The Benefits and Limits of FPSO Standardisation

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Scope of presentation

- Objectives and approaches to standardisation
- Historical examples and lessons learnt
- System approach to standardization - FAST4WARD™

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Objectives of standardisation

- Reduction in project CAPEX:
  - Reduction in man-hours (and smaller project teams)
  - Reduction in rework
  - Use of frame agreements

Objectives of standardisation

- Reduction in project CAPEX
- Reduction on project OPEX:
  - Incorporation of lessons learnt from one unit to another
  - Common spare parts inventory
  - Reduction in training costs

Objectives of standardisation

- Reduction in project CAPEX
- Reduction on project OPEX
- Reduction in project schedule:
  - Improved NPV
  - (reduction in CAPEX)

Approaches to standardisation

- Standardisation of an entire FPSO: A number of generic FPSO's have been developed in the past, often as a mechanism to build versatile production units on speculation

Approaches to standardisation

- Standardisation of an entire FPSO
- Standardisation of selected systems within an FPSO: The degree to which different systems can be standardised is dependent upon the design envelope which they must accommodate.

Approaches to standardisation

- Standardisation of an entire FPSO
- Standardisation of selected systems within an FPSO
- Standardisation of equipment: Use of supplier's standard equipment, typically procured through frame agreements, can reduce equipment costs and delivery schedule

Approaches to standardisation

- Standardisation of an entire FPSO
- Standardisation of selected systems within an FPSO
- Standardisation of equipment
- Standardisation of equipment interfaces: System layout is affected by the footprint of the equipment incorporated, particularly by the location and design of the interfaces between the equipment and remainder of the system.

Approaches to standardisation

- Standardisation of an entire FPSO
- Standardisation of selected systems within an FPSO
- Standardisation of equipment
- Standardisation of equipment interfaces
- Standardisation of the project execution plan: Executing projects using the same project organization, even when there are differences in the FPSO design, improves communication and reduces ambiguity and project schedule by capitalizing on existing relationships with suppliers and fabrication yards. The more standardised the design, the greater the standardisation that can be achieved in the project execution plan.

Functional versus Prescriptive Specifications

- The Functional Specification approach: The client specifies the functionality required from the FPSO, but leaves the FPSO contractor to use their own detailed specifications to perform the EPCI work.
- The Prescriptive Specification approach: The client specifies not only the functionalities required, but also how the the project is to be executed, typically in accordance with the client's in-house engineering standards. The 'standard' product must then be customized.

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Generic FPSO Failures

Project	Contractor	Launch Date	Closure Date	Status
Nexus 1 FPSO	Nexus	2006	2009	Nexus 1 FPSO built on speculation, laid up and finally sold to OSX and reconverted to OSX1 FPSO. Programme cancelled.
Deep Producer	FPSOcean	2007	2009	Bankrupt. FPSO abandoned part constructed, later sold.
East Fortune FPSO	Nortechs	2006	2010	Bankrupt. Vessels sold for reconversion.
Aker Smart FPSO	Aker Floating Production	2006	2010	The first generic unit was modified to include a turret mooring and a major topsides upgrade. Programme for 4 FPSOs cancelled after first FPSO.

Generic FPSO successes

Project	First Oil Date	Field
FPSO Falcon	2002	Produced on Yoho field in Nigeria
FPSO Serpentina	2003	Producing on Zafiro field in Equitorial Guinea
FPSO Xikomba	2003	Produced on Xikomba field in Angola until 2011 then redeployed to N'Goma field in Angola for Eni
FPSO Mondo	2007	Producing on Mondo field in Angola
FPSO Saxi-Batuque	2008	Producing on Saxi and Batugue field in Angola

SBM's 'Generic FPSOs for ExxonMobil

Extent of standardization of the series for ExxonMobil

- Generic FPSO functional specification
- The FEED for a generic design provided a starting point for each project specific application

