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# Developing a Configure-to-Order Product in the Subsea Oil and Gas Domain

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Master thesis paper for TechnipFMC

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# Take 5 moment



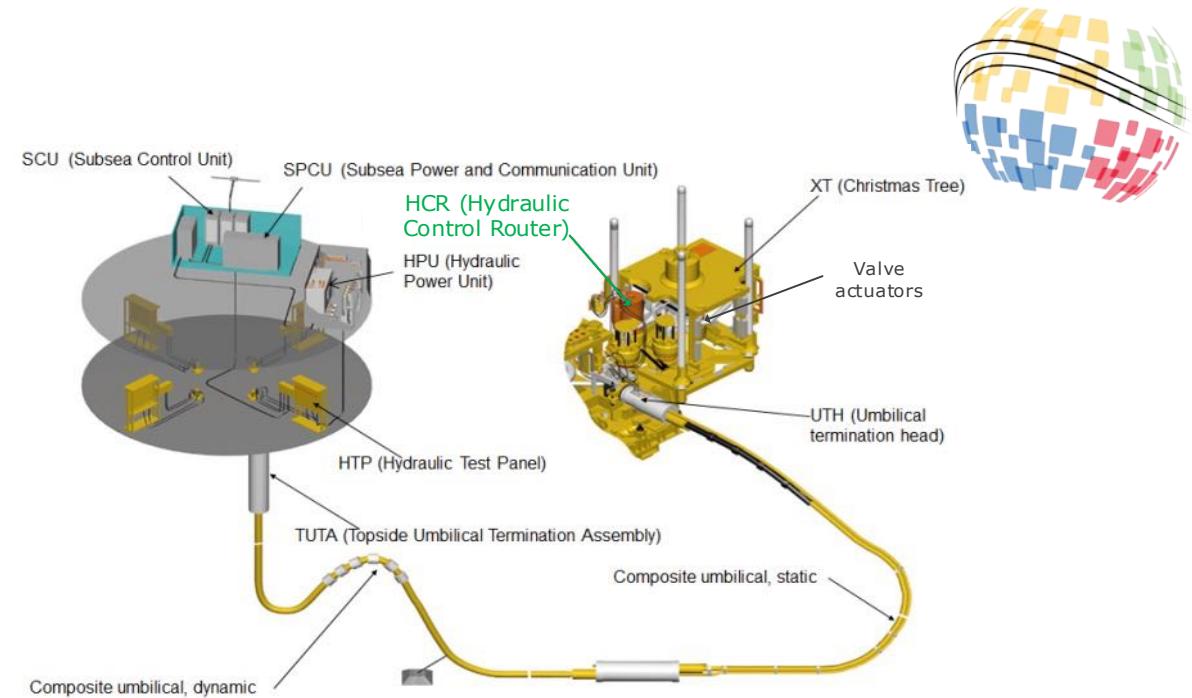


# Agenda

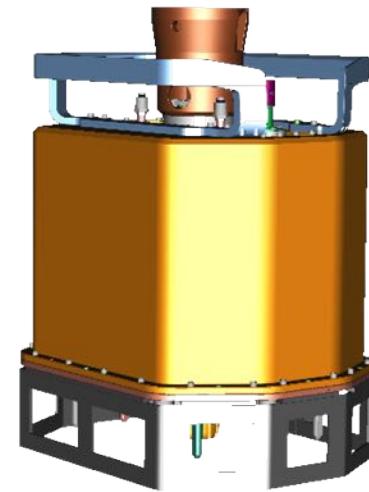
- Introduction
- Problem statement
- The theoretical approach
- Research questions
- Research methodology
- Development of the case product
- Modularity overview
- Results
- Discussion & further work
- Concluding the research questions

