Data Models in Ship Design and Construction

Insights from 4D BIM and the SEUS Project

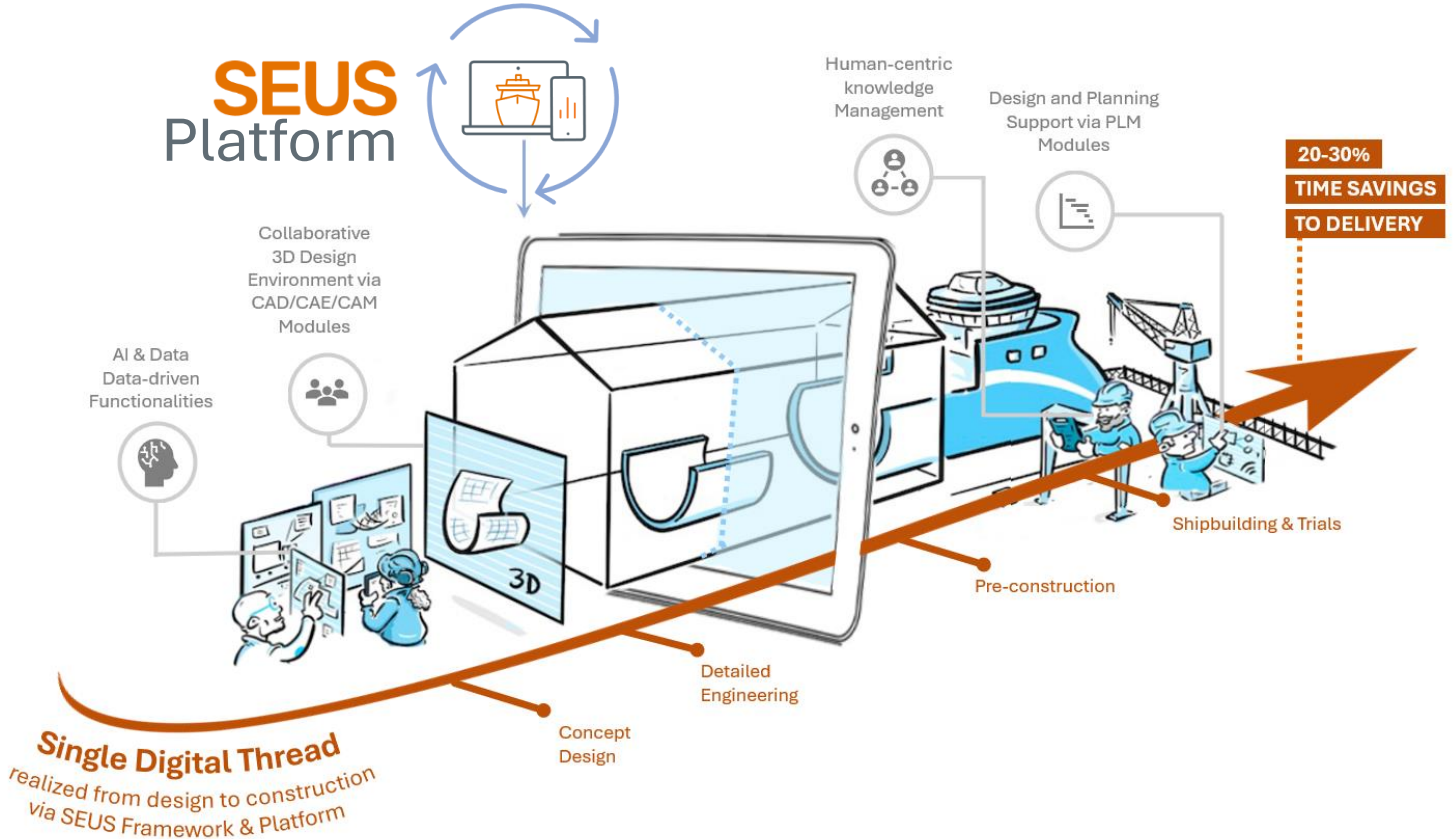
SEUS
Smart European Shipbuilding

NTNU IHB (Henrique Gaspar, Janica A. Bronson)

