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Application of a Systems Engineering Framework to the Subsea Front End Engineering study

TechnipFMC

USN University of South-Eastern Norway

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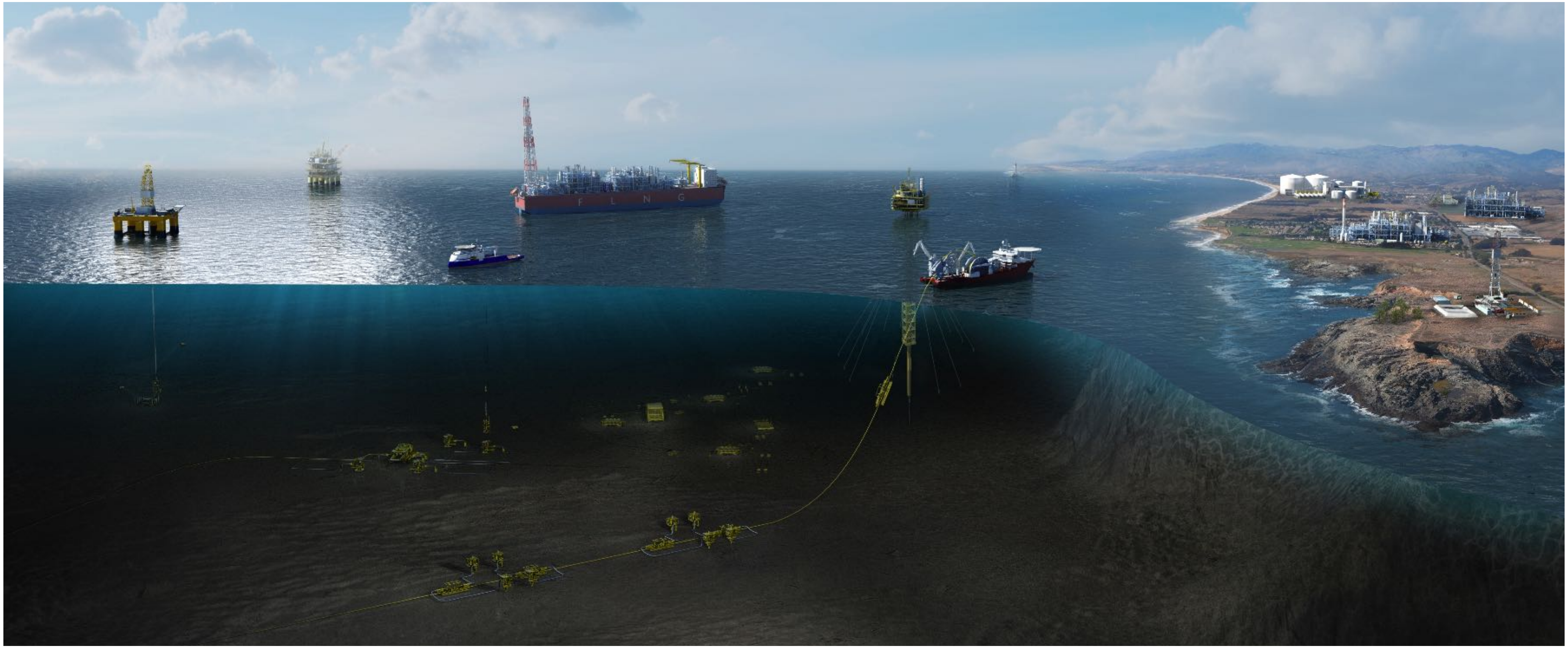
“How can we improve the field development study process by applying a more formal system engineering framework?”