# Introduction

- Subsea Oil and Gas Domain as Laboratory
- Increased focus on cost and lead time in the industry
  - Allow changes in how the industry thinks and do business
- Researched the Subsea Production System
  - Subsea Hydraulic control system
  - Hydraulic Control Router
- New product development project
  - No customer have experience with the product
  - Easily affect product design
  - Project wanted to research new ways to execute projects

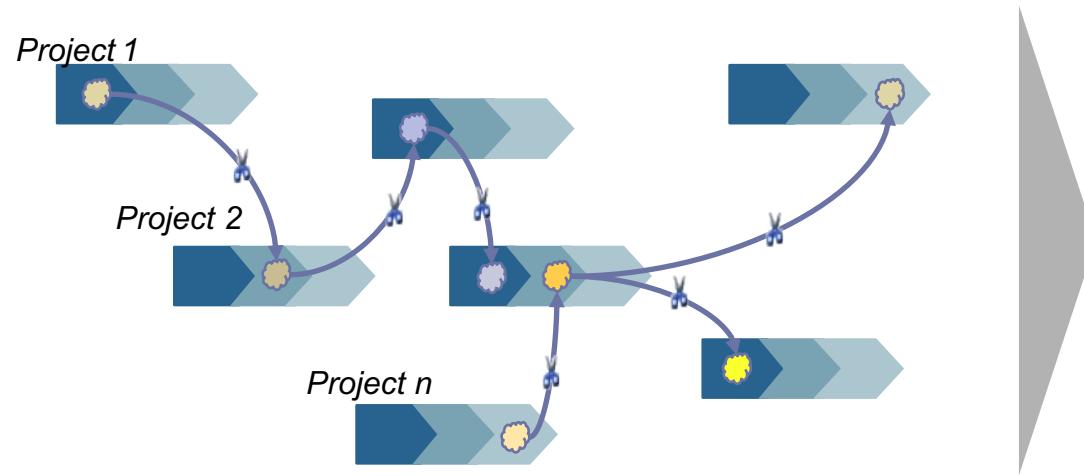


**Subsea Hydraulic Control System**



**Hydraulic Control Router**

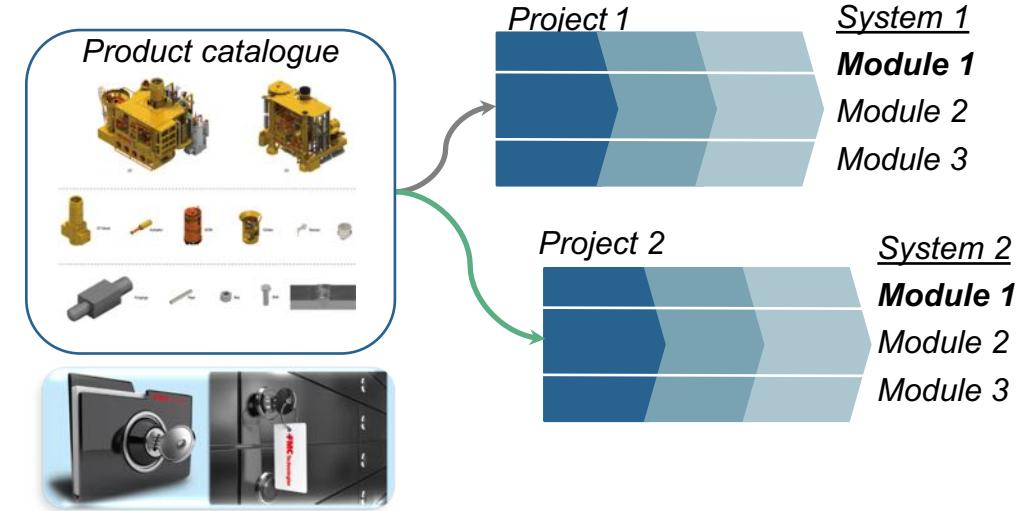
# Problem statement



## Current situation

### Engineer-to-Order strategy

- ▶ Customization and tailoring
- ▶ Detailed customer requirements
- ▶ Growing system and Product Portfolio
- ▶ Project focus



