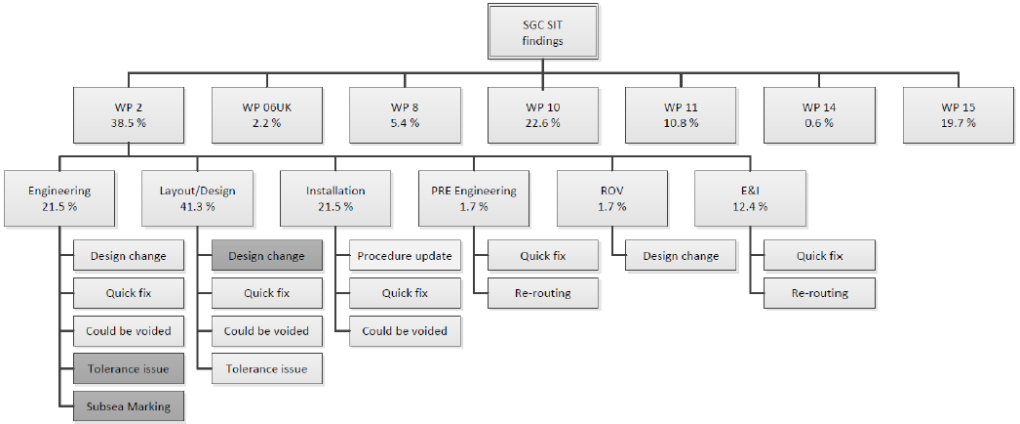
- 3 years in the System Integration & Test team
- Large number of faults discovered during testing
- Reoccurring faults discovered from project to project
- Desire for improvements in quality
- Desire for reduced cost and time consuming delays

Methodology



From a retrospective viewpoint

- Categorized and investigated previous SIT errors
  - Root cause analysis of the most severe errors.
    - Fishbone diagram
    - 5 why's

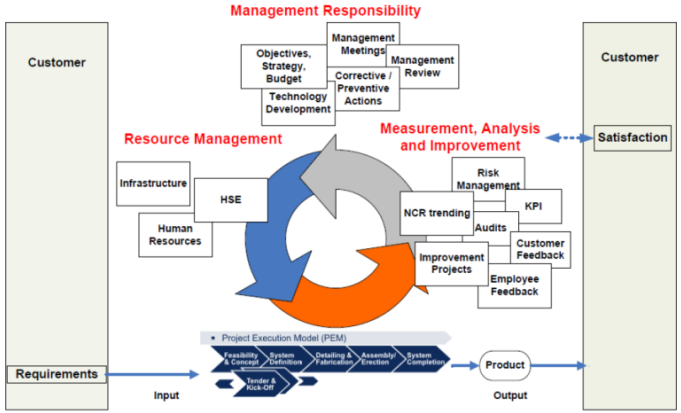


- Discussed errors with the different work packages.

Business Practice

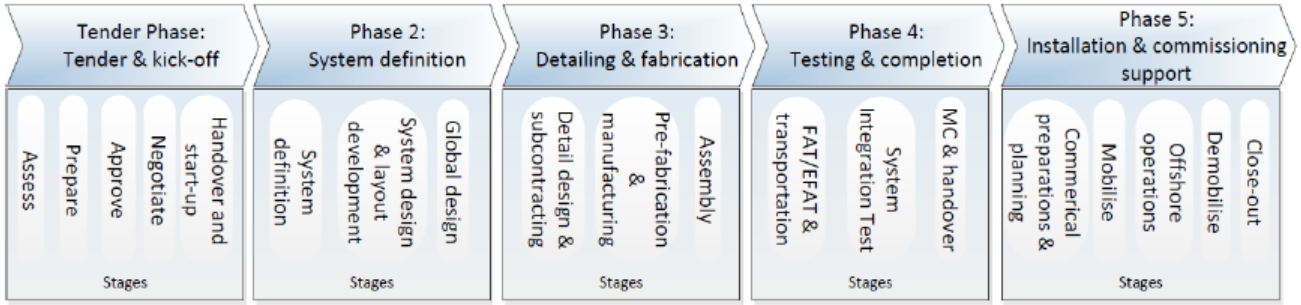
Internal research was pursued around the company's regulations

- Quality Manual – ISO 9001:2008
  - Valid for whole business organization
- Continuous improvement
- Change Control Board(CCB)
- Project Execution Model (PEM)
- Non-conformance request (NCR)
- Lessons Learnt



The Project Execution Model

- Developed by Aker Solutions with the purpose to guide and monitor complex projects.
- PEM has been modified over several years from its basis “PEM Capex”, specified/standardized more towards the SPS and topside projects.



