Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment

Webinar ETIP Ocean

Structured Innovation tool

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Energy Systems Catapult
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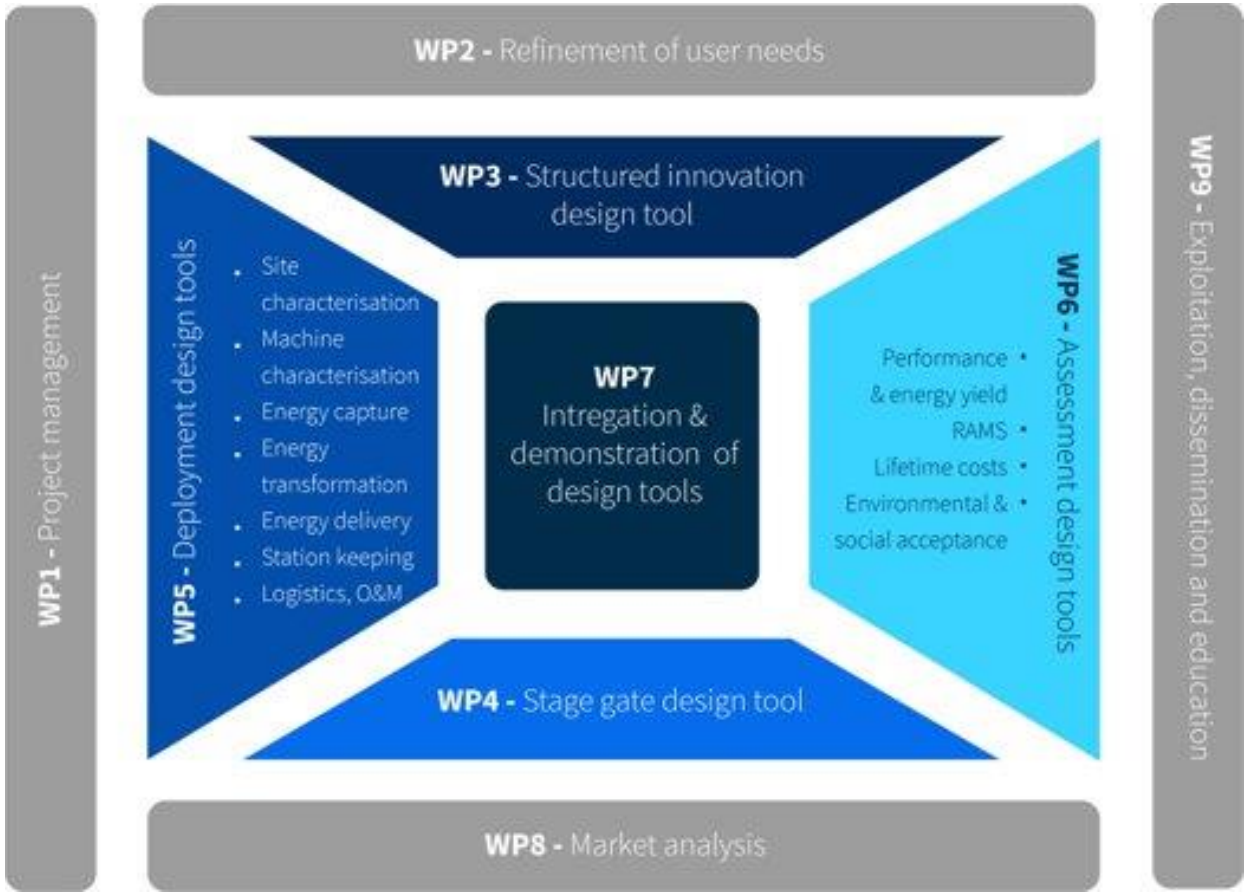
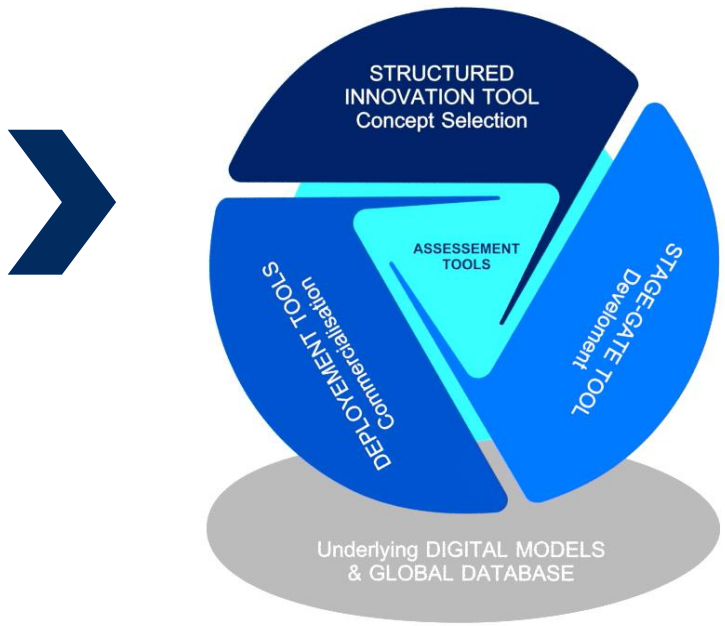
Contents

1. DTOceanPlus: Motivation (I)

- To support the **entire technology innovation process**, from concept to deployment.
- To propose advanced design tools for **sub-systems**, **energy capture** devices and **arrays**.
- To bring tools to TRL6 by **demonstration scenarios in real world cases**.
- To make **freely available** tools as **open source** to the entire ocean energy sector.
- To develop an integrated suite of tools that will be a **professional user-friendly product**.

1. DTOceanPlus: Structure (II)

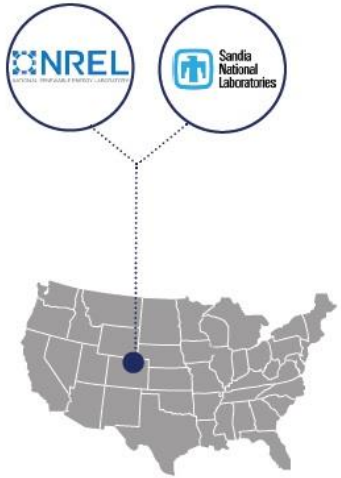




1. DTOceanPlus: Collaboration (III)

- A 3-year EU project (May 2018 - April 2021) with a total budget of **8 M€**.

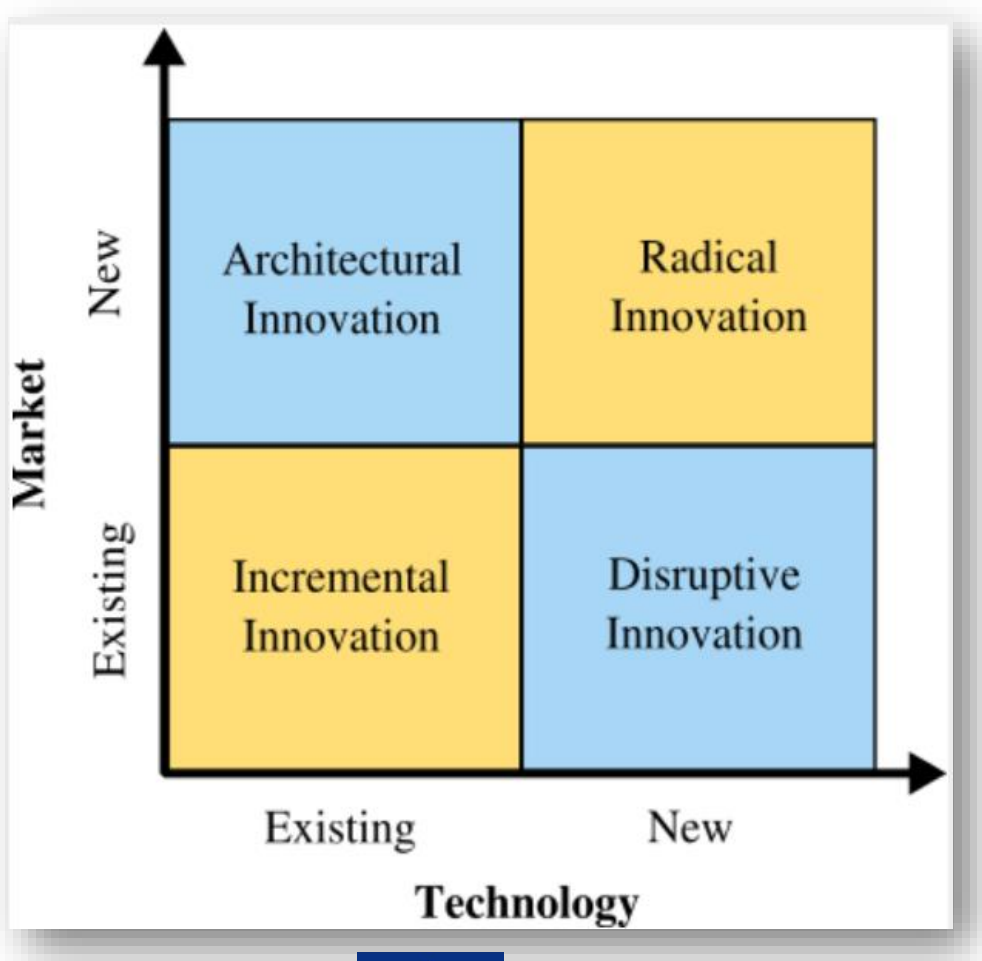
- **Multidisciplinary team** of 16 partners from 7 EU countries, with the collaboration of 2 leading research laboratories from the USA.