1 FPSO Falcon
2 FPSO Serpentina
3 FPSO Xikomba
4 FPSO Mondo
5 FPSO Saxi Batuque

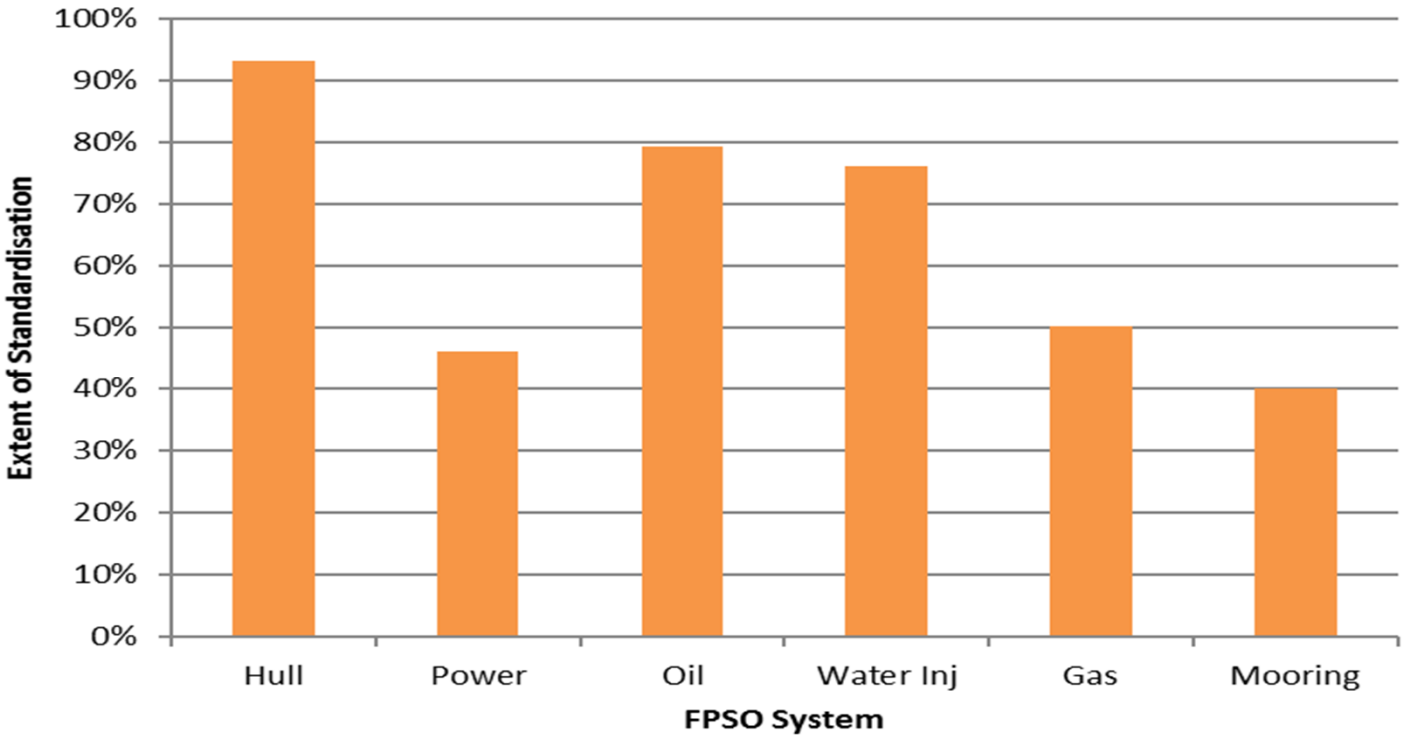
Extent of standardization of the series for ExxonMobil

