Concluding 8 years of research in Field Architecture (FA)

Sigbjørn Sangesland / Milan Stanko, Nov 27, 2023
Goals and objectives

Develop methods, models, technologies and alternative architectures to improve subsea field development
Research area chronologic overview

Completed and current projects


1.1 Subsea Gate Box
Postdoctoral fellow Mariana Diaz

1.1.a Superstructure optimization of field development and subsea layout
PhD student Leonardo Soares

1.1.b Superstructure optimization of field development and subsea layout
PhD student Leonardo Soares

1.1.c Enabling technology for low cost subsea field development
Postdoctoral fellow Lucas C. Sevillano

1.1.d Valves and materials - design concepts for simplifications
PhD student Mehran Radli

1.2 Field development concepts
PhD student Diana Gonzales

Innovation project

1.3 Multiphase booster models
PhD student Gilberto Nunez

1.4 Subsea field layout optimization
PhD student Haoge Liu

2.1 Compact separation
PhD student Håvard Stettahjell Skjefstad

Innovation project

2.2 Subsea bulk oil-water separation
PhD student Hamidreza Asaadian

Researcher - Abraham

Researcher - Tamires
Research area chronologic overview

Designing better subsea systems:
- Location of subsea templates and wells
- Location, type and scheduling of (processing) equipment
Research area chronologic overview

Improve early field planning
Research area chronologic overview

- Designing production and drilling schedule
- Simplified booster models
- X-mas tree re-design
- Gate valves
- Efficient flushing
- Better estimation of equalizing chemicals
- Integration of fields with renewable energy
- Better designs with CO2 injection
- Efficient oil-water pipe separation
Innovation – knowledge transfer

Completed and current projects


**1.1 Subsea Gate Box**
Postdoctoral fellow Mariana Diaz

**1.1.b Superstructure optimization of field development and subsea layout**
PhD student Leonardo Soles

**1.1.c Enabling technology for low cost subsea field development**
Postdoctoral fellow Lucas C. Sevillano

**1.1.d Valves and materials - design concepts for simplifications**
PhD student Mehran Ahmadi

**1.2 Field development concepts**
PhD student Diana Gonzales

**1.3 Multiphase booster models**
PhD student Gilberto Nunez

**1.4 Subsea field layout optimization**
PhD student Haoge Liu

**2.9 Compact separation**
PhD student Håvard Stetlahjell Skjefstad

**2.9.b Subsea bulk oil-water separation**
PhD student Hamidreza Asaadian

**Researcher - Tamires**

**Researcher - Abraham**

**White box/quick model for CO2 flow in pipelines**

- Commercial tool development (Equinor /other)
- Equinor support

«Open source» technology for oil-water separation

Working in AkerSolutions (pumping)

Tool development and implementation in commercial software (Aker Solution)

Tool development for in-house use (AkerBP) - OFFA
PD Project: The Subsea Gate Box

Postdoc: Mariana Diaz
Supervisors: Sigbjørn Sangesland
Milan Stanko

The Subsea Gate Box is a decentralized subsea processing approach.

Tailored solution of separation and boosting for each well

LEGO principle

Template that accommodate individual well modules and compartments

Retrievable individual well modules – smaller sizes, smaller intervention vessels

Honor the reservoir strategy, increasing recovery

Increase flexibility and efficiency.
Summary of activities

Specifics of project

Subsea Gate Box Concept Development and Feasibility Study

Stages

Feasibility Analysis

Technology evaluation

Concept

Design methodology

Objectives

Production Performance

Modules Equipment

Configuration Layout

Assembly Design

Scenario Screening and Optimization

Tool development and implementation - OFFA (AkerBP) with MatLab and IPM (Petex)

OFFA- OPTIMAL FLEXIBLE FIELD ARCHITECTURES
PhD project: Methods for early-phase field development

Candidate: Diana Gonzalez
Supervisor: Milan Stanko

- Develop and test a methodology to provide decision support during early field development using integrated models, optimization and quantifying uncertainty
PhD project: Multiphase boosting models

Simple *multiphase boosting models* to use in integrated modelling of subsea field solutions and production optimization.