2. Innovation approaches (I)

Common approaches

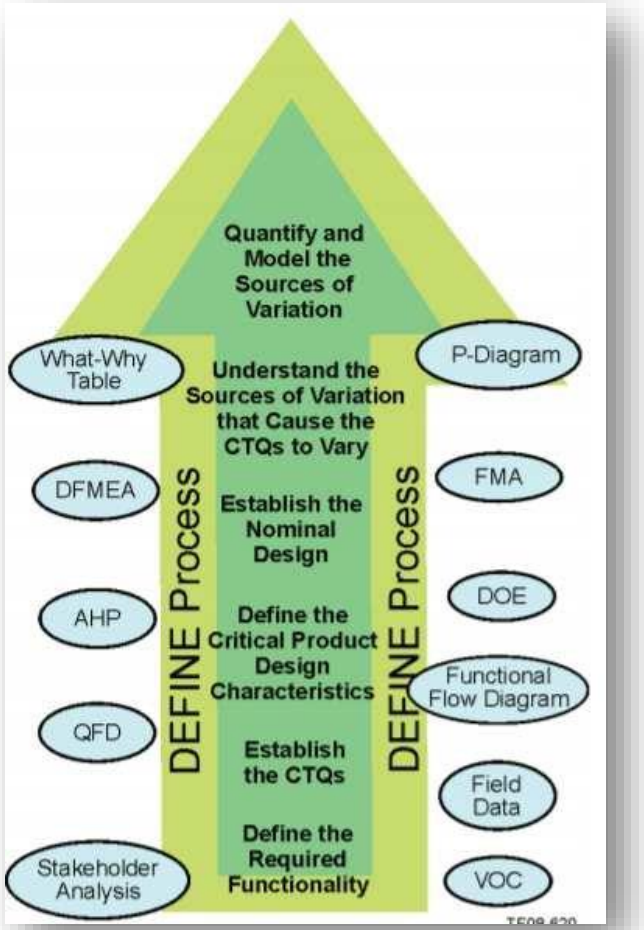
- Incremental or Sustainable
- Disruptive
- New Markets/ Open innovation
- Radical approaches



2. Innovation approaches (II)

Automotive sector

- Design for Six Sigma
- Requirement capture & management
- Design Characterise Optimise Verify
- Enhanced customer integration tool
- QFD & DFMEA application

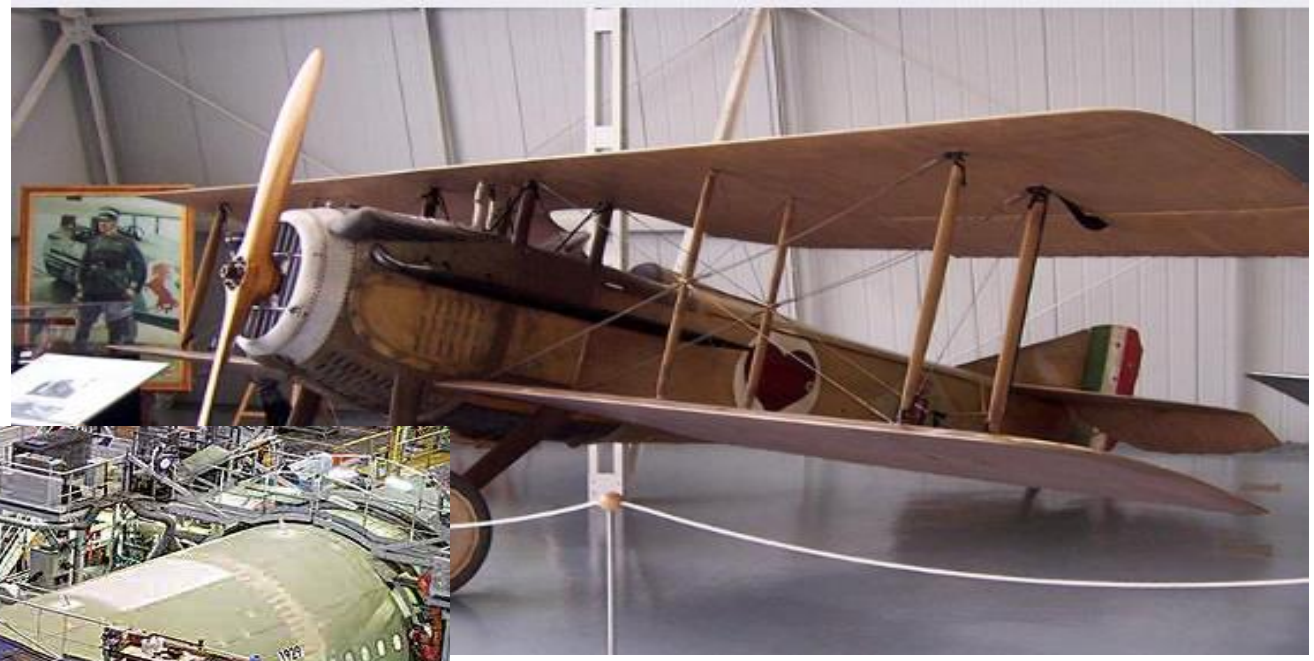


Courtesy of Rolls Royce

2. Innovation approaches (III)

Aerospace

- Incremental approach
- Disruptive innovation
- QFD & TRIZ approach
- System implementation

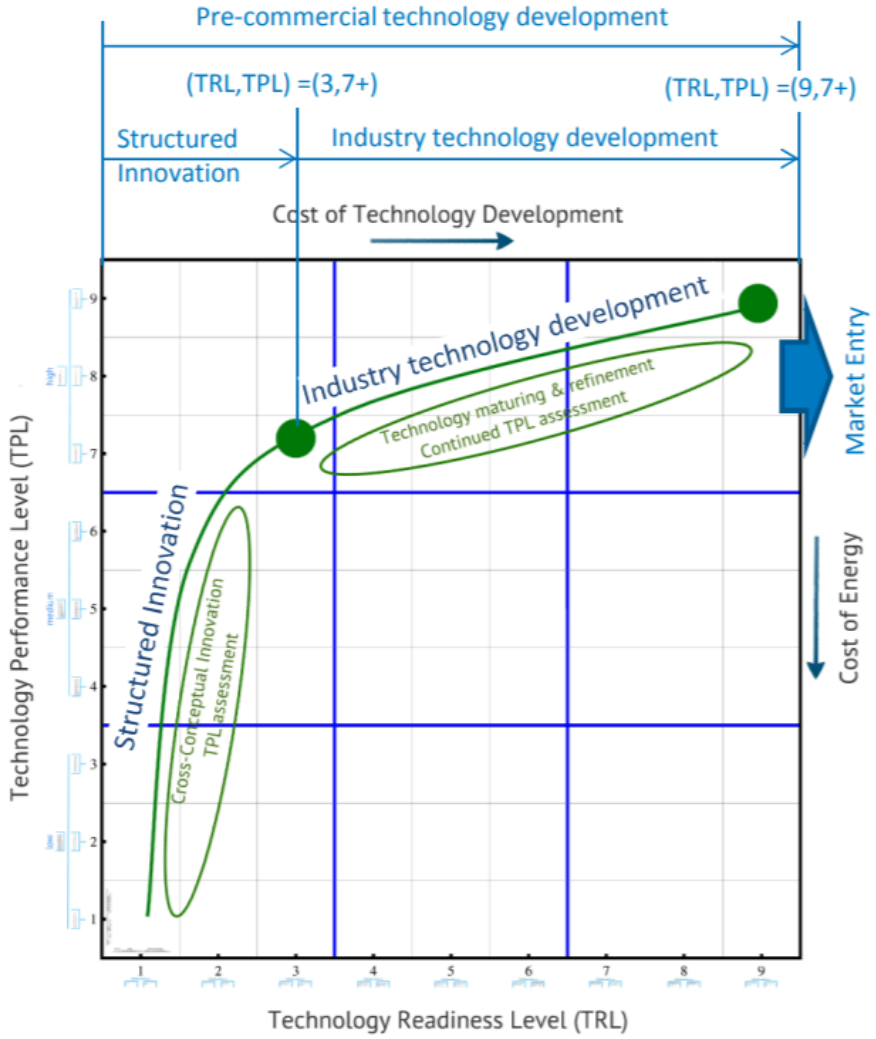


2. Innovation approach in the sector (IV)

Energy Sector

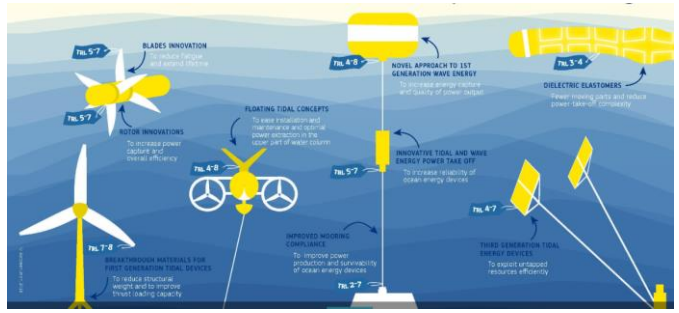
- Wind sector
  - Disruptive - Additive manufacturing
  - GE- Novel electric drive systems
  - Adoption of QFD & Cost analysis

- Ocean Energy Sector
  - NREL, Sandia Lab- from intuitive invention
  - WES Structured approach



2. Innovation approaches in the sector (V)

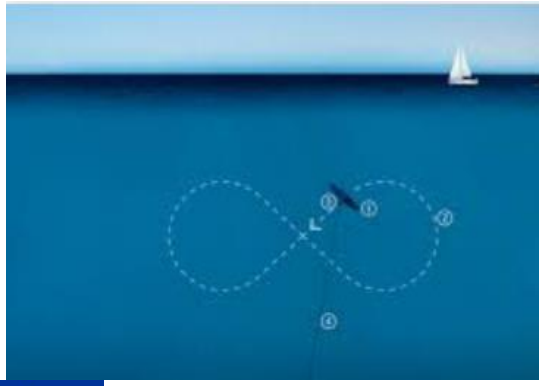
DTOceanPlus-Motivation and objectives



- Lack of a **standard structured innovative process** for Ocean Energy technologies:
  - Makes it difficult to impartially analyse innovative designs.
  - Renders impossible to objectively compare competing technologies.
  - Can lead to functional fixedness