- Project specific application introduced considerable differences
- 6 key systems reviewed for level of standardization: Hull, Power generation, Oil processing, Water injection, Gas processing, Mooring system

$$\textit{System parameter deviation around mean, } \textit{Devi} = \frac{\textit{maximum} - \textit{minimum}}{2 \text{ x } \textit{mean}}$$

$$Extent\ of\ Standardization\ = 1 - \frac{\sum_{i=1}^{j} Dev_i}{\text{j}}$$

Extent of standardization of the series for ExxonMobil

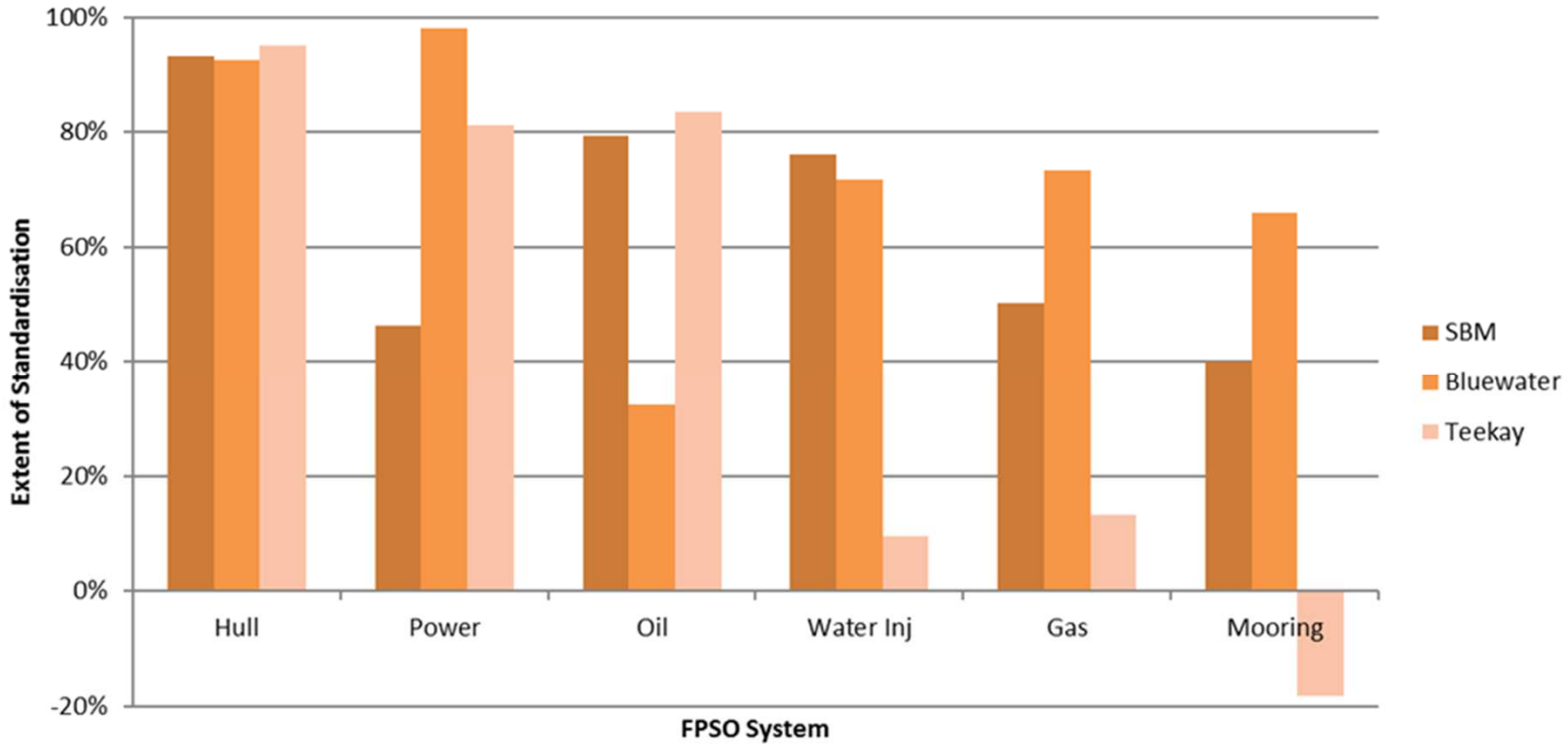


Other successful series of FPSO based on generic hulls

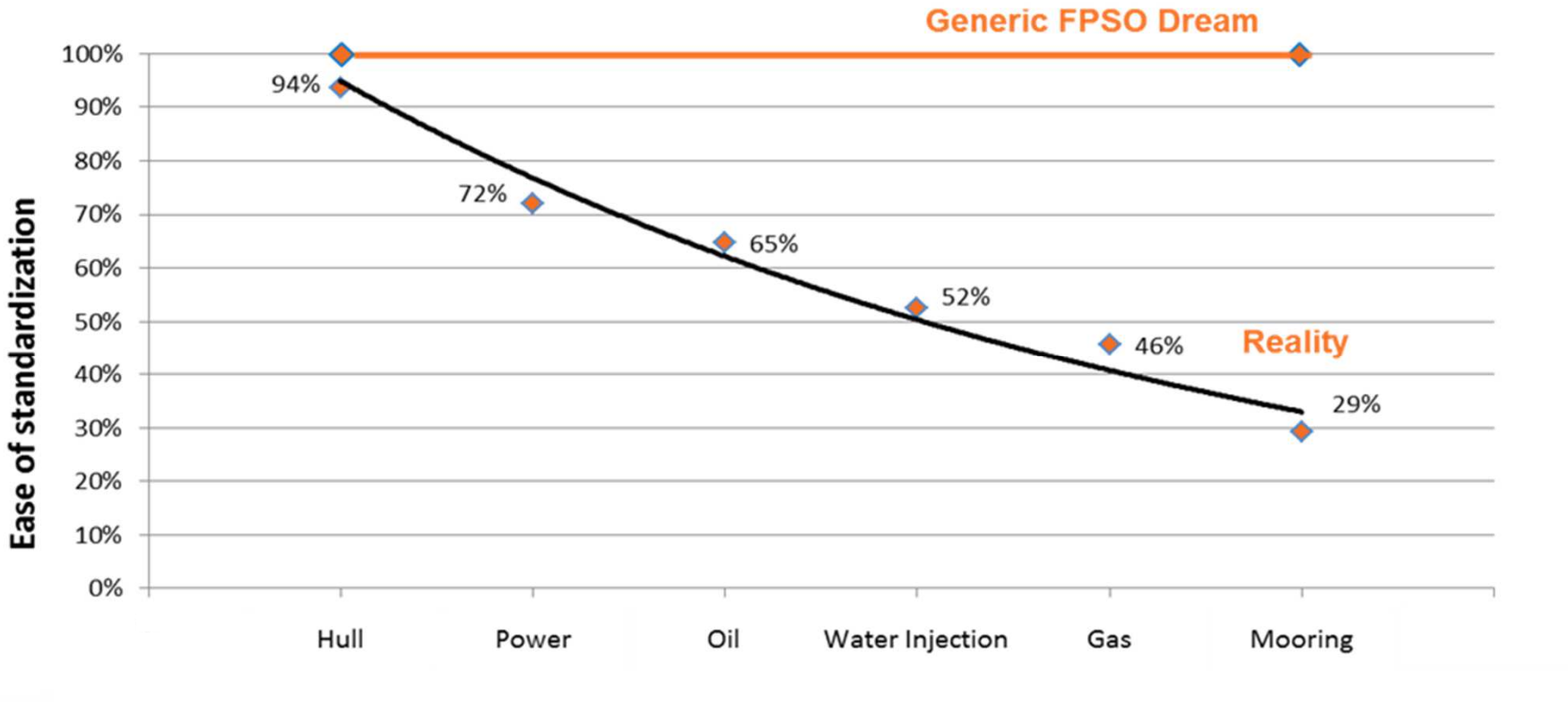
- Bluewater series (Bleo Holm, Glas Dowr and Aoka Mizu)
  - Based on new build Aframax sized hull
  - North Sea applications