Field development



Subsea field layout

Manifold

Pressure containing intelligent well

Well barrier

Collect flow

Control flow

Distribution

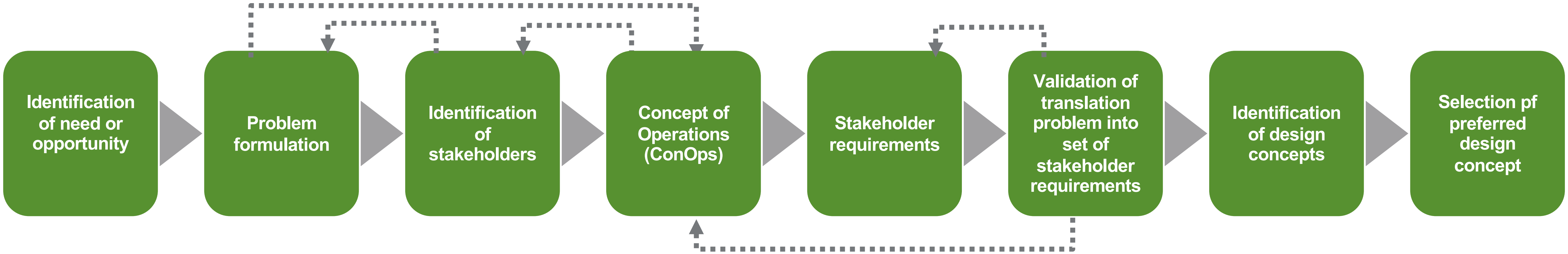
Company process for front end studies

Identify customer needs and requirements → Populate evaluation criteria and weights → Develop system solutions → Evaluate system solutions → Verify solution towards needs and requirements

Review of study reports
- Client is the only stakeholder
- Client ask for solution, not concept
- No standard for documenting the study

Interviews
- Clients asking for concept
- Integrated contracts
- Shorter time span

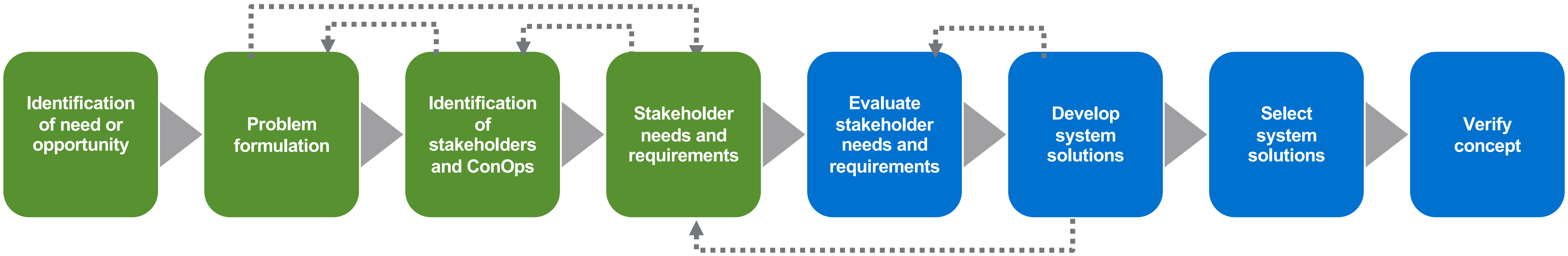
Sols System Engineering Framework



Findings

- Identification of stakeholder and stakeholder needs
- Iteration between the steps