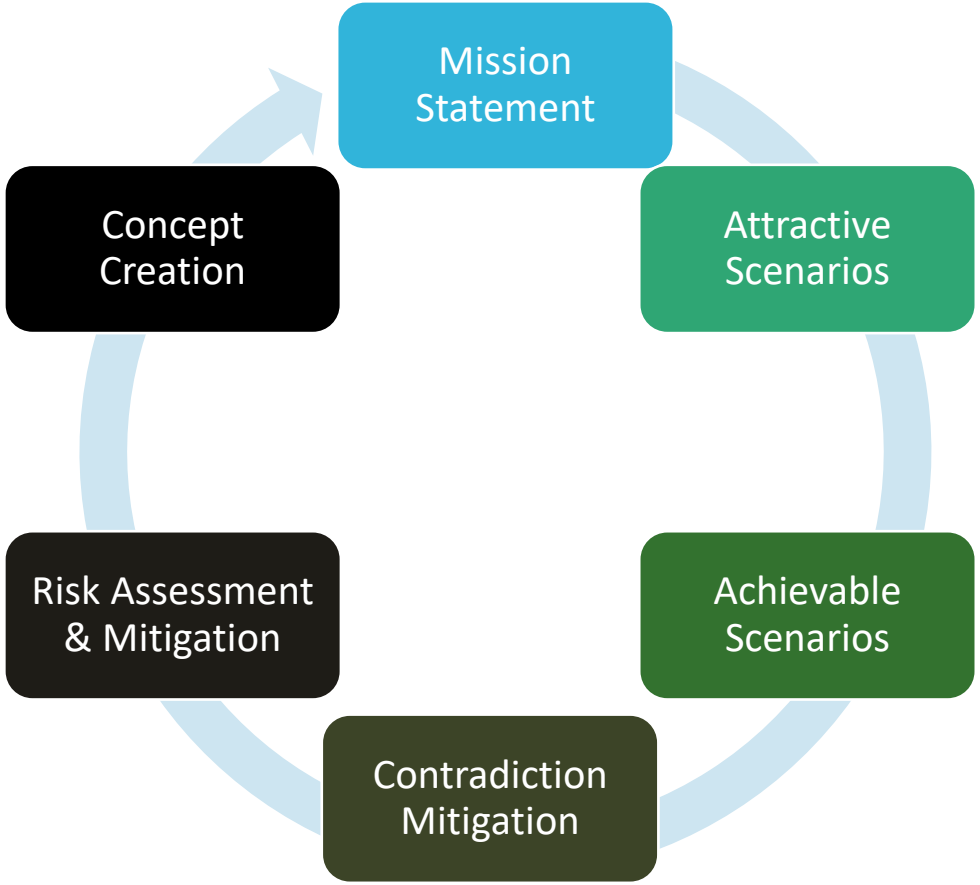
?

- The **Structured Innovation tool** aims to:
  - Provoke innovation and help represent the voice of the customer
  - Allow the design to understand the art-of-the possible for concept targets
  - Enable objective comparisons between various technologies.
  - Enhance systematic thinking for design beyond the current state-of-the-art.
  - Create new or improve concepts

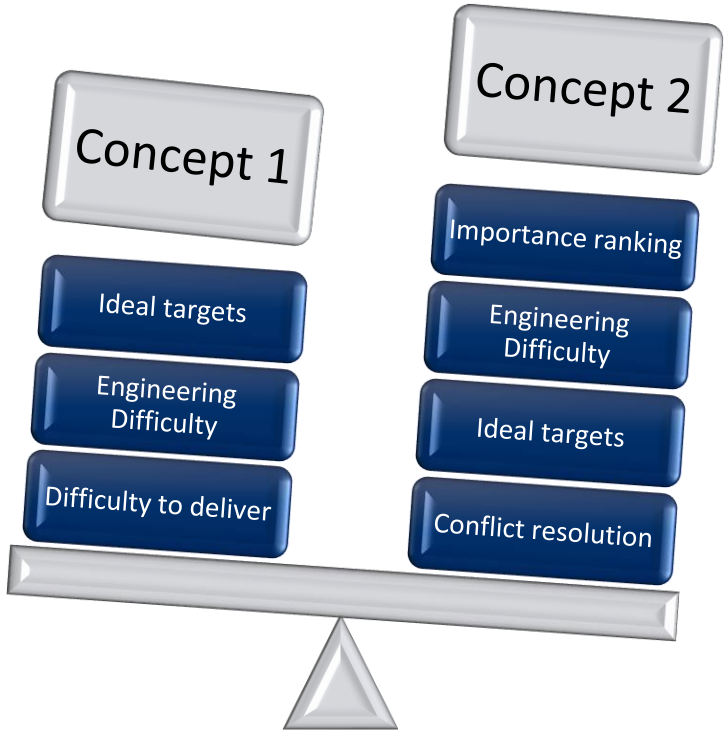


3. DTOcean+ Structured Innovation tool (I)

DTOcean+ Structured Innovation tool



3. DTOcean+ Structured Innovation tool (II)



Who benefits from it?

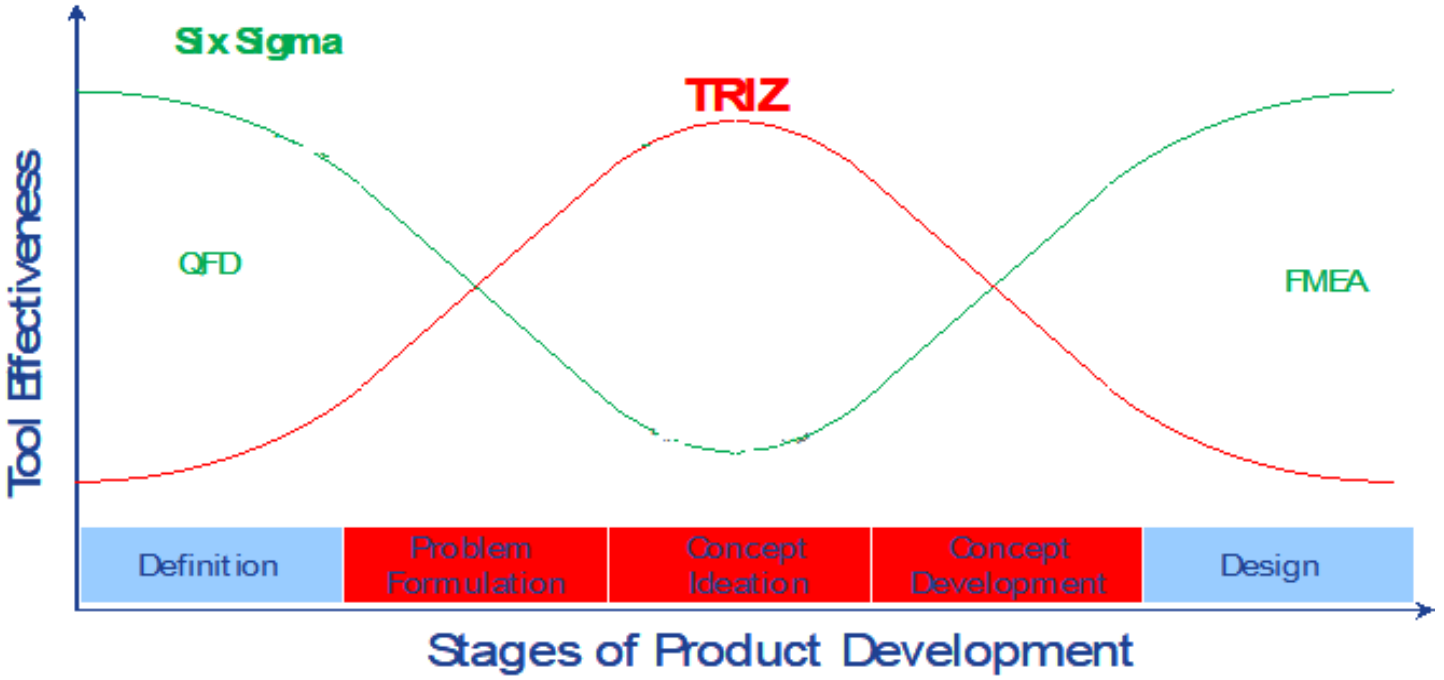
- Technology developers ~ to create/ assess areas of improvement and technical challenges
- Funders & Investors~ to identify attractive areas of innovation for investment
- Innovators & Developers~ to assess novelty in technology at any level of aggregation

3. DTOcean+ Structured Innovation tool (III)

Innovation at the heart of concept creation, using QFD, TRIZ and FMEA

- Captures and prioritises requirements
- Assesses solutions for impact
- Provides problem solving for contradictions
- Encourages risk assessment and mitigation
- Gives development direction and impact
- Improve commercial acceptability