- Teekay Offshore series (Piramena 1, Hummingbird Spirit and Voyageur Spirit)
  - Based on new build circular hulls of the Sevan Marine design.
  - North Sea applications

Extent of standardization of 3 series of FPSO



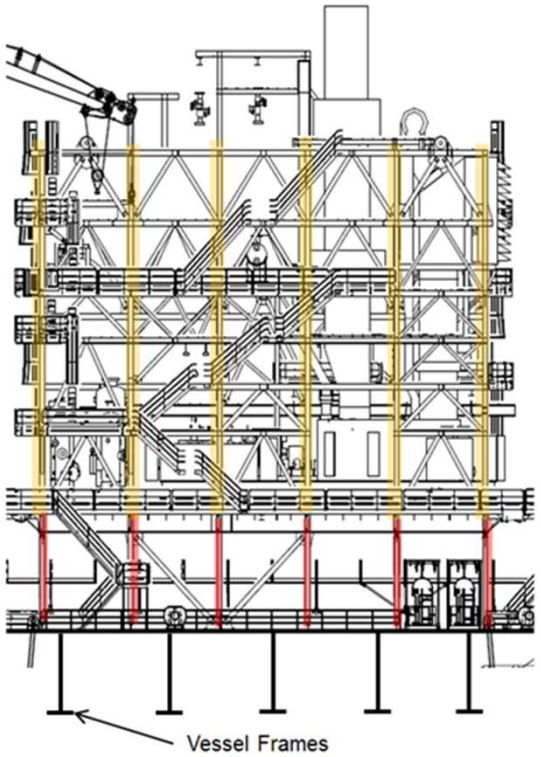
Ease of standardization of FPSO systems



CDI, CDM, and CDS – an opportunity for standardisation

- Cidade de Ilhabela (CDI) delivered to Petrobras in 2014
- Two near identical units then awarded by Petrobras
  - Oil (bpd) 150,000
  - Prod Water (bpd) 120,000
  - Water Injection (bpd) 200,000
  - Gas Compression (MMscfd) 212
  - CO2 Compompression (MMscfd) 100
  - Re-injection Pressure (Barg) 550
- Topsides weight 25,000 tonnes
- Storage requirement 1,600,000 barrels

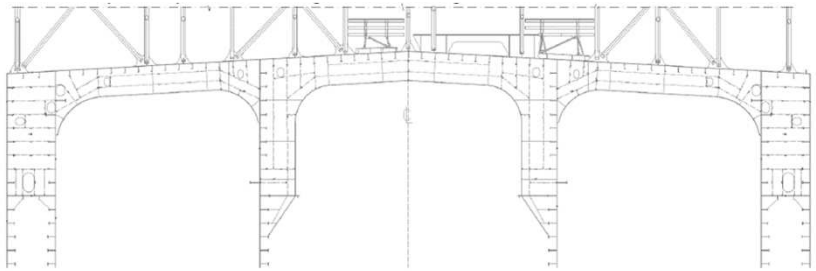
Mismatch between topsides bay spacing and vessel framing