Likert Scale Survey

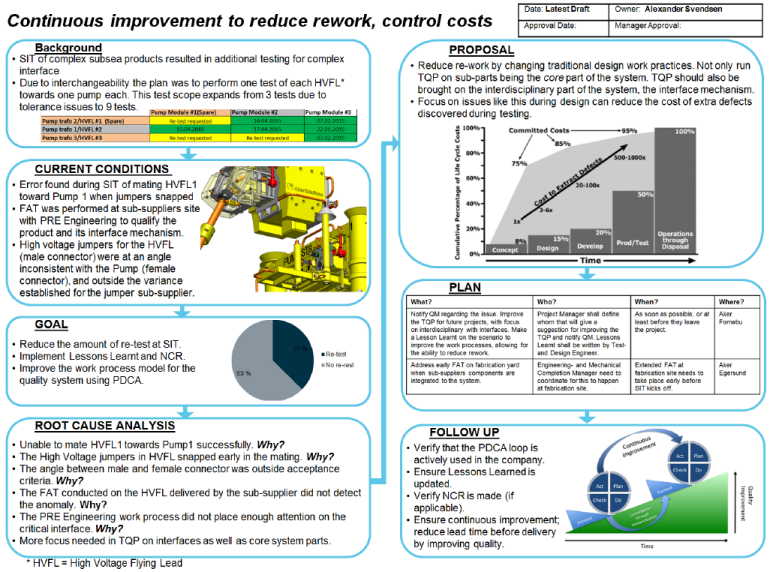
- A full anonymity survey was sent out in the project to question employees about their awareness and usage of the PEM.
- The survey had 9 questions with 5 response alternatives ranging from strongly agree to strongly disagree.
- Last question opened a communication link, allowing respondents to answer with text.
- Survey was sent to 40 employees in the project, varying from managers to project engineers.
- 90% of 40 employees answered the survey.
- Relatively high consistency in the results.

Interview

- Interview held with project managers and systems engineering lead.
- RCA's were displayed and discussed.
- Cause of actions taken throughout the project was elaborated by management.
- Many TQP's.
- Much focus on sub-suppliers product quality.
- More focus could be brought up on product integration and system quality.

The advantage of using A3

- Used A3's for elaborating and discussing SIT faults .
- Helped illustrating if/how errors could been discovered earlier, fixed sooner?
- Opened up for a smoother communication thread.
- Simplified record keeping.



Continuous improvement to reduce rework, control costs

Date: Latest Draft | Owner: Alexander Svendsen
Approval Date: | Manager Approval:

Background
- SIT of complex subsea products resulted in additional testing for complex interface
- Due to interchangeability the plan was to perform one test of each HVFL* towards one pump each. This test scope expands from 3 tests due to tolerance issues to 9 tests.

	Pump Module #1(Spare)	Pump Module #2	Pump Module #3
Pump trafo 2/HVFL #1 (Spare)	Re-test requested	19.04.2015	07.02.2015
Pump trafo 1/HVFL #2	Re-test requested	17.04.2015	07.02.2015
Pump trafo 3/HVFL #3	Re-test requested	Re-test requested	07.02.2015

CURRENT CONDITIONS
- Error found during SIT of mating HVFL1 toward Pump 1 when jumpers snapped
- FAT was performed at sub-suppliers site with PRE Engineering to qualify the product and its interface mechanism.
- High voltage jumpers for the HVFL (male connector) were at an angle inconsistent with the Pump (female connector), and outside the variance established for the jumper sub-supplier.

GOAL
- Reduce the amount of re-test at SIT.
- Implement Lessons Learnt and NCR.
- Improve the work process model for the quality system using PDCA.

ROOT CAUSE ANALYSIS
- Unable to mate HVFL1 towards Pump1 successfully. ***Why?***
- The High Voltage jumpers in HVFL snapped early in the mating. ***Why?***
- The angle between male and female connector was outside acceptance criteria. ***Why?***
- The FAT conducted on the HVFL delivered by the sub-supplier did not detect the anomaly. ***Why?***
- The PRE Engineering work process did not place enough attention on the critical interface. ***Why?***
- More focus needed in TQP on interfaces as well as core system parts.