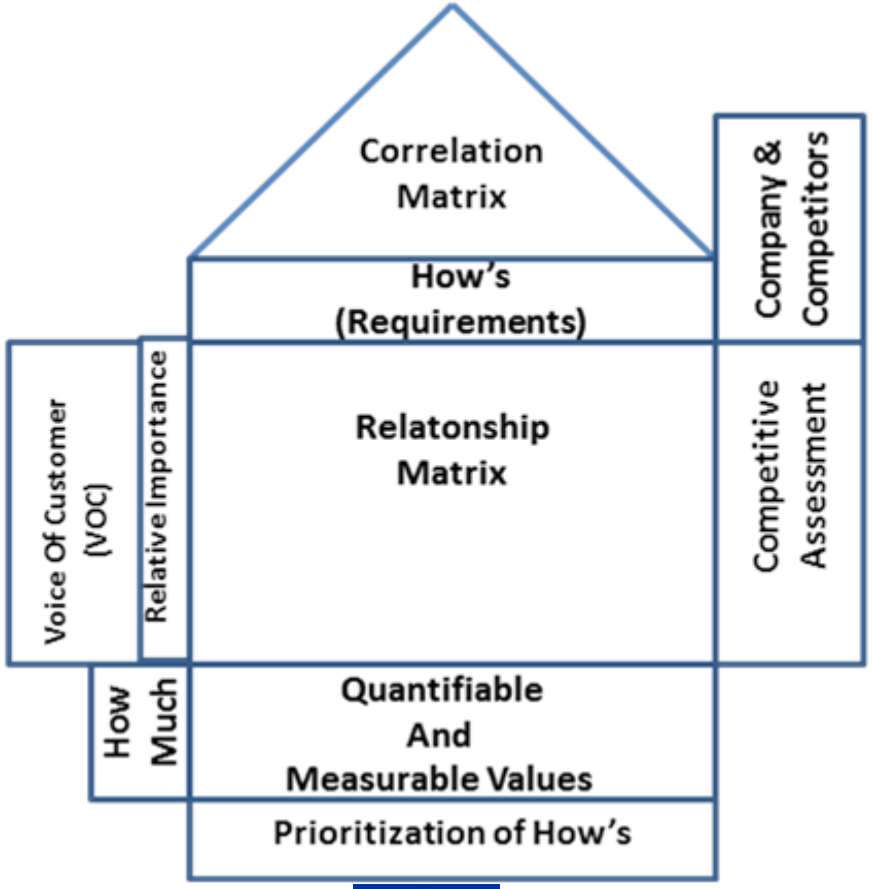
** Freely available, user-friendly, Used at different levels of complexity and aggregation



3. DTOcean+ Structured Innovation tool (IV)

Quality Function Deployment

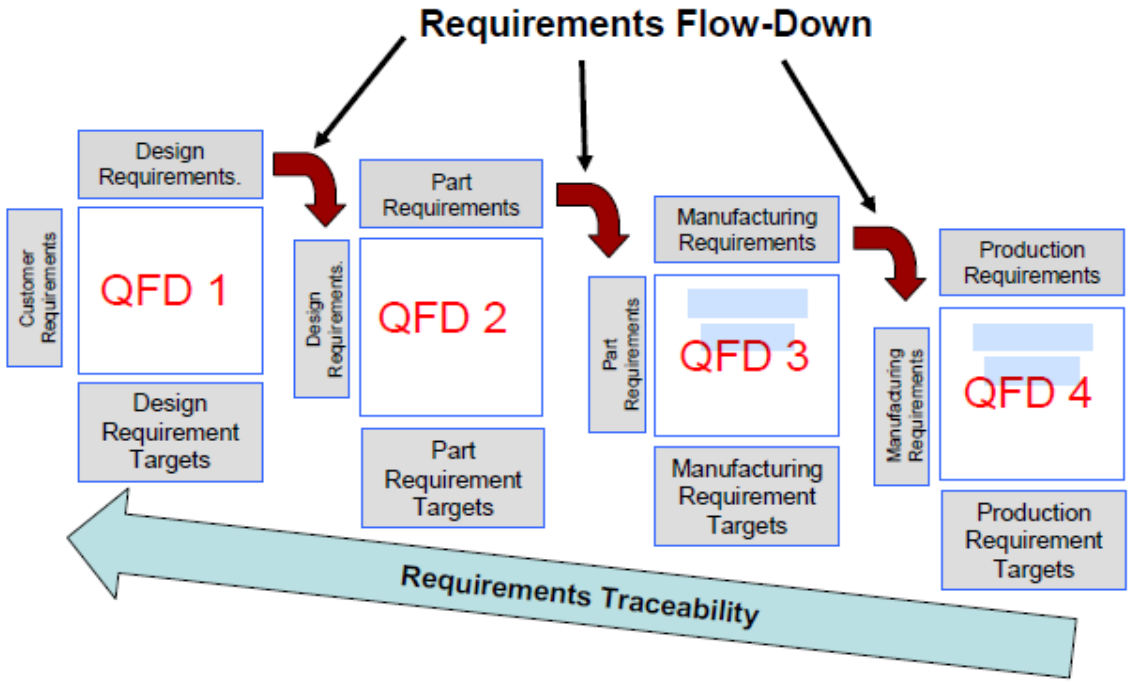
- Concept selection methods
  - Prioritise product requirements
  - Gain insights into conflicts
  - Understand relationships and impact
  - Assess difficulty in engineering and delivering
  - Impact and organisational efforts
  - Potential for Ideality



3. DTOcean+ Structured Innovation tool (V)

Quality Function Deployment

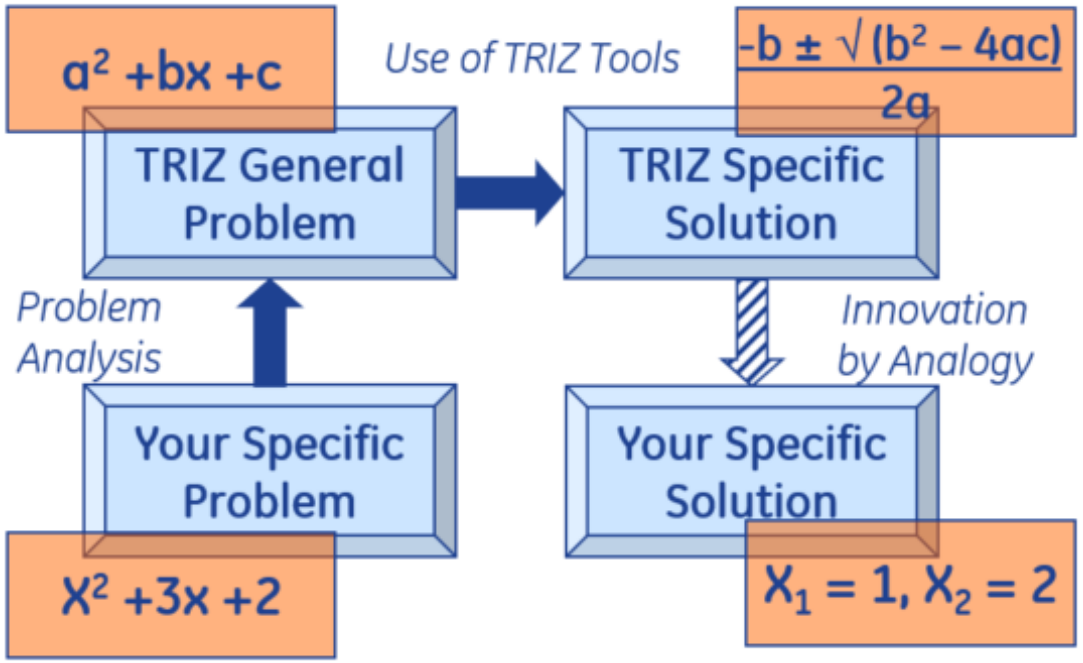
- Strengths
  - Multi level analysis
  - Multiple solutions to Needs
  - Subjective and Objectives measures
  - Impact and Organisation Efforts
- Weaknesses
  - No direct inventive thinking tool
  - Functional fixedness



3. DTOcean+ Structured Innovation tool (VI)

TRIZ- Theory of Inventive Problem Solving

- Library of problems & solutions
- Engineering field patents
- Evolution of technical systems
- Impact analysis (quality)
- Functional performance Vs conflicts
- State of ideality



3. DTOcean+ Structured Innovation tool (VII)

Failure Modes and Effect Analysis (FMEA)

- Concept & design evaluation
- Possible causes & failures
- Risk Priority Number
- Threshold for mitigation
- Criteria for corrective actions