Original vessel framing 4 x 5,700 = 22.8m
Topside framing: 5 x 5,300 = 26.5m

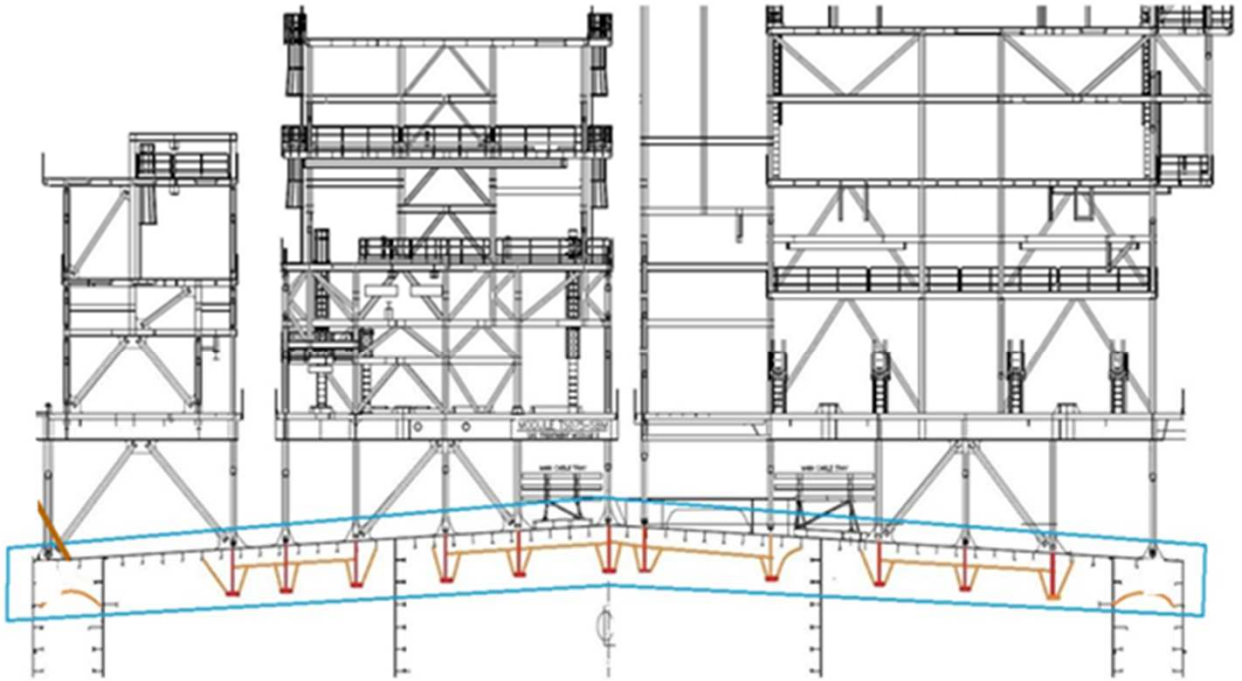
Integration solutions considered:

- Reinforcement above deck
- Intermediate web frames



- Additional longitudinal girders

Longitudinal girders to support modules



‘Upper Deck Renewal and Topsides Integration, the Example of Cidade de Maricá and Cidade de Saquarema’
Arselin, Jarry, Marchalot, d’Este, DOT 2015

Deck renewal to incorporate additional framing aligned with CDI topside module supports

New accommodation block with transition piece

Cidade de Maricá and Cidade de Saquarema during conversion

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Incorporating lessons learnt