## Future situation

### Configure-to-Order strategy

- ▶ Standardization and modularization
- ▶ Functional requirements exchanges
- ▶ Controlled system and Product Portfolio
- ▶ Product focus



# The theoretical approach

## The Operational model

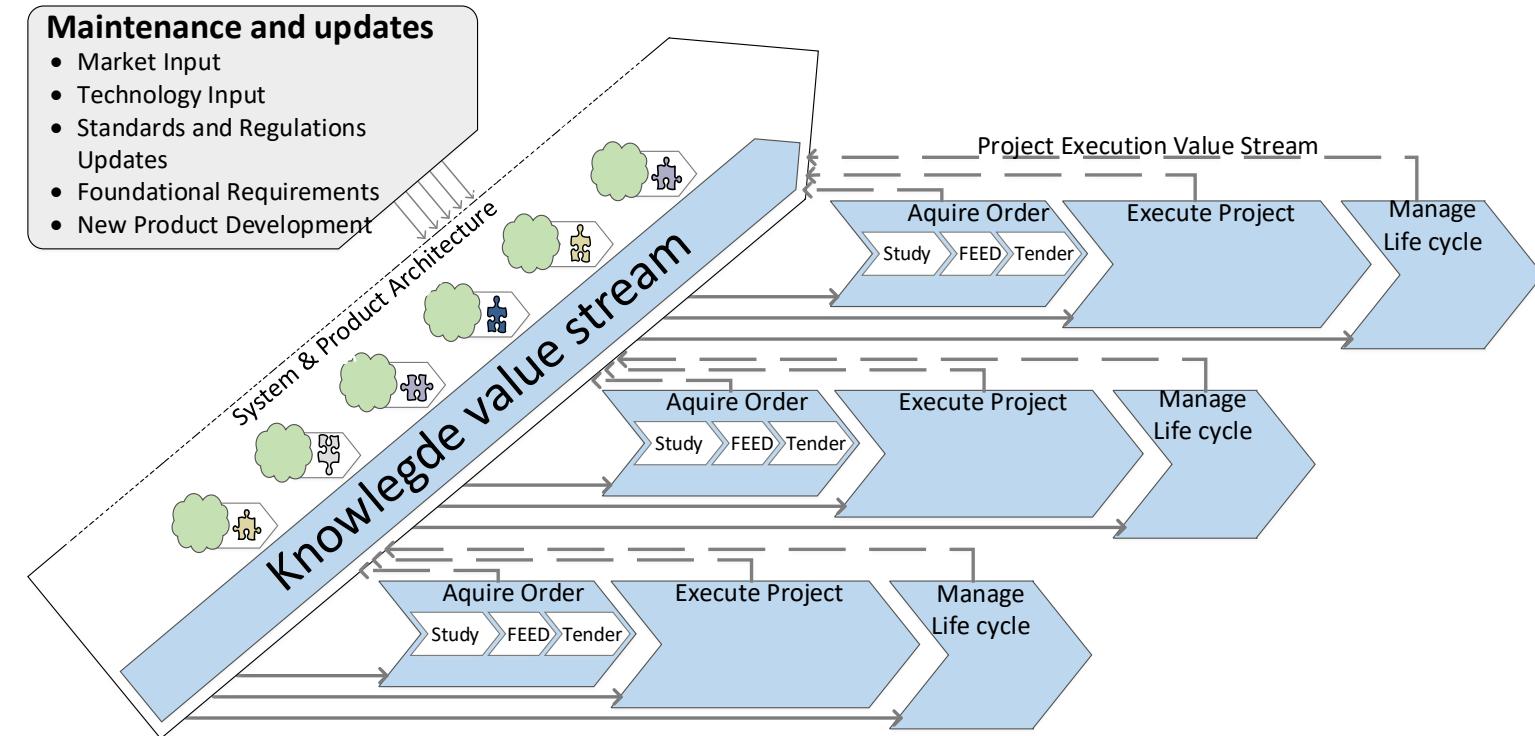
- Knowledge value stream
  - All product variance and variants
- Project execution value stream
  - Project specific variants