Warning - Occ higher than 4 MUST be mitigated

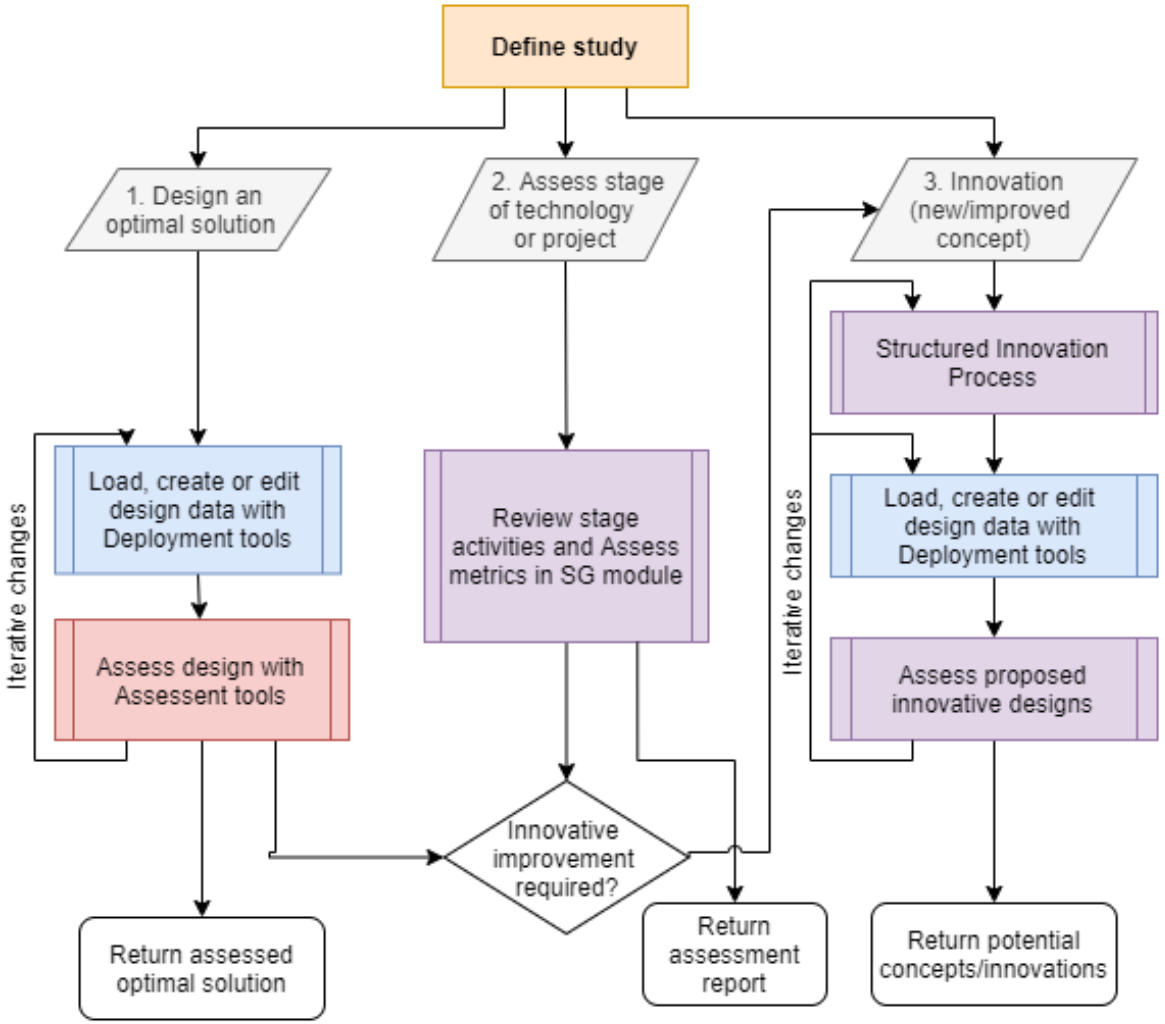
RPN Action Level 70

Requirements	Failure Mode(s)	Effect(s) of Failure	SEV	Cause(s) of Failure	OCC	Design & Process Control(s)	DET	RPN	Remedial Action: Recommended Solution(s)	SEV	OCC	DET	RPN
To provide wind assisted thrust to the ship	Thrust produced incorrect, lack of lift vs drag	Increased fuel consumption, loss of profit, increased emissions, loss of confidence, reputation, operational on-costs,	6	Electrical power loss and failure to restart **one** Rotor	3	Electrical system test	3	54					
				Electrical power loss and failure to restart **all** Rotors	3	Electrical system test	3	54					
				Electrical sensor loss	3	Electrical system test	3	54					
				Rotor Seizure	2	Root Cause Investigation	3	36					
				Device not able to use to wind resource (Direction)	4	Design Review	3	72	Minimum 2 wind sensors installed. Control system reverts to "idle mode" to reduce drag. No thrust produced from FRS.	6	3	2	36
				Device not able t			3	72	Minimum 2 wind sensors installed. Control system reverts to "idle mode" to reduce drag. No thrust produced from FRS.	6	3	2	36
				Main Bearing system (SRB) failure	2	Design Review	3	36					
				Main Bearing system (ASRB) failure	2	Design Review	3	36					

RPN= **Severity** X **Occurence** X **Detection**

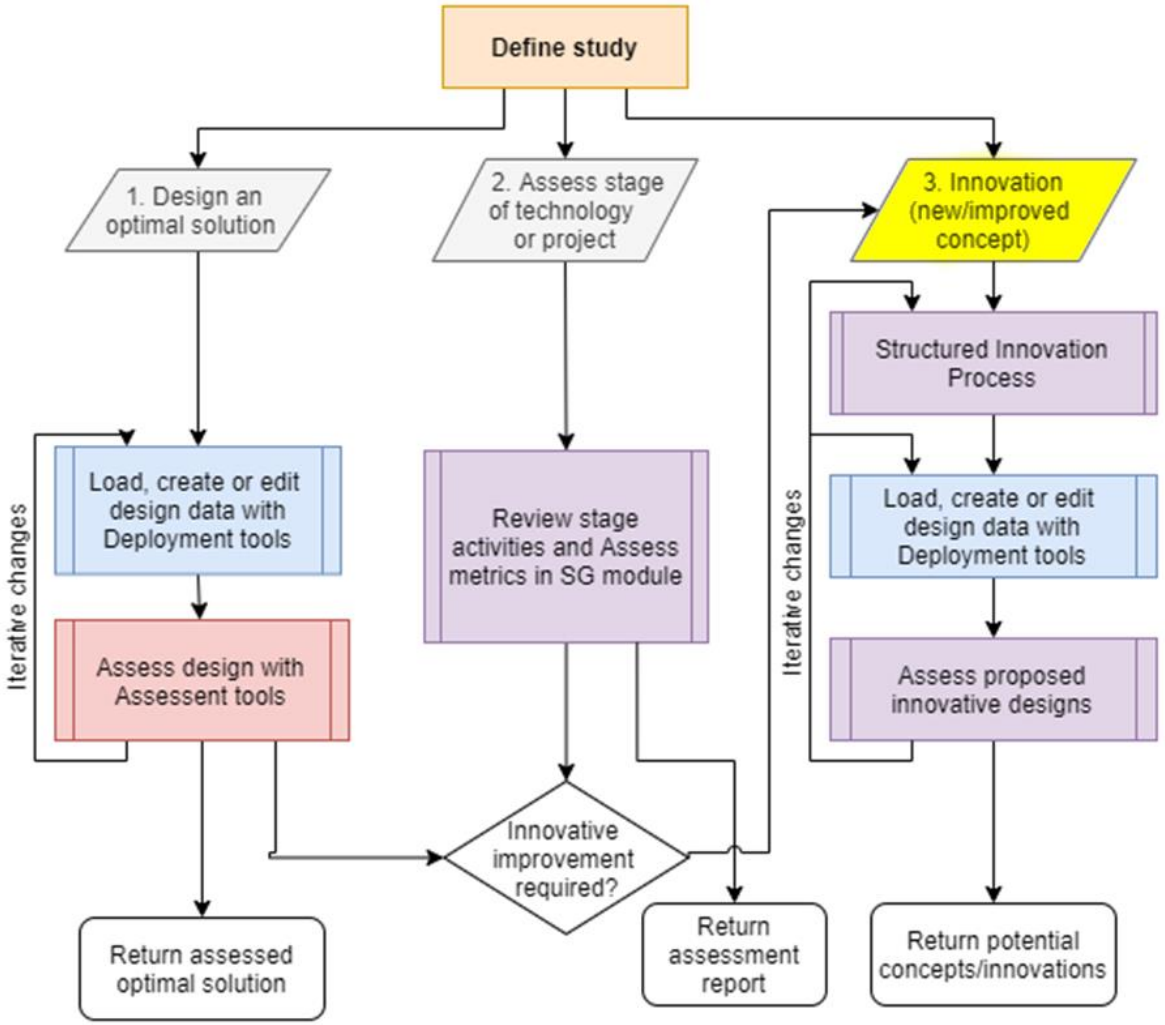
3. DTOcean+ Structured Innovation tool (VIII)

Overall process of using DTOcean+



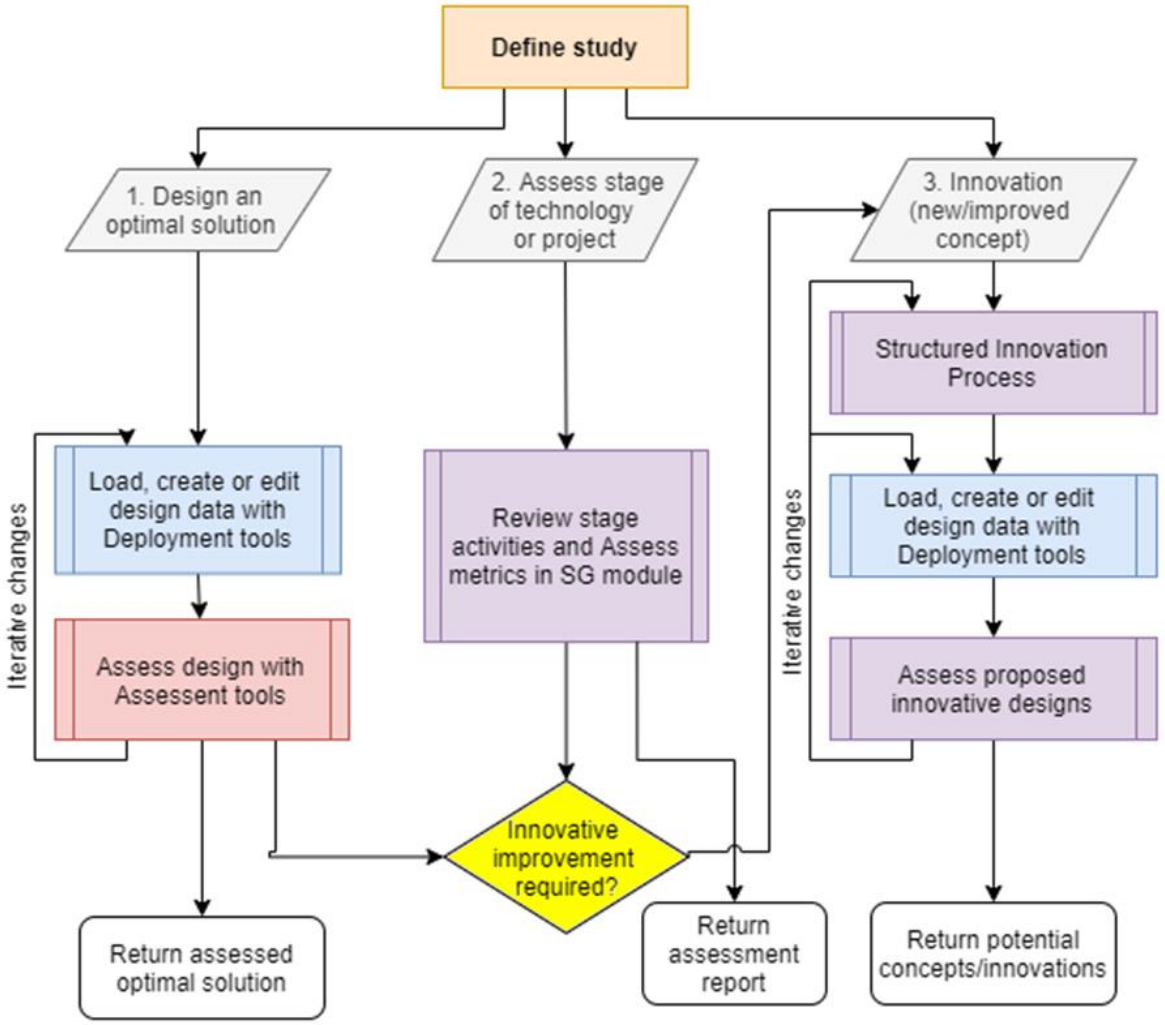
3. DTOcean+ Structured Innovation tool (IX)