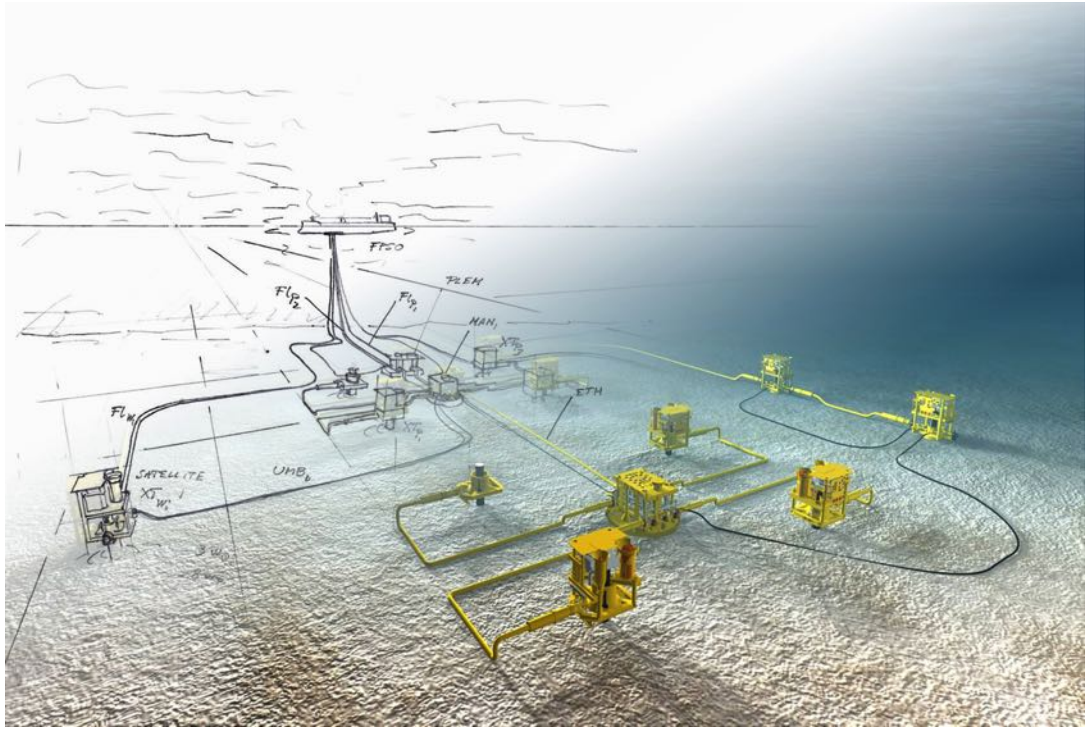
New framework for front end studies



Improvements
- Initial activities from Sols framework
- Increased focus on identification of stakeholder and stakeholder needs

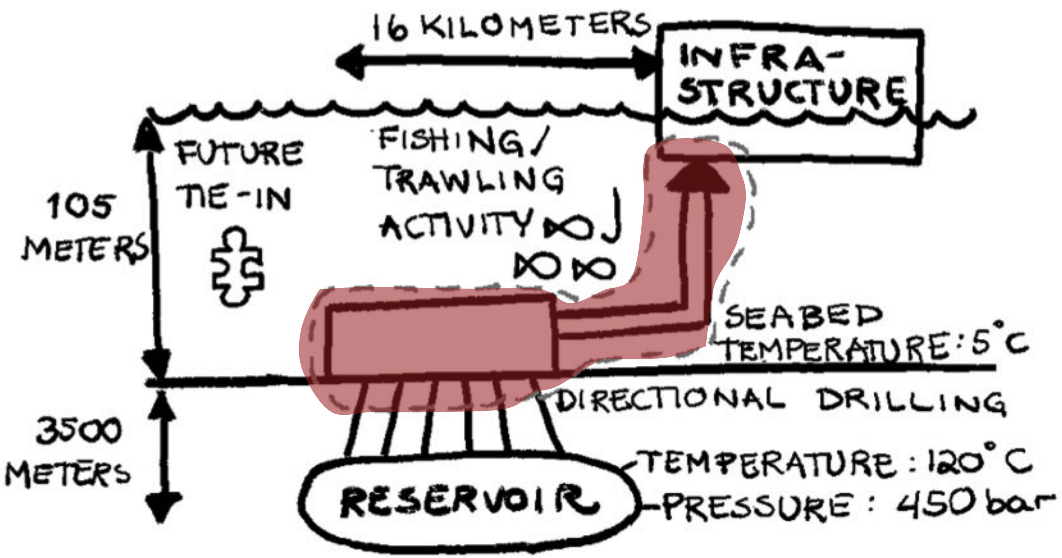
Case study – The Donald Field

Perform a field development study for the Donald field located in the Norwegian Sea.



Identification of need or opportunity → Problem formulation → Identification of stakeholders and ConOps → Stakeholder needs and requirements → Evaluate stakeholder needs and requirements → Develop system solutions → Select system solutions → Verify concept

Problem formulation



PRODUCTION RATE:

OIL: 3386 sm³/d

GAS: 1800 ksm³/d

NUMBER OF WELLS:

3 x OIL PRODUCERS

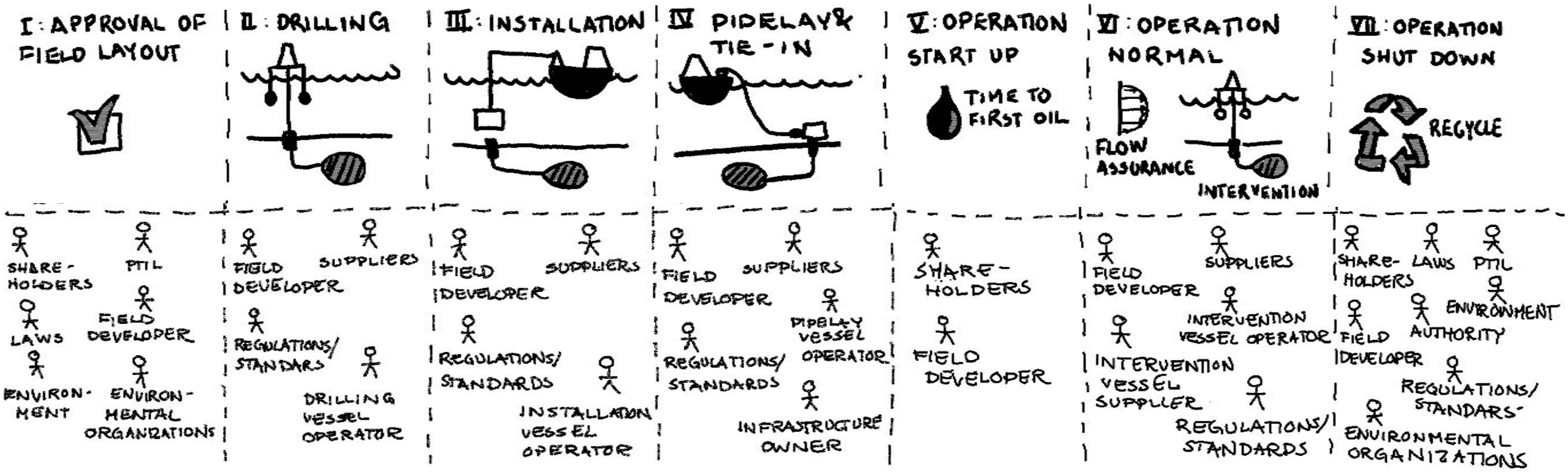
2 x GAS PRODUCERS

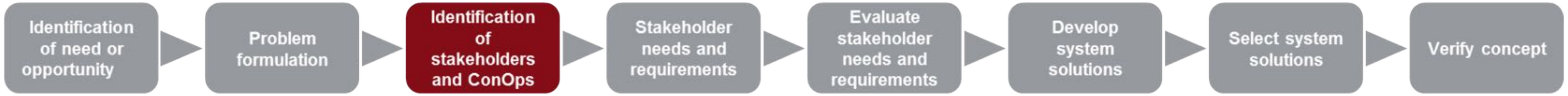
2 x WATER INJECTIONS

? Bring oil and gas from the reservoir to the infrastructure with an efficient and low-cost system solution