## Systems engineering and Systems architecture

- Requirements
- Functionalities
- Physical elements

## Modularization and standardization

- Product families
- Configurators



Fundamental model adapted from

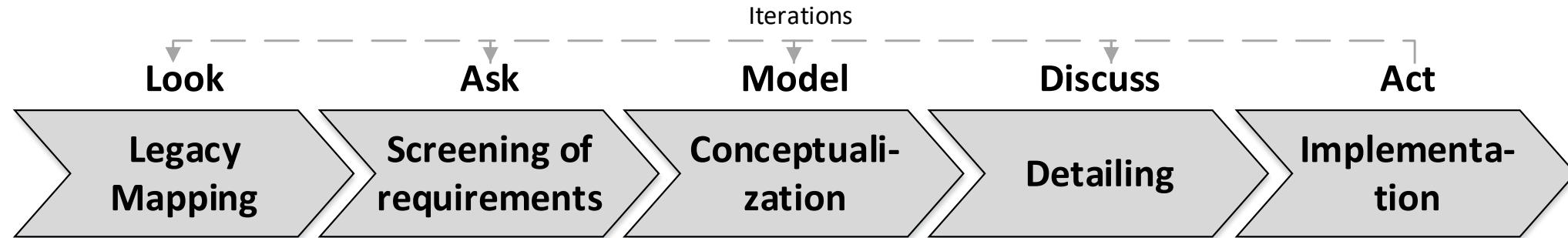
- Lean product development
- knowledge based development



# Research Questions

- How can we apply systems engineering framework and lean product development principles to create a configurable HCR?
- How does the Configure-to-Order strategy affect the HCR during design and project execution?