Overall process of using DTOcean+

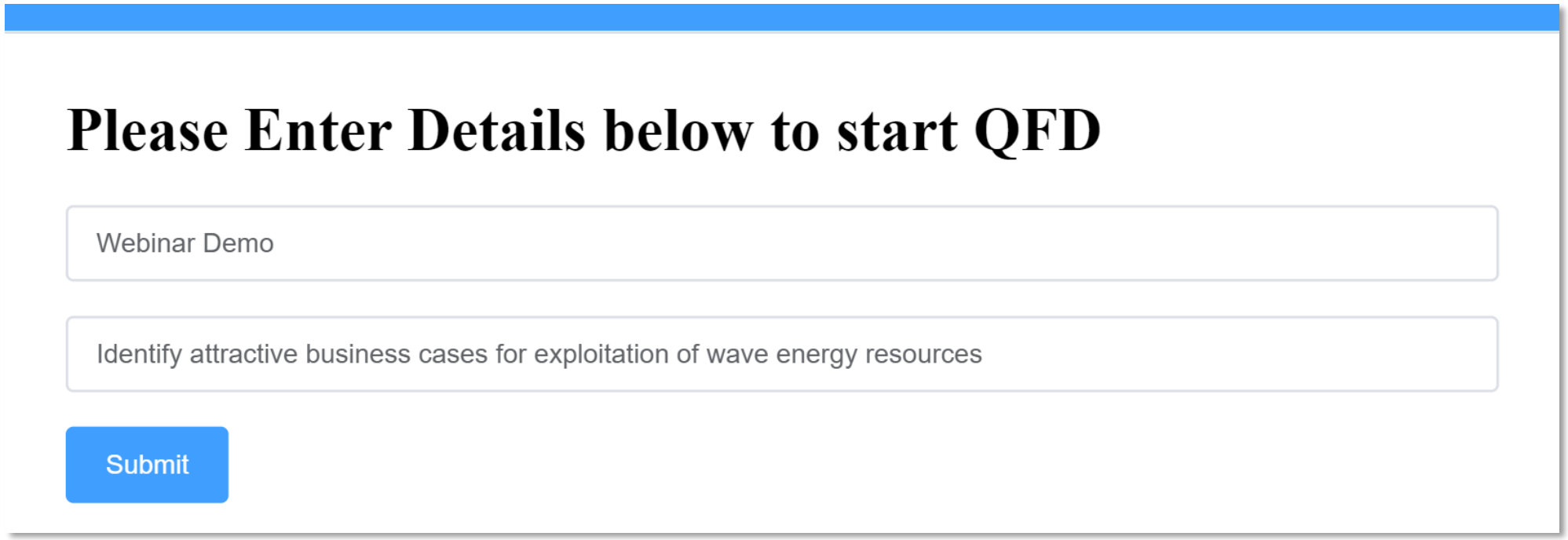


3. DTOcean+ Structured Innovation tool (X)

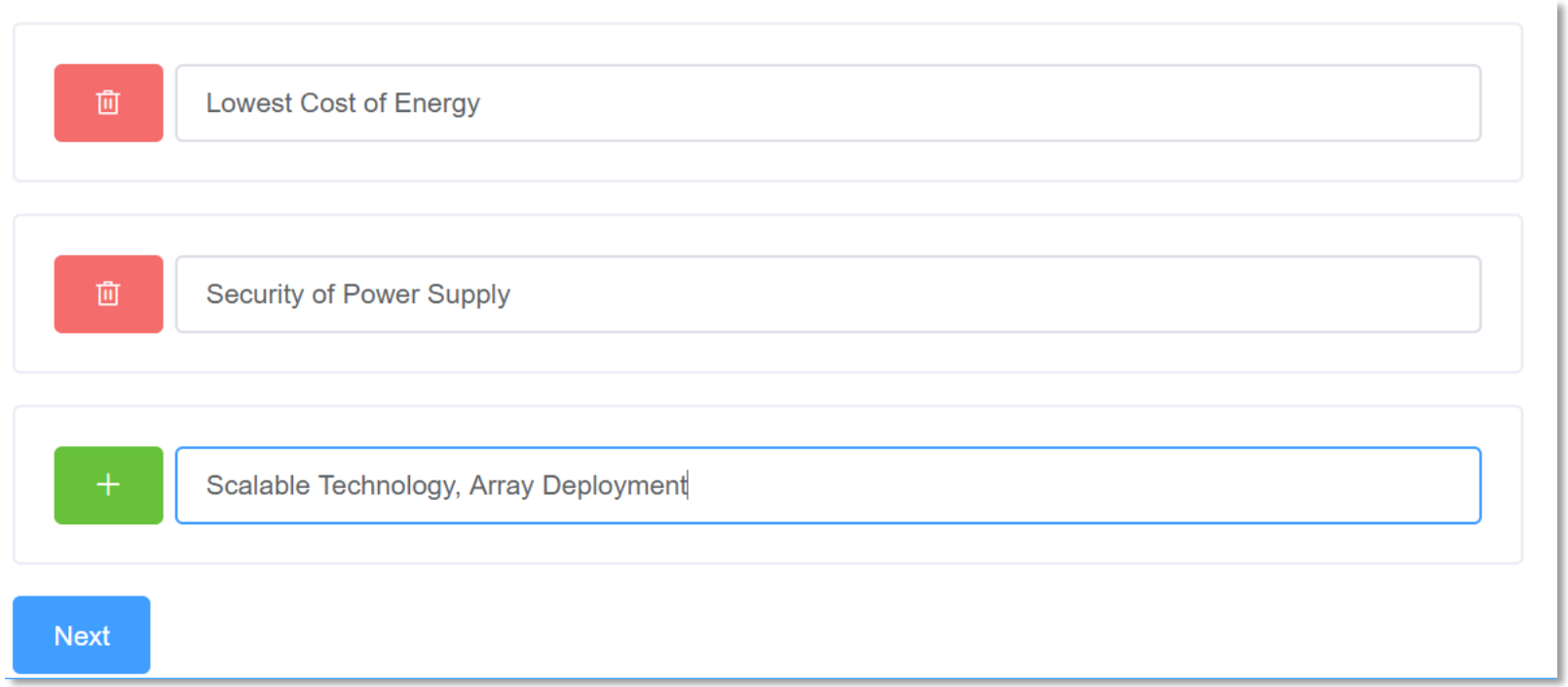
Overall process of using DTOcean+



3. DTOcean+ Structured Innovation tool (XI)



3. DTOcean+ Structured Innovation tool (XII)

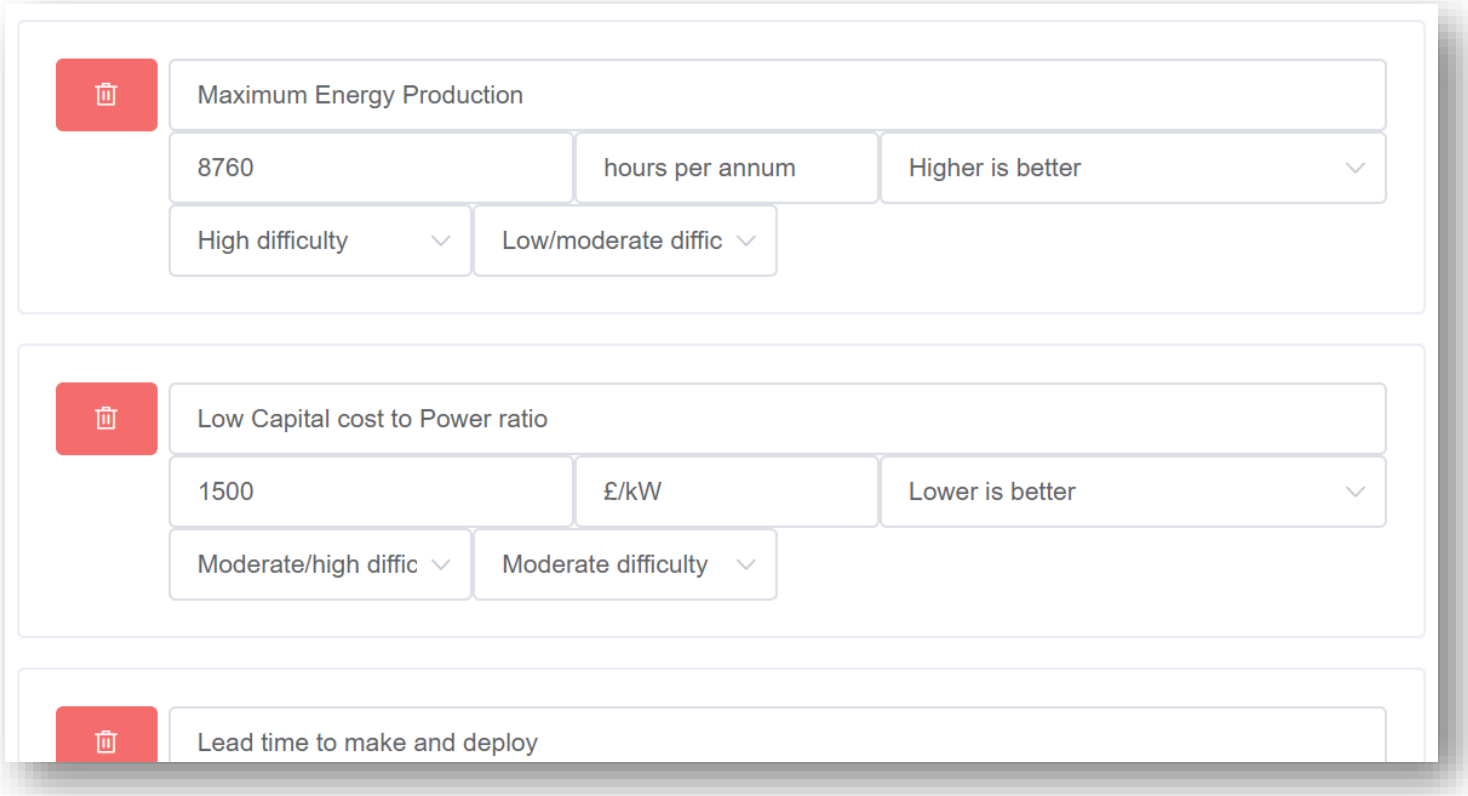


Data sources:

- **Custom input**
- **Existing QFD or FMEA analysis**
- **Solution hierarchy**

L1	L2
Lowest Cost of Energy	Capital cost
	Operational costs
	Energy Conversion
Security / Safety of Power	Survivability