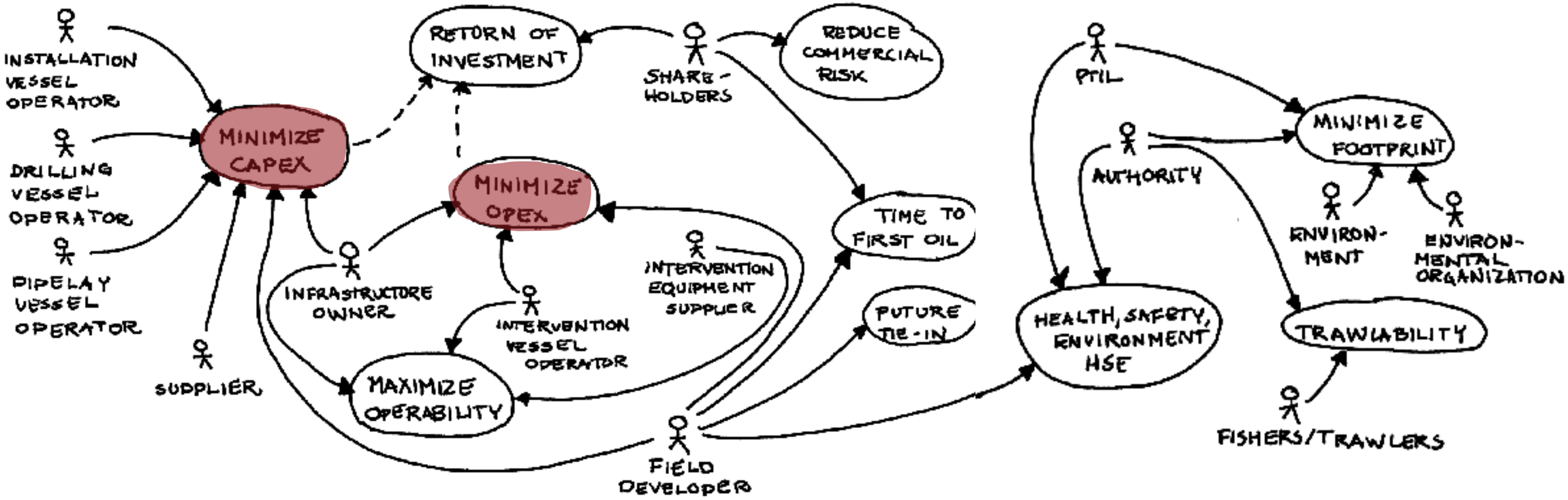
Identification of need or opportunity ▶ **Problem formulation** ▶ Identification of stakeholders and ConOps ▶ Stakeholder needs and requirements ▶ Evaluate stakeholder needs and requirements ▶ Develop system solutions ▶ Select system solutions ▶ Verify concept

Identify stakeholders and ConOps





Stakeholder needs

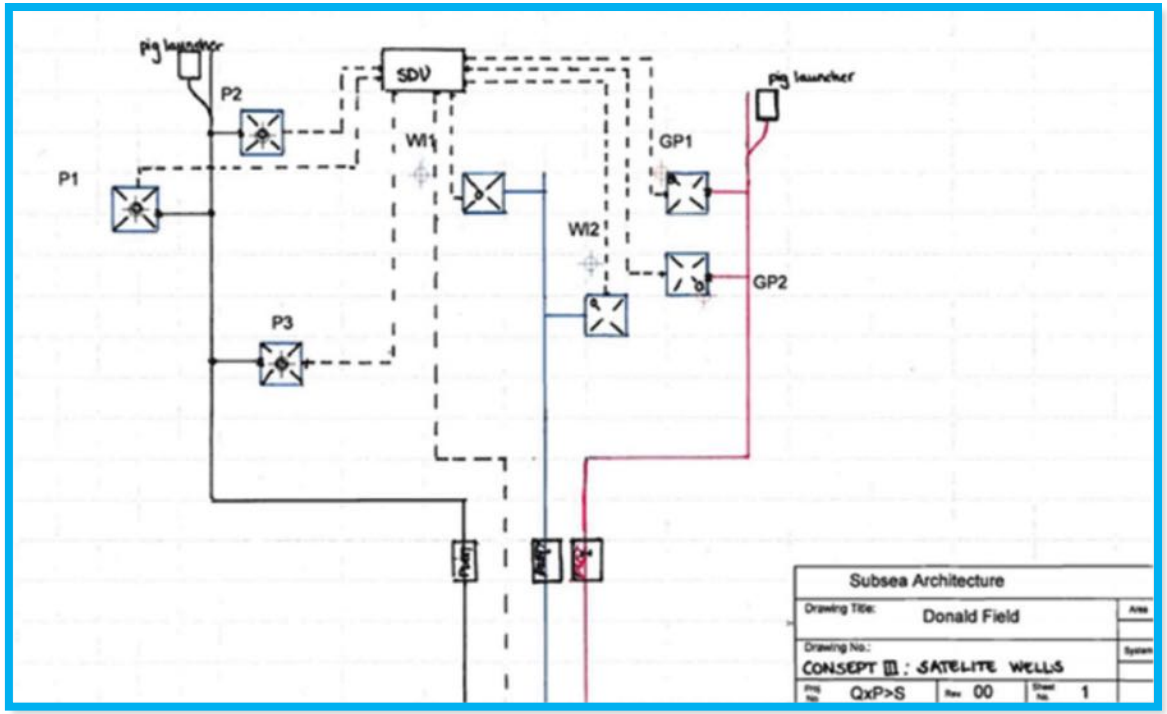


Identification of need or opportunity ▶ Problem formulation ▶ Identification of stakeholders and ConOps ▶ **Stakeholder needs and requirements** ▶ Evaluate stakeholder needs and requirements ▶ Develop system solutions ▶ Select system solutions ▶ Verify concept