# Research methodology



**Step 1:**  
Analysis of the existing architecture  
Top-down and bottom-up approach

**Step 2:**  
Stakeholder interviews and requirement analysis to understand the relationships and interrelations (why)

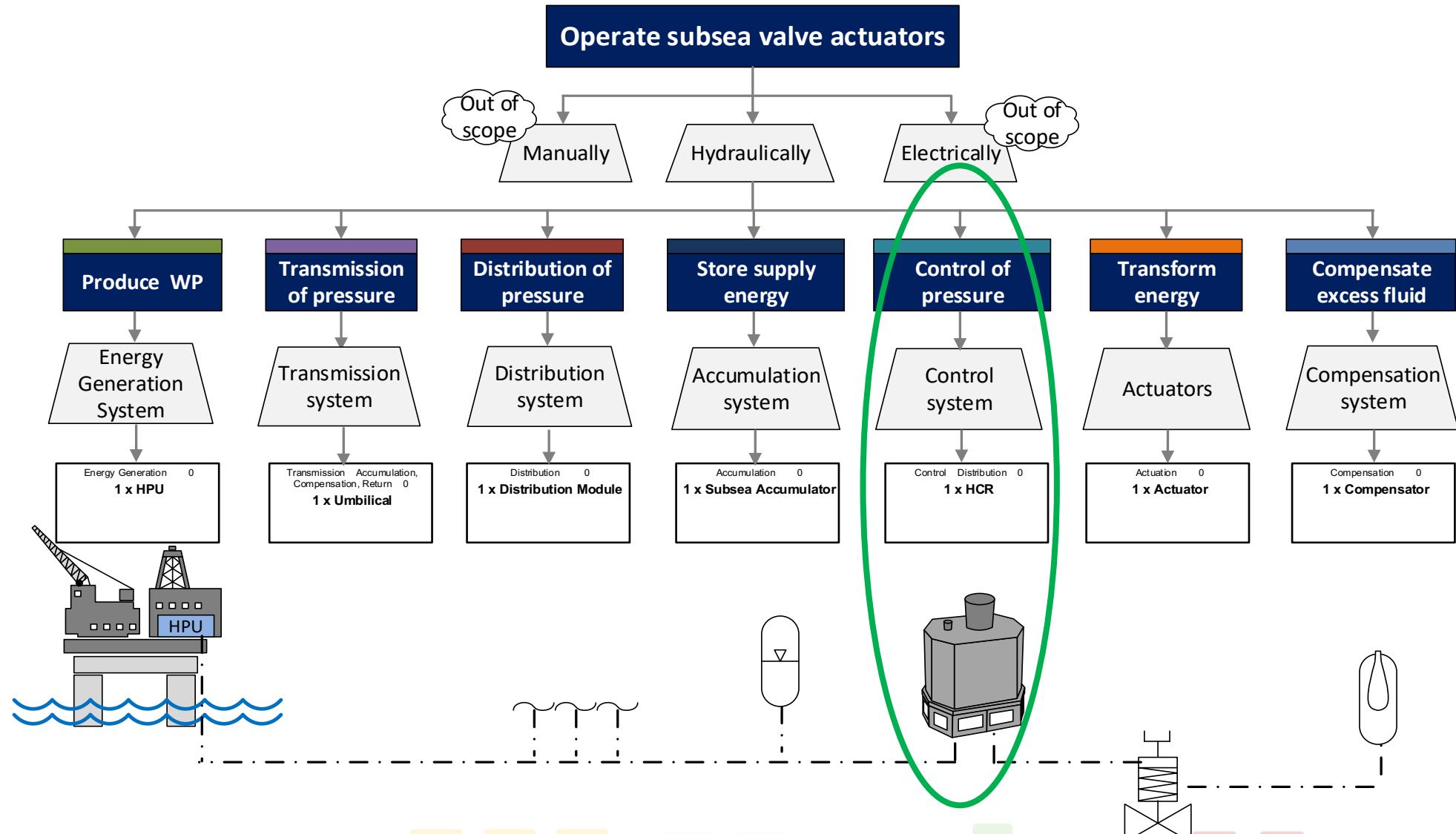
**Step 3:**  
Conceptualization of modular product design showing interactions by visual means

**Step 4:**  
Consult with experts and perform design reviews to create a configurator based on the functional needs or findings

**Step 5:**  
Implementing of the modular product.  
Createing a updated process for how to configure and produce the product

- **LAMDA**
- Understand functional requirements
- Create a modular product
- Establish a configuration process
- **Validation**
- Design reviews during product development
- Semi-structured interviews
- **Analysis of a reference project documentation**
- Documentation types
- Revisions
- Hours
- Effects of the CTO strategy

# Development of the case product



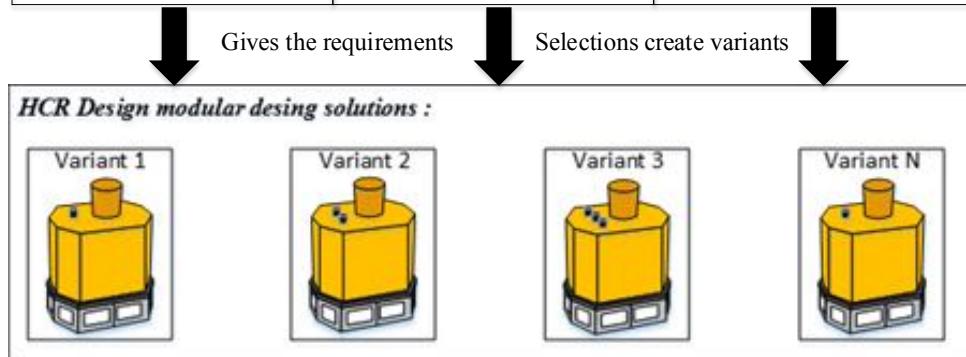
# HCR modularity overview



- Customer drivers
- System selection
- Hydraulic control system selections
- HCR design sections