	Grid support
	Grid strength
	High TRL components
	Reliability

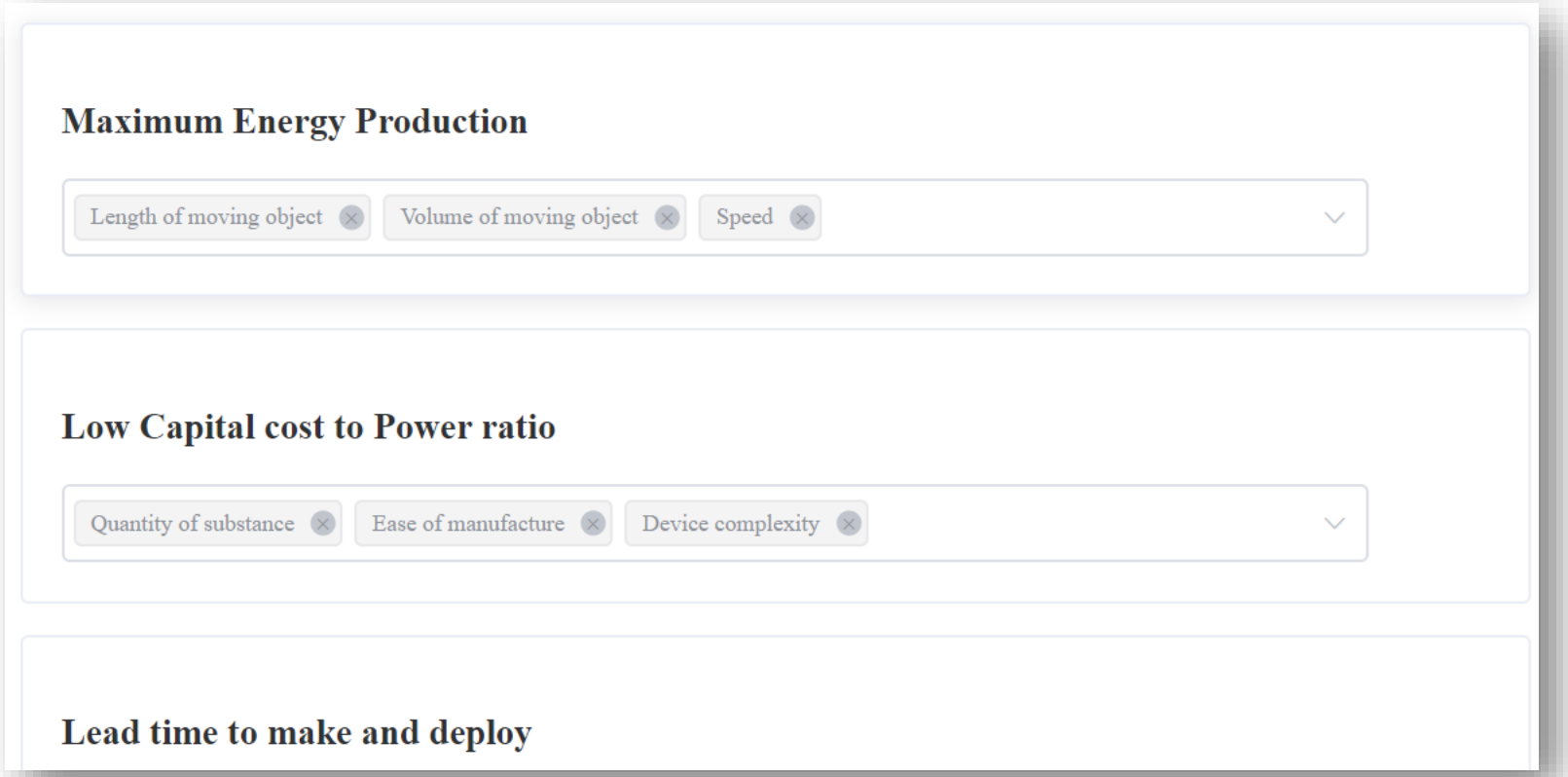
3. DTOcean+ Structured Innovation tool (XIII)



Data sources:

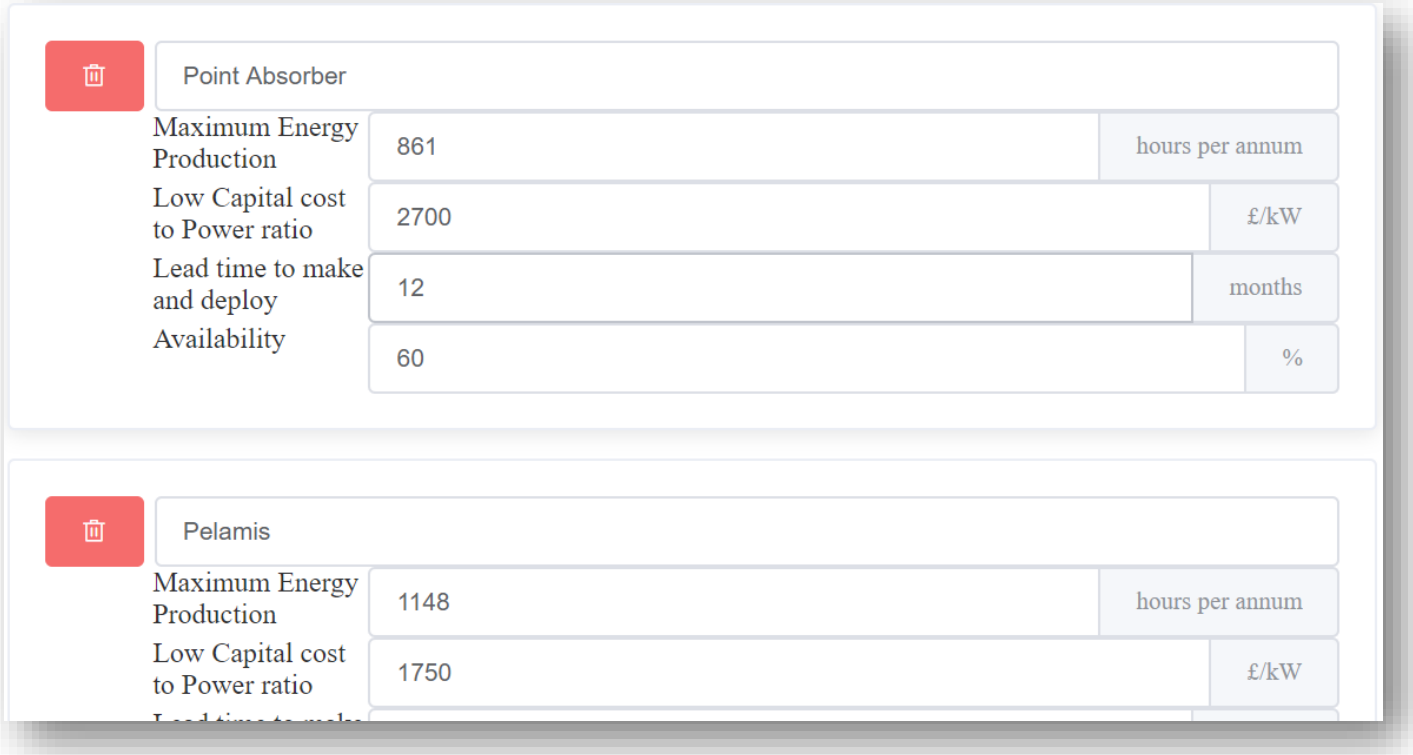
- **Custom input**
- **Existing QFD or FMEA analysis**
- **Metric thresholds**
- **Metric results**
- **Deployment parameters**
- **Fundamental relationships (Art of the possible)**

3. DTOcean+ Structured Innovation tool (XIV)



TRIZ is integrated into the QFD process, complementing the roof of the House of Quality in the traditional process.