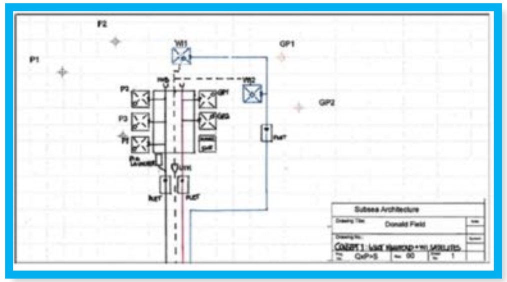
Evaluate stakeholder needs

Criteria		Weight
Minimize CAPEX	Cost of equipment	5
	Cost of drilling	3
	Cost of installation of equimpent	3
	Cost of installation of pipelies	3
	Cost of tie in and connection	1
Minimize OPEX	Cost of operations	5
	Cost of intervention operations	1
Maximize operability	Flow assurance	3
	Pigging	3
Time to first oil	Phased development	5
Commercial risk	Technology readness level	3
HSE		5
Minimize footprint		1
Owertrawability		1
Future tie in		3

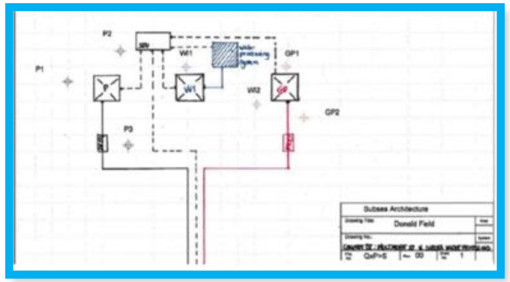
Develop system solutions



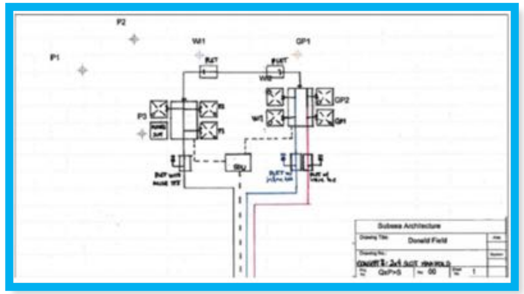
Concept III: Satellite wells



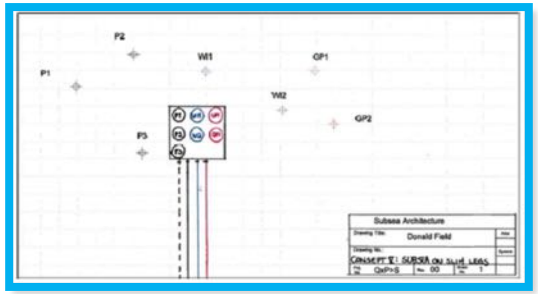
Concept I



Concept IV



Concept II



Concept V

Identification of need or opportunity → Problem formulation → Identification of stakeholders and ConOps → Stakeholder needs and requirements → Evaluate stakeholder needs and requirements → **Develop system solutions** → Select system solutions → Verify concept