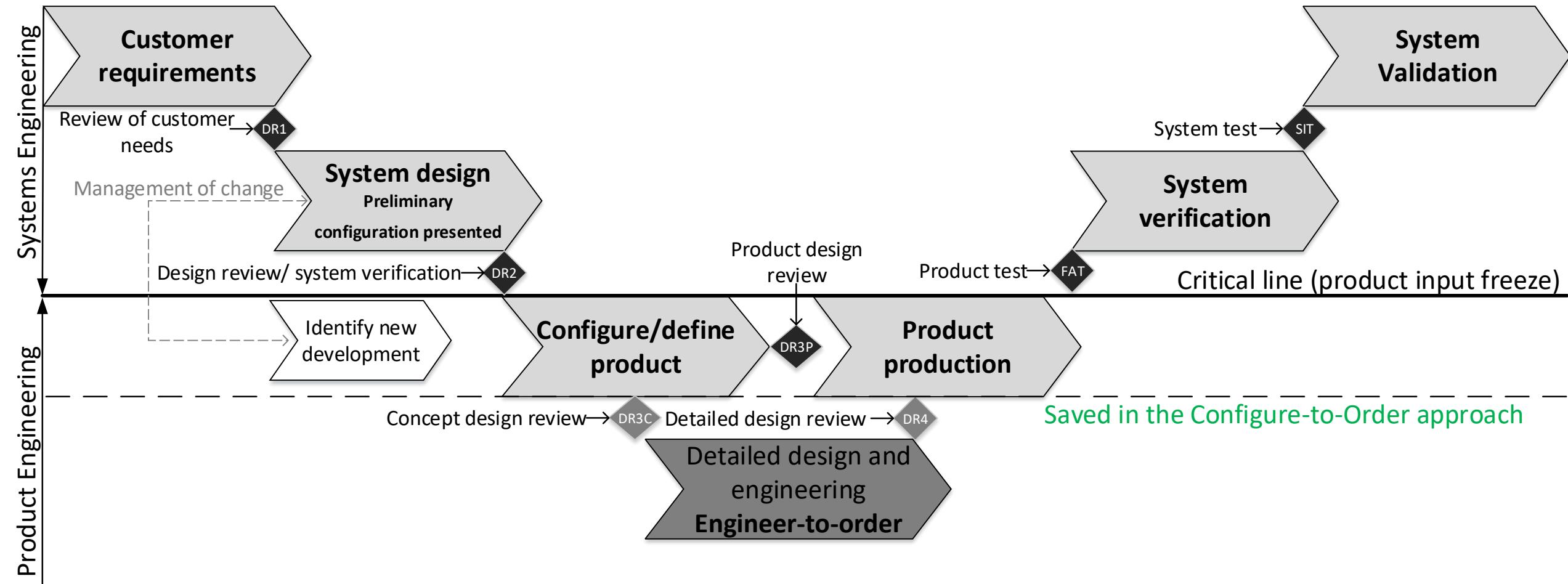
Configure based on  
**FUNCTIONALITY!**

<b>Customer main drivers:</b> <ul style="list-style-type: none"><li>• Safety &amp; sustainability</li><li>• Government regulations</li></ul>	<ul style="list-style-type: none"><li>• Overall System Performance:<ul style="list-style-type: none"><li>• Productivity/capacity and uptime = increased revenue</li><li>• Total cost of ownership</li></ul></li></ul>	
<b>SPS design parameters:</b> <ul style="list-style-type: none"><li>Reservoir:<ul style="list-style-type: none"><li>• Pressure</li><li>• Temperature</li><li>• Reference depth</li><li>• Topology</li><li>• Fluid type</li><li>• Composition</li></ul></li><li>Environment &amp; location:<ul style="list-style-type: none"><li>• Seabed</li><li>• Water depth</li><li>• Step out length</li><li>• Existing infrastructure</li><li>• Location</li><li>• Climate</li></ul></li><li>Capabilities:<ul style="list-style-type: none"><li>• Number of wells</li><li>• Enhanced recovery (gas lift, boosting etc.)</li><li>• Reliability</li><li>• Maintainability</li><li>• Life time</li></ul></li></ul>	<b>Hydraulic control system design selections:</b> <ul style="list-style-type: none"><li>Parameter 1:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li><li><input type="checkbox"/> Option 3</li><li><input type="checkbox"/> Option 4</li></ul></li><li>Parameter 2:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li><li><input type="checkbox"/> Option 3</li></ul></li><li>Parameter 3:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li></ul></li><li>Parameter 4:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li><li><input type="checkbox"/> Option 3</li><li><input type="checkbox"/> Option 4</li><li><input type="checkbox"/> Option 5</li></ul></li></ul>	<b>HM Design selections:</b> <ul style="list-style-type: none"><li>Parameter 1:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li><li><input type="checkbox"/> Option 3</li><li><input type="checkbox"/> Option 4</li></ul></li><li>Parameter 2:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li><li><input type="checkbox"/> Option 3</li></ul></li><li>Parameter 3:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li></ul></li><li>Parameter 4:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 1</li><li><input type="checkbox"/> Option 2</li><li><input type="checkbox"/> Option 3</li></ul></li><li>Parameter 5:<ul style="list-style-type: none"><li><input type="checkbox"/> Option 4</li><li><input type="checkbox"/> Option 5</li></ul></li></ul>