Postdoc: Gilberto Nunez
Supervisors: Sigbjørn Sangesland Jesus de Andrade
PhD project: Subsea Field Layout Optimization to Minimize Development Cost

Haoge Liu
(PhD 2018-2022)

Supervisor: Tor Berge S. Gjersvik, NTNU
Co-supervisor: Audun Faanes, NTNU and Equinor

One-sentence description:
Given subsurface completion intervals, cost items/functions and engineering constraints, optimize the subsea field layout so that the overall development cost can be minimized.
Equinor has now awarded a software development contract with a SoW to supply a demo application with specified features.

“A first step towards commercialization”
PhD project: Methods to design subsea systems with subsea processing

How should we select the best subsea layout, considering subsea processing, uncertainties and others?

Candidate: Leonardo Sales
Advisor: Milan Stanko

Manual design to Computer-aided design

Insights about this problem
PD Project: Enabling technology for low cost subsea field development

Lucas C. Sevillano

Professors: Sigbjørn Sangesland, Tor Berge S. Gjersvik, NTNU, and Audun Faanes (NTNU / Equinor)
PhD project: Valves and materials – design concepts for simplifications

Mehman Ahmadli
(PhD 2021-2024)

Goal:
To reduce friction force and power requirements in subsea valve operations

Activities:
• Investigate alternative coating materials
• Simulation of compatibility (Thermal expansion)
• Lab testing at Sintef, WC (Tungsten Carbide) and PDC (Poly crystaline Diamond Compact)

Results:
• Replacing WC with PDC material coating decreases the total friction force by approximately 15 -16%
**Researcher Project:** Operation and design of fields with power constraints

**Researcher:** Abraham Parra  
**Supervisor:** Milan Stanko

How to integrate power from renewables with oil and gas offshore fields?

- New fields → design considerations  
- Existing fields → operational considerations

**Issues:**

- Quantify technical, economical feasibility  
- Integration of power storage (hydrogen, amonia)  
- Fluctuating production  
- Gas line-pack management
Researcher Project: Simplified model for subsea CO2 transport in pipelines

Supervisors:
Sigbjørn Sangesland
Audun Faanes
Milan Stanko

Tamires de Souza Alves da Silva

SUMMARY
• Easy-to-use tool for studying CO2 transport
• Simplest model in agreement with benchmark Software (OLGA)
2 PhD projects: Bulk oil-water separation in pipes

PhD candidates:
Håvard Skjefstad
Hamidreza Asaadian

Supervisors:
Milan Stanko
Construction of experimental facilities

New bulk oil-water pipe separator design

Performance quantification and design improvement

Develop and test control strategies

What happens when you choke and add surfactant?

Develop models for design and prediction
Effect of crude oil spiking

Separator Efficiency

Modeling for design

Tapping point drainage potential

O&W mixture rheology and dispersion

Effect of gas
Seminars - Student exchange
Brazilian Norwegian Subsea Operations Consortium (BN-SOC) Intpart
Linked to SFI Subpro and MOVE

Intpart 1, 2017 - 2020
Intpart 2, 2022 - 2024

Annual funding (RCN and SIU): NOK 1,12 mill.
Objective of the project partnership

• The main objective of the Brazilian-Norwegian Subsea Operations Consortium (2022-2024) is to continue / establish and develop a partnership within subsea operations, education, research and development.
Workshop in Rio de Janeiro, April 2017

• Subsea field development and architecture
• Safety, reliability and maintenance of subsea facilities and systems
• Subsea operations
• Process operations and process control
Workshop in Trondheim, May 2018
BN-SOC Intpart - Summer school 2019- UniCamp, Brazil

Project task:
Deep water field development
Workshop in Rio de Janeiro, November, 2022

- Subsea field development and architecture
- Safety, reliability and maintenance of subsea facilities and systems
- Subsea operations
- Process operations and process control
Workshop in Trondheim, May 2023
Way forward

SUBPRO-Zero projects (2023 – 2026)

Project Title:
• (PD) Lean designs for carbon dioxide subsea injection systems
• (PD) Design and operation of subsea oil and gas fields powered by renewable sources
THANK YOU!