* HVFL = High Voltage Flying Lead

PROPOSAL
- Reduce re-work by changing traditional design work practices. Not only run TQP on sub-parts being the *core* part of the system. TQP should also be brought on the interdisciplinary part of the system, the interface mechanism.
- Focus on issues like this during design can reduce the cost of extra defects discovered during testing.

PLAN

What?	Who?	When?	Where?
Notify QM regarding the issue. Improve the TQP for future projects, with focus on interdisciplinary with interfaces. Make a Lesson Learnt on the scenario to improve the work processes, allowing for the ability to reduce rework.	Project Manager shall define whom that will give a suggestion for improving the TQP and notify QM. Lessons Learnt shall be written by Test- and Design Engineer.	As soon as possible, or at least before they leave the project.	Aker Fornebu
Address early FAT on fabrication yard when sub-suppliers components are integrated to the system.	Engineering- and Mechanical Completion Manager need to coordinate for this to happen at fabrication site.	Extended FAT at fabrication site needs to take place early before SIT kicks off	Aker Egersund

FOLLOW UP
- Verify that the PDCA loop is actively used in the company.
- Ensure Lessons Learned is updated.
- Verify NCR is made (if applicable).
- Ensure continuous improvement; reduce lead time before delivery by improving quality.

Continuous improvement to reduce rework, control costs

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Pump trafo 2/HVFL#1 (Spare)	Re-test requested	16.04.2015	07.02.2015
Pump trafo 1/HVFL#2	15.04.2015	17.04.2015	22.01.2015
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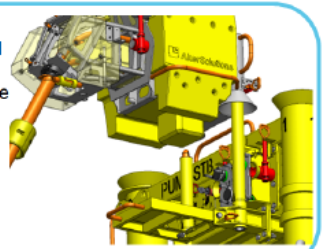

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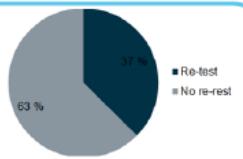

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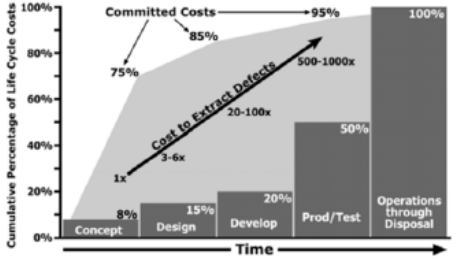

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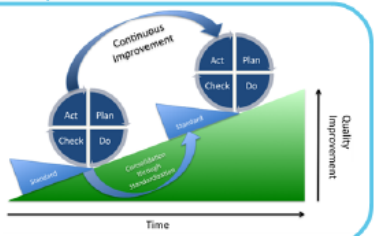
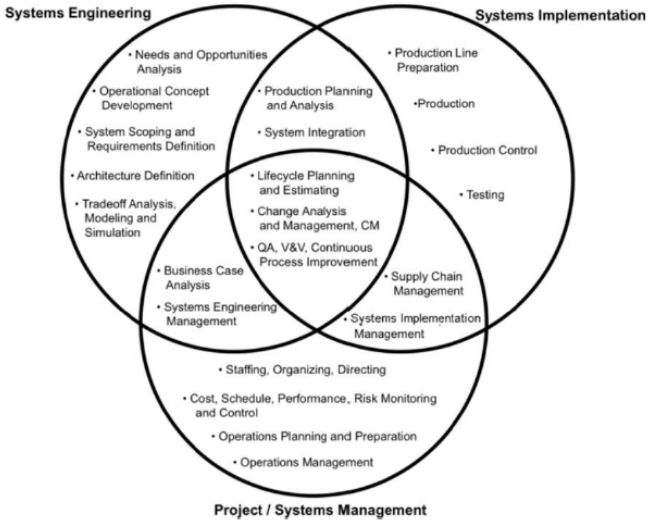


Summary

- For future customization of PEM for new product development - it is suggested that the company pays closer attention to configuration management and continuous process improvement, ref. Venn diagram.
- Also, A3 problem solving reports are suggested as SE methods that could be applied to asses future projects and improve processes.

Future research

- Systems Engineering follow up.
- More focus on the three way intersection of Venn diagram for next generation PEM “new product development”
- Implementation of SE processes to facilitate quality assurance and continuous process improvement.
- A3 problem solving technique



Questions