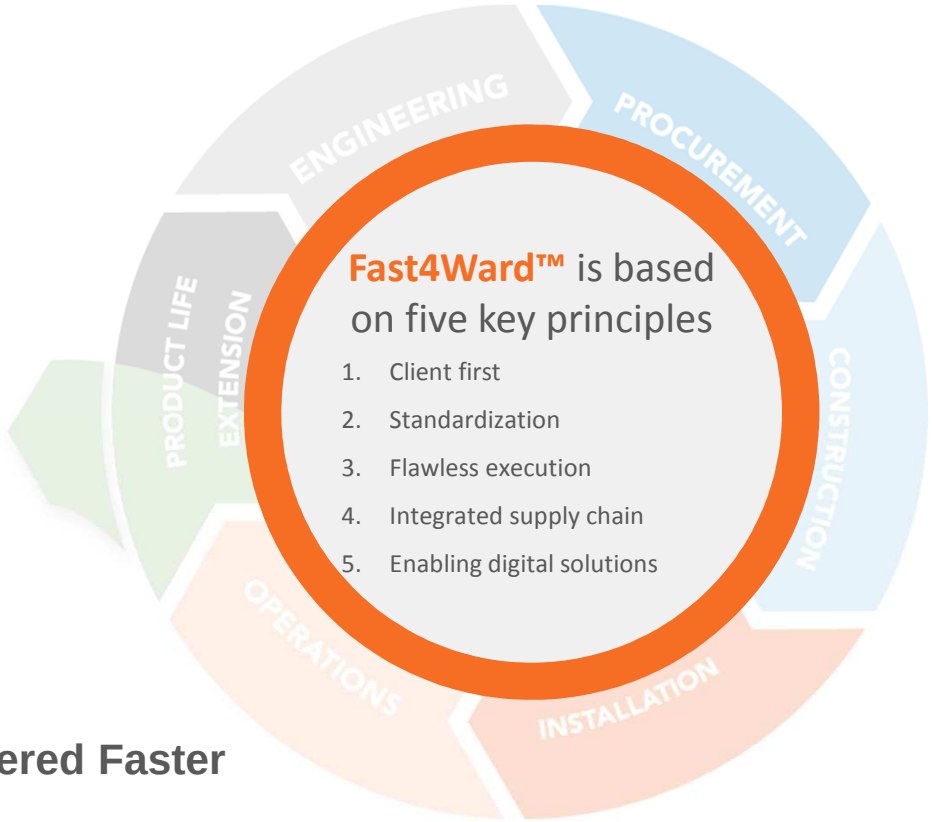
- In 2015, SBM launched an FPSO project called Fast4Ward™, including standardization as a key element

- The standardisation is based on three pillars:
  - A generic new build VLCC sized hull optimised for West African and Brazilian conditions
  - A catalogue of Topsides modules covering a range of capacities and product specifications
  - A catalogue of Mooring Systems covering a range of water depths, environments and risers.

A principle based approach: Fast4Ward™

Our ambition is to transform the business by reducing cycle time to energy delivery, de-risking projects, and improving quality & safety. This is what we refer to as

Fast4Ward™

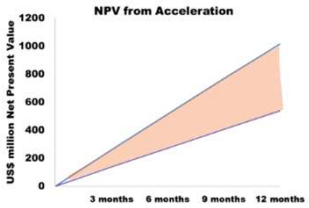


Fast4Ward™ Better Performance, Delivered Faster

Fast4Ward™ Better Performance, Delivered Faster

Fast4Ward™ Better Performance, Delivered Faster

Reducing cycle time	De-risking projects	Enabling lower break-evens
Up to 12 months faster; Up to US$1 bn NPV gain	Standardized hull and topsides	Lower Capex and Opex