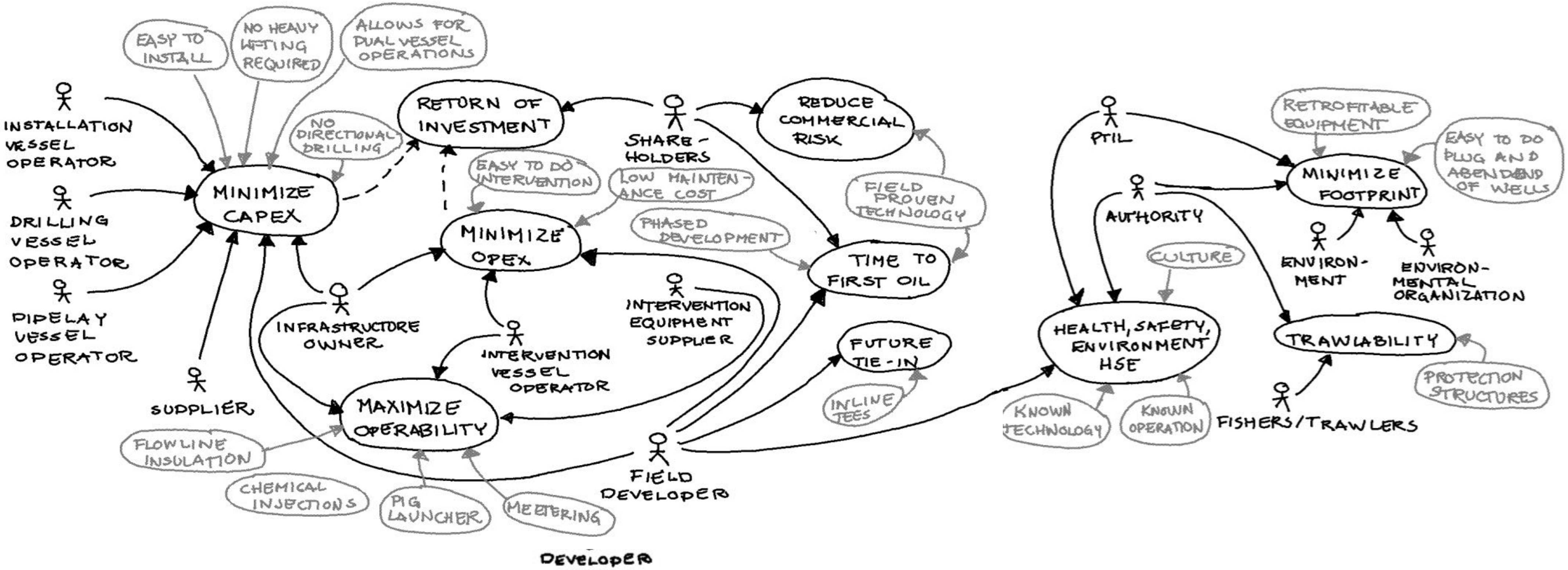
Select system solution

Criteria		Weight	Concept 1 6 slot + 2 x WI	Concept II 2 x 4 slot	Concept III Satellites	Concept IV Multibore XT	Concept V Slim leg
Minimize CAPEX	Cost of equipment	5	S	S	-S	+S	S
	Cost of drilling	3	S	S	-S	S	+S
Minimize OPEX							
Maximize operability							
Time to first oil							
Commercial risk							
HSE							
Minimize footprint							
Owertrawability							
Future tie in							
Weighted sum of +S							
Weighted sum of -S							
Total weighted sum							

Equipment	Cost factor	Concept 1 6 slot + 2 x WI	Concept II 2 x 4 slot	Concept III Satellites	Concept IV Multibore XT	Concept V Slim leg
Wellhead	2	7	7	7	7	7
XT	3	7	7	7		7
6 slot maifold with template	6	1				
4 slot maifold with template	4		2			
Overtrawability structure	1	3	2	7	3	
PLET	1	3	5	3	2	3
Inline Tee	2	2	2	7		
UTH	1	1				
SDU	1		1	1	1	
Pig Launcher	2	1		2		
Multibore XT	4				3	
Subsea water processing system	4				1	
Platform	10					1
Total cost factor		**54**	**55**	**64**	**36**	**48**

1. Identification of need or opportunity
2. Problem formulation
3. Identification of stakeholders and ConOps
4. Stakeholder needs and requirements
5. Evaluate stakeholder needs and requirements
6. Develop system solutions
7. **Select system solutions**
8. Verify concept

Verify concept



Identification of need or opportunity → Problem formulation → Identification of stakeholders and ConOps → Stakeholder needs and requirements → Evaluate stakeholder needs and requirements → Develop system solutions → Select system solutions → **Verify concept**

Conclusion

Change in industry requires increased focus on identification of stakeholder and stakeholder needs

A **new framework** for front end study based on current process and Sols System Engineering Framework

Need for improvement of the way of **documenting decisions** in the front end studies

Use of **unformal models** to document the rationale behind the decisions done

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