Ancona, Italy | October 31, 2024

Norwegian University of Science and Technology

SEUS Ambition: A single digital thread from design to construction



SEUS Consortium

APPLIED RESEARCH AND INNOVATION

NTNU

NHL STENDEN university of applied sciences

UNIVERSITY OF TURKU

Research
smart technologies, applied use cases, research of implications, knowledge management

metrics from applied research in shipbuilding

SOFTWARE DEVELOPMENT

CADMATIC

CONTACT Software

SARC MARITIME SOFTWARE AND SERVICES

computational tools
development, integration and implementation

new business cases for the software developed

SHIP DESIGNS AND SHIPYARDS

ULSTEIN

GONDAN SHIPBUILDERS

identification of gaps in processes in shipbuilding and potential to fill these.

short lead time during design, engineering and construction

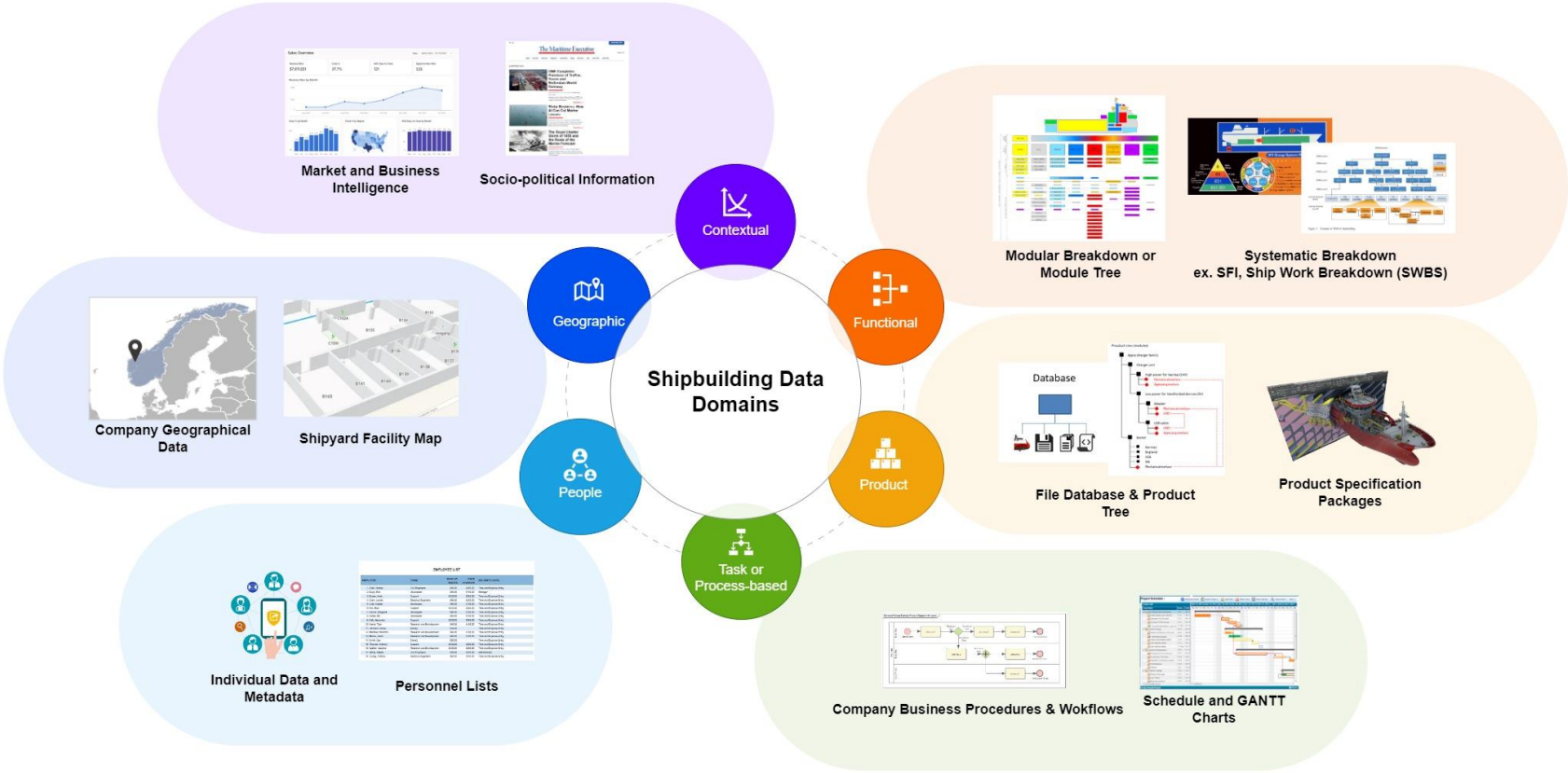
SEUS
Smart European Shipbuilding

SEUS Consortium

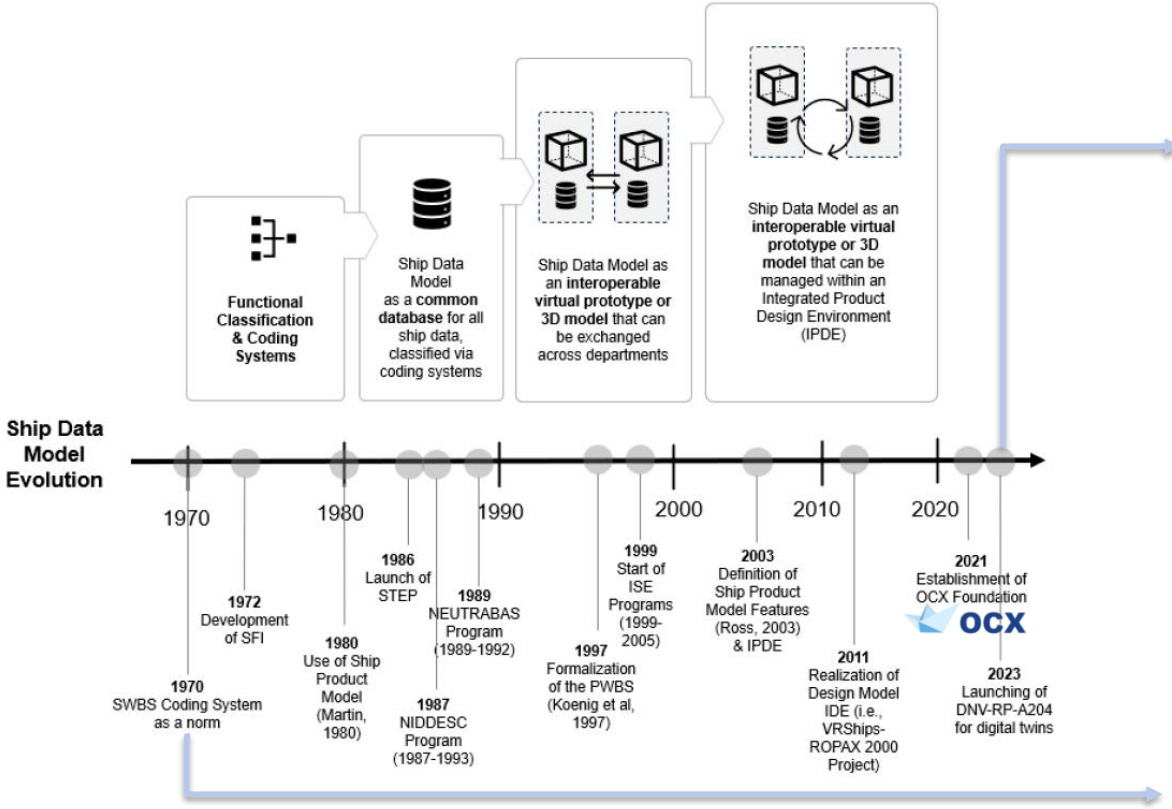
The presentation aims to explore:

1. **Current Challenges to a Comprehensive Multi-domain Model**
2. Introduction and Insights from 4D BIM
3. Adoption Potential in Shipbuilding Industry

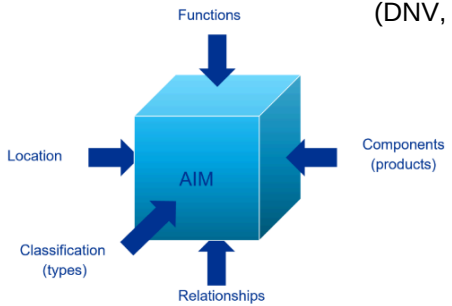
A comprehensive and cohesive ship data model: Multi-domain Model