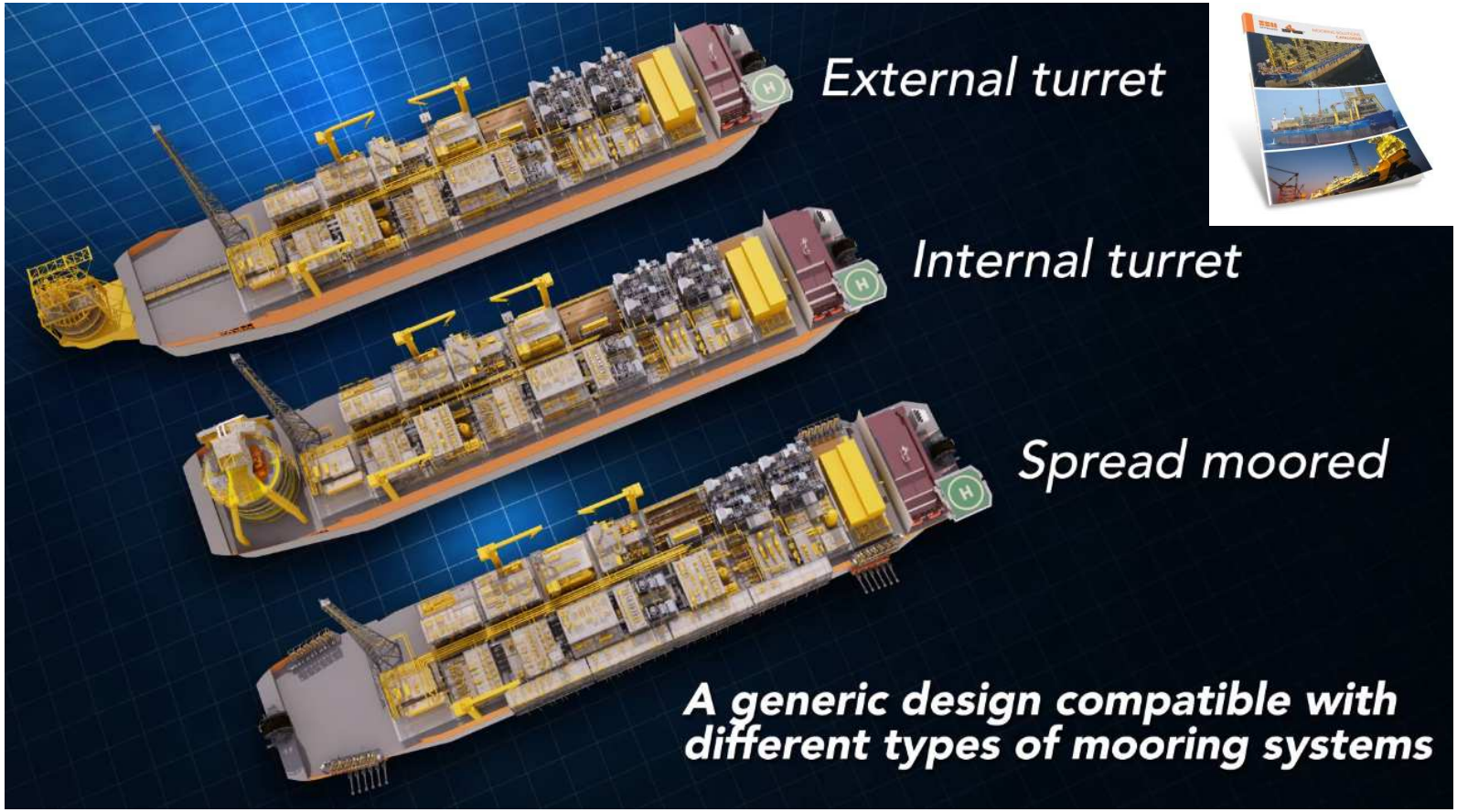
- Fewer engineering hours
- Integrated supply chain
- Greater safety and reliability

Next Generation FPSO

- Standardised Hull: the **Multi Purpose Floater**
- Topsides Modules, Vessel & Mooring Components: **Catalogue** Approach

Topsides – The Catalogue

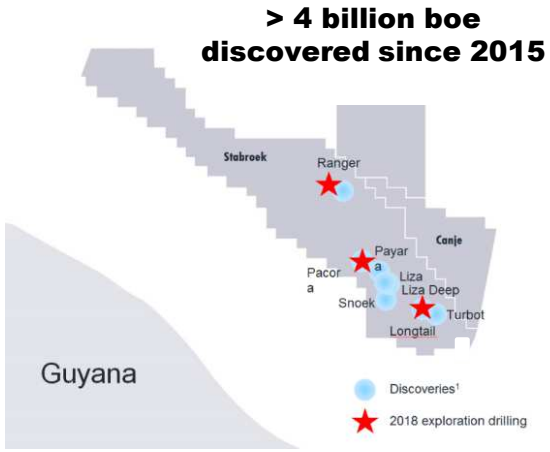
Mooring – Flexible Solutions



Next Generation FPSO: Guyana

- FEED contract awarded for 2nd FPSO Liza field offshore Guyana
- Construction and Installation, Lease and Operate contracts awarded for a period of up to 2 years, subject to project sanction
- Oil production capacity of 220,000 bbls/day

source: SBM Offshore (general Fast4Ward™ rendering)



source: ExxonMobil

Questions ?