3. DTOcean+ Structured Innovation tool (XV)



Data sources:

- **Custom input**
- **Stage Gate metrics**
- **Design modules**

3. DTOcean+ Structured Innovation tool (XVI)

Solution Ideality

This check tells the user if the competitive solutions meet the target criteria, and their compliance. The higher the number the better.

Point Absorber	-46.24
Pelamis	-78.58

Click to toggle detail

Development Ideality

This check tells us about the likelihood that the competitve solution can meet the target criteria with more development. This comes from the organisational impact. Higher number = better

Point Absorber	-28.27
Pelamis	-50.07

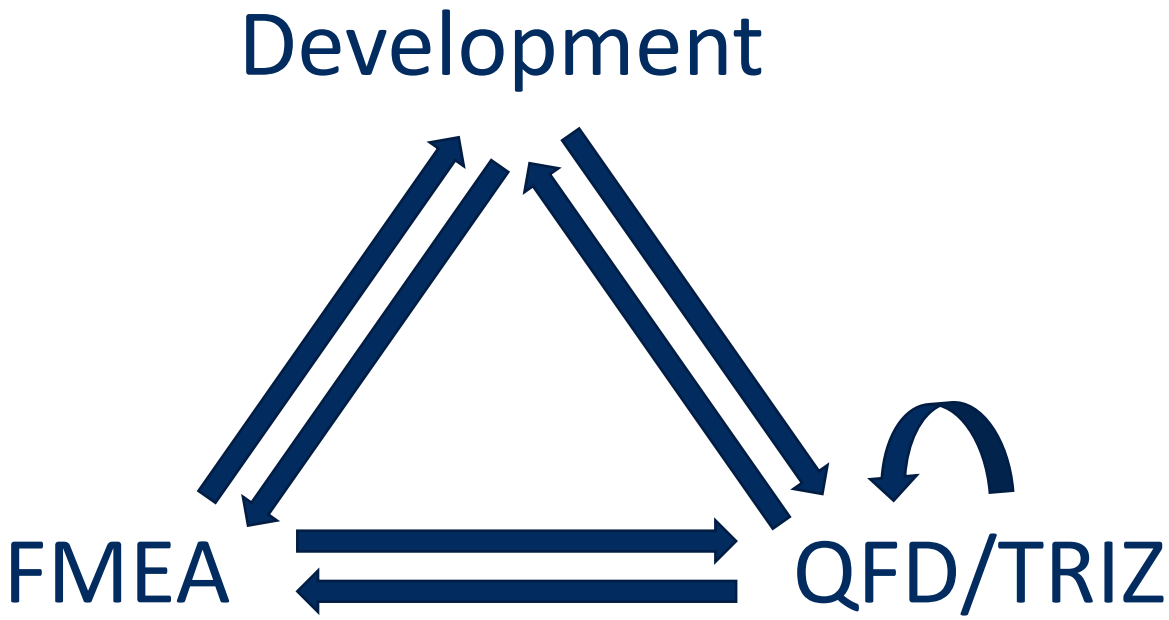
Click to toggle detail

Suggested Inventive Principles

Functional Requirement	Description	Definition	Example	Marine example
	Substitution of Mechanical system	Replace mechanical system with electrical, optical or radiation	Magnetic couplings, Optical sensors	
Maximum Energy Production	Pneumatics or hydraulics	Replace solids with gas or liquids	Air tools, water jets for cutting, inflatable boats	
	Preliminary action	In advance of function, do part or whole action or function	perforation, pre-selection,	install blades before turbine installation

Show more Show less

3. DTOcean+ Structured Innovation tool (XVII)



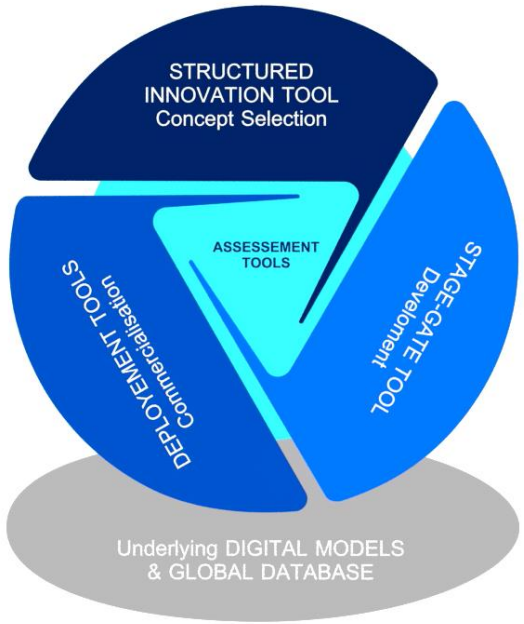
4. Summary and next steps (I)

- Structured Innovation design tool aims to:
  - Provoke innovation and help represent the voice of the customer
  - Allow the design to understand the art-of-the possible for concept targets
  - Enable objective comparisons between various technologies.
  - Enhance systematic thinking for design beyond the current state-of-the-art.
  - Create new or improve concepts

- Benefits to stakeholders:
  - Assess potential of technology
  - Assess novelty in technology
  - Target funding opportunities in sector
  - Assess areas of improvement and technical challenges

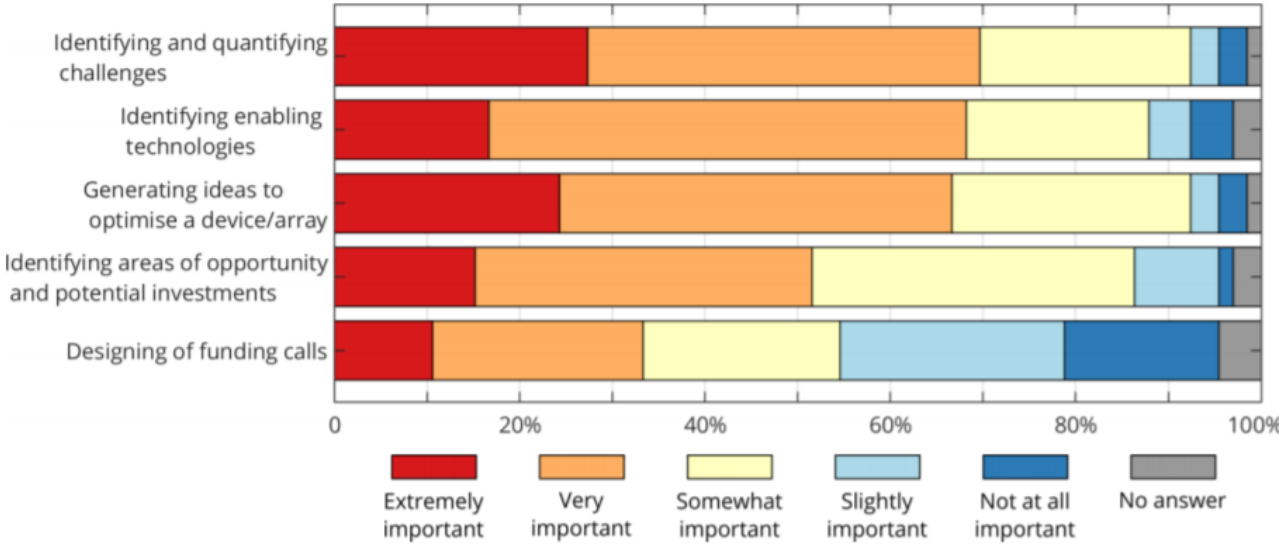
4. Summary and next steps (II)

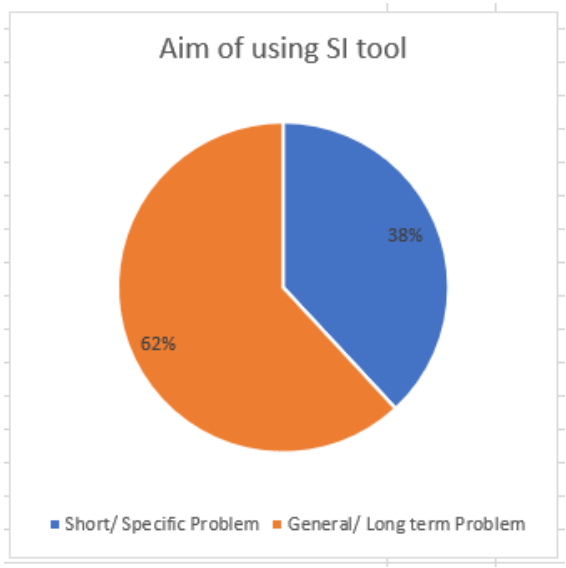
- The Structured Innovation design tool will be integrated with the other DTOceanPlus design tools
  - **Stage Gate Tool**
  - **Deployment Tools**
  - **Assessment Tools**
- … and tested with data from real case technology projects



4. Summary and next steps (III)

Verification of standalone tool





QFD/TRIZ → FMEA → SI tool

4. Summary and next steps (IV)

Validation of the integrated tool

To satisfy the use cases of:

Technology developers

- Create new/improve device concept
- Identifying enabling technologies required (gap analysis)

Public and private investors

- Identify attractive areas of innovation for investment
- Identifying potential areas of opportunity

5. Reference material

Deliverable **D3.1** - TECHNICAL REQUIREMENTS FOR THE IMPLEMENTATION OF STRUCTURED INNOVATION IN OCEAN ENERGY SYSTEMS

Deliverable **D3.2**- Structured Innovation design tool alpha version (Due 30th April 2020)

Dissemination:

Date	Event
Sept. 2020	AllEnergy 2020, Glasgow (TBC)
Oct. 2020	RENEW 2020 Lisbon, Portugal
Dec. 2020	OEE 2020 Brussels, Belgium

More on the Project
https://www.dtoceanplus.eu/About-DTOceanPlus

DTOcean+

Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment

Thank you for your attention!

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Disclaimer: This presentation reflects only the author's views and the Agency is not responsible for any use that may be made of the information contained therein.

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