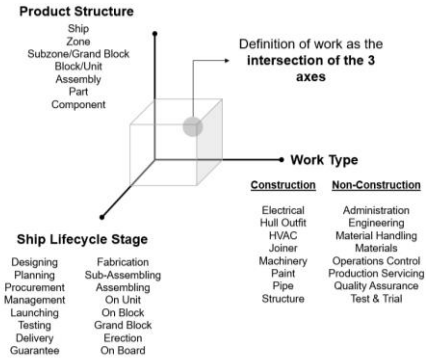
Evolution of Design and Planning Representations Used in Shipbuilding



(DNV, 2023)



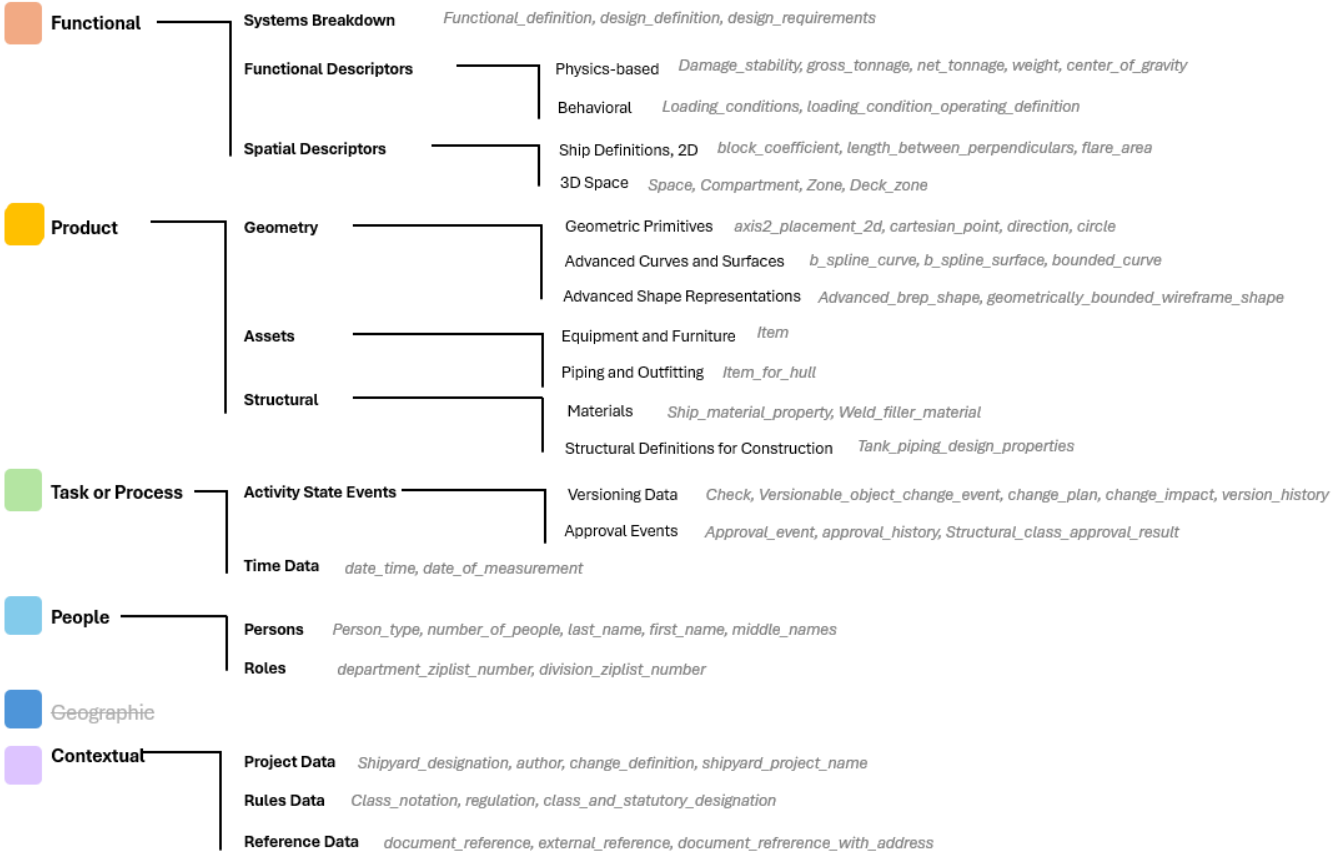
DNV A204 AIM Definition



Generic Product Work Breakdown Structure

ISO 10303 215/218 provides a considerable model covering design to maintenance data for vessels.

Domains represented with ISO 10303/STEP 215/218



Challenges to arriving and implementing a cohesive understanding of a vessel across its lifecycle:

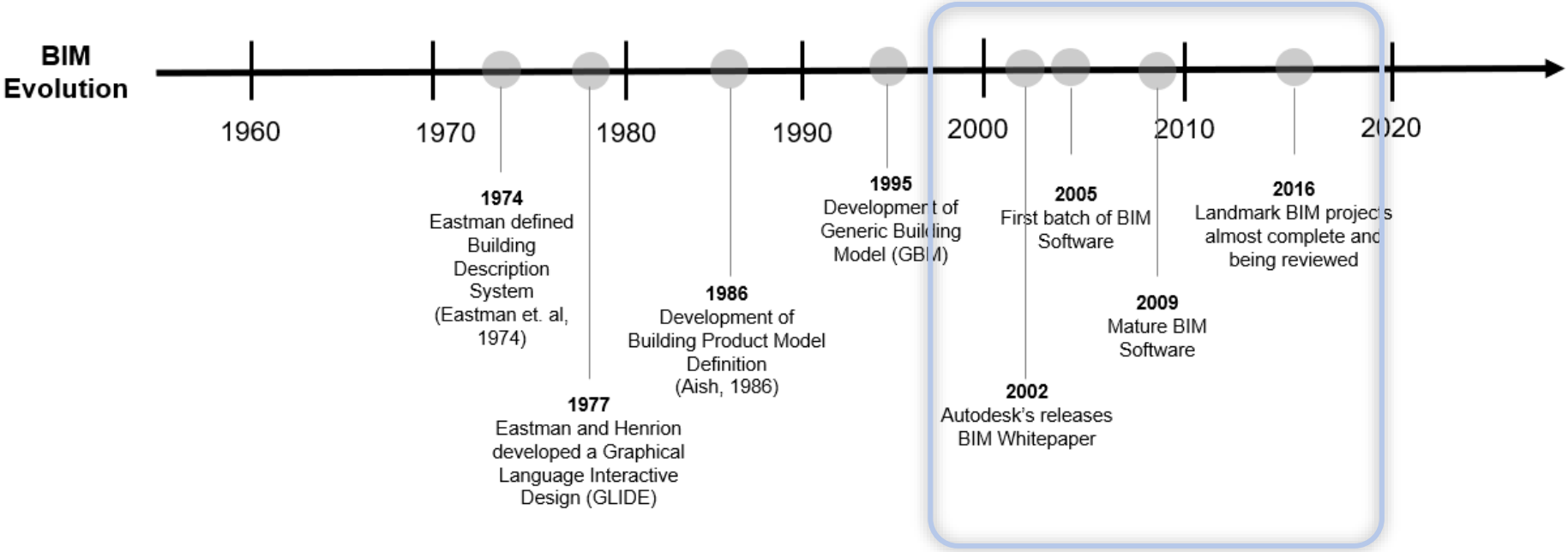
Formalized Data Model	Undefined ship product data model representation that is unfederated and unable to incorporate multi-domain ship data incorporating time, process, and functional information
Open Standards	The lack of industry-wide data exchange standards impeding interoperability
Development Workflow	The lack of an Integrated Product Development Environment (IPDE) or similar that impedes collaboration
Adoption & Maintenance Strategies	The lack of data management protocols to support the IPDE, modeling standards, and exchange standards

The presentation aims to explore:

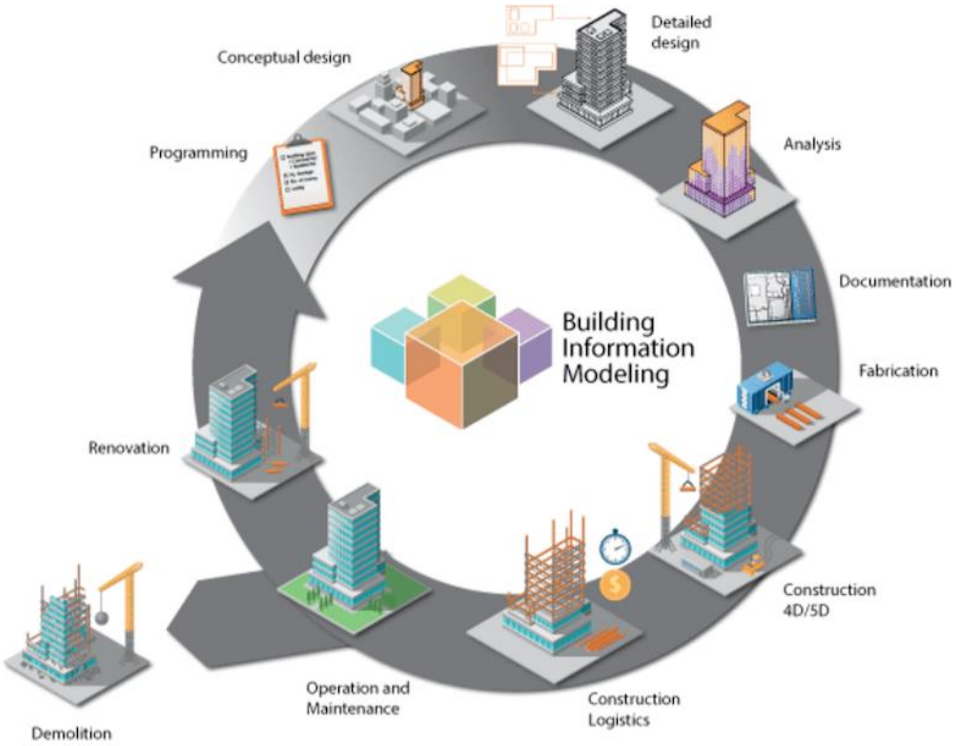
1. Current Challenges to a Comprehensive Multi-domain Model
2. **Introduction and Insights from 4D BIM**
3. Adoption Potential in Shipbuilding Industry

The architecture, engineering, construction (AEC) industry had a notoriously long history of tackling data integration and interoperability issues

The AEC industry is increasingly embracing digitalization with the development of Building Information Modeling (BIM).



Building Information Modeling (BIM) is a ‘process of designing, constructing or operating a building or infrastructure asset using electronic object-oriented information’.

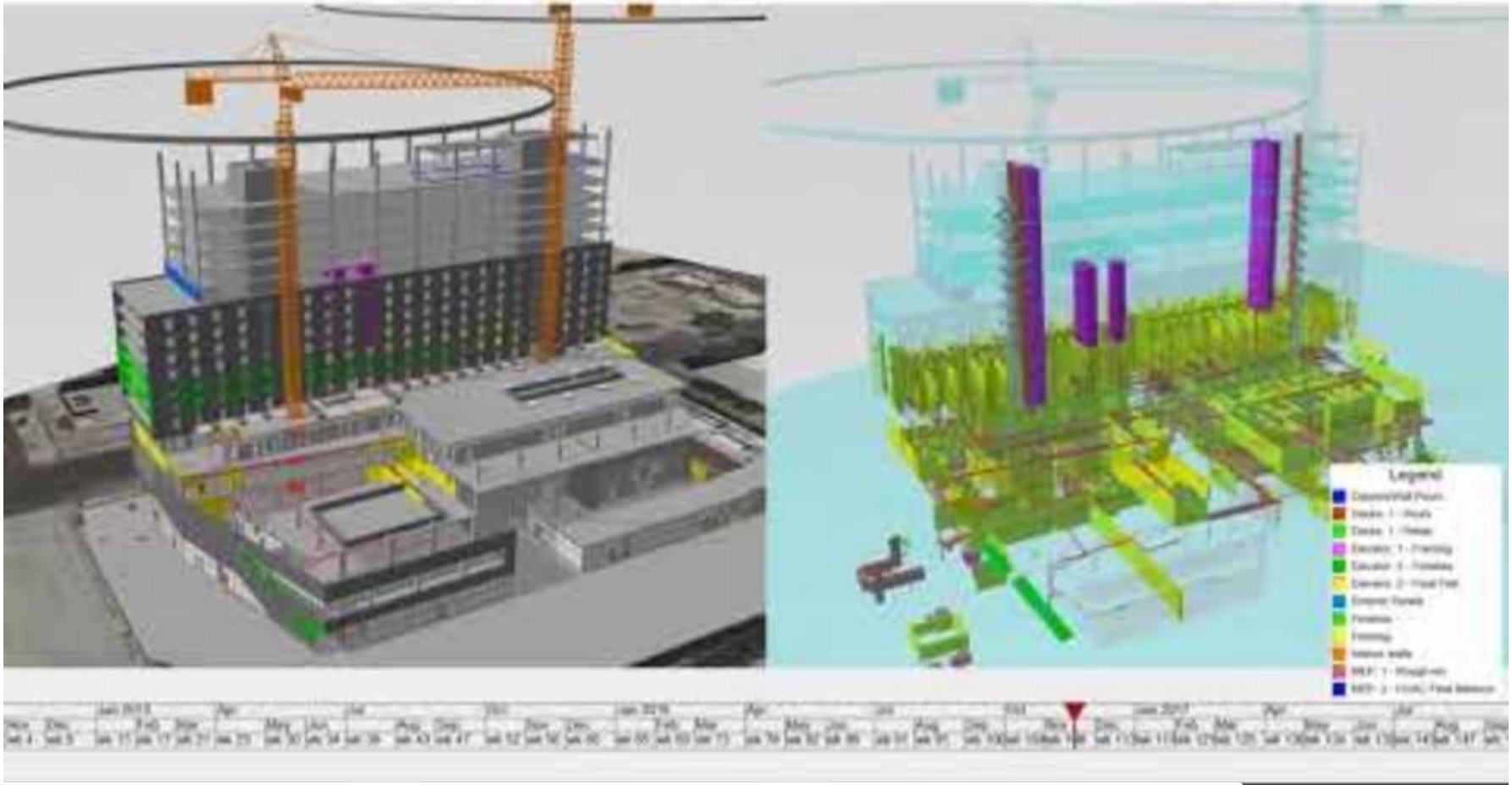


(The Institution of Structural Engineers BIM Panel, 2021)

- It is a ***collaborative process*** enabled by technology
- As a ***tool***, it enables the management of building data from design to operations with use cases covering (Azhar, 2011):

Visualization
Fabrication and Shop Drawing support
Code Reviews
Cost Estimating
Construction Sequencing
Conflict and collision detection
Forensic Analysis
Facilities Management
Quality Take-off
Model-based Estimating
Feasibility Analysis
Alternative development
Environmental Analysis

11/22/2016



BIM as a process and a tool addresses key gaps determined in the maritime industry:

Open Standards	**Collaboration mandated by BIM:** Standards defined for Controlled Data Exchange Required Data Federation practices (ISO 19650)
Formalized Data Model	**Structured & Federated Information Model Required:** IFC for 3D Model (Neutral file exchange)
Development Workflow	**Defined Process Required:** Defined execution of BIM with Common Development Environment (CDE)
Adoption & Maintenance Strategies	**Mandated by client or government**

State of the Art 4D BIM enables the combination of 3D model with temporal aspects and scheduling (time as 4th dimension)

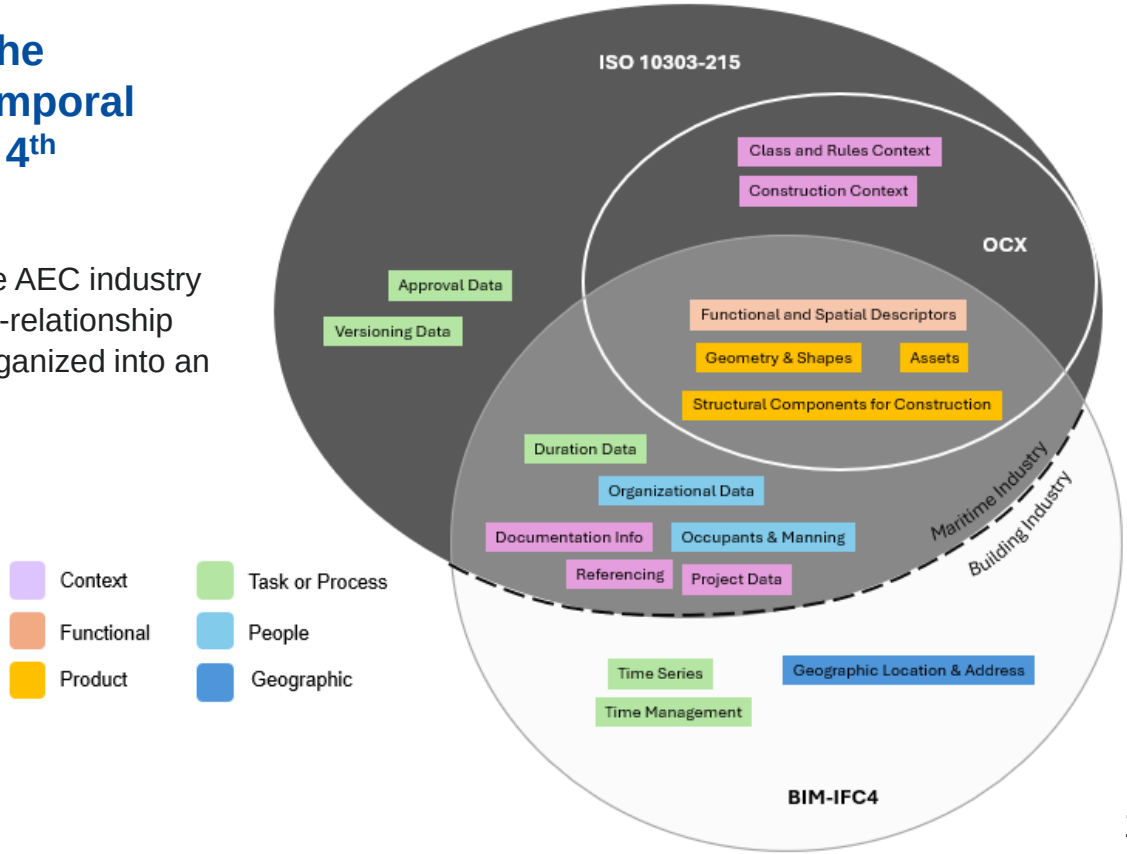
IFC is a neutral data schema specifically for the AEC industry to hold. IFC defines an EXPRESS based entity-relationship model consisting of several hundred entities organized into an object-based inheritance hierarchy.

ISO 16739-1:2018

Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries

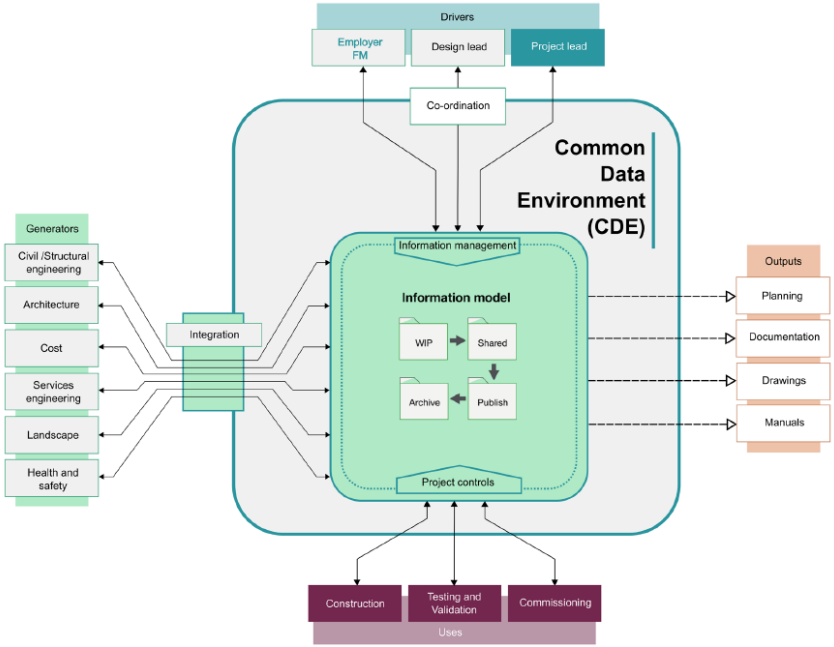
Part 1: Data schema

Status : **Published** (To be revised)
This standard will be replaced by ISO 16739-1



Defined Development Workflow

A CDE is a centralized system that compiles, manages, and distributes all project documentation. Along with providing the environment, the CDE defines states for the development and sharing of versions of a design before it is handed over to the client.



Work In Progress (WIP) State

WIP is the only state where information is editable

WIP to Shared Transition

Information container passes QA check and review

Shared State

Shared information is visible and accessible as read-only

Shared to Published Transition

Information model is reviewed for coordination, completeness, and accuracy

Published State