# Configuration process



# Results



## Qualitative data from ten interviews

### Benefits and reasons for CTO

- ▶ Pre-engineered solutions
- ▶ Synergy effects
  - ▶ Product specific
  - ▶ Other products
- ▶ Automated processes

### Challenges for CTO

- ▶ Implementation in the company and industry, e.g. Must change way of working

## Data gathered during development

- ▶ Customer liked the idea
- ▶ Using functional requirements to configure
- ▶ Impacts product design
- ▶ Correct interpretation of requirements

## Quantitative data from a reference project analysis

- ▶ 92% reduction in documentation hours
- ▶ From between 1 and 7 revisions per document to 1 revision
- ▶ Based on creating 14 configurable templates and 9 standard documents

Total of 23 required documents for the HM	
<b>Reference project documentation</b>	<b>Configure-to-order documentation</b>
<b>300 hours to A revision</b>	<b>Estimated 25 hours to A revision</b>
Documents made from:	Documents made from:
Master templates	Configurable templates
	
Scratch	Standard documents
14 documents	9 documents
<b>56 document revisions</b>	
Estimated 92 % reduction hours used to create documents for the HM	

# Discussion and further work



- The oil and gas industry is not solving a “new” problem during their projects
  - However, performance and capabilities are changing
- New way of working in the industry
  - Culture change to become successful
  - Execute projects differently and engineer products
- Customazation versus Modularization
- The Configure-to-Order strategy on piloted in a project
  - Quantifiable data
- Research other products in the subsea oil and gas domain
- Establish a digital platform
  - Model Based Systems Engineering
  - Configurators



# Concluding research question 1



*RQ1: How can we apply systems engineering framework and lean product development principles to create a configurable HCR?*

- Adapted the LAMDA process from Lean Product Development worked well
- Combining systems architecture together with the knowledge value stream
- Using the Systems engineering framework and the “Vee” model in the Configure-to-Order strategy



# Concluding research question 2



## Indication of Cost and lead time reduction on the HCR

- ▶ Pre-engineered components
- ▶ Fewer component variants
- ▶ Efficient engineering processes because of reuse



## Requirements

- ▶ Fewer requirements exchanges
- ▶ Functional requirements for product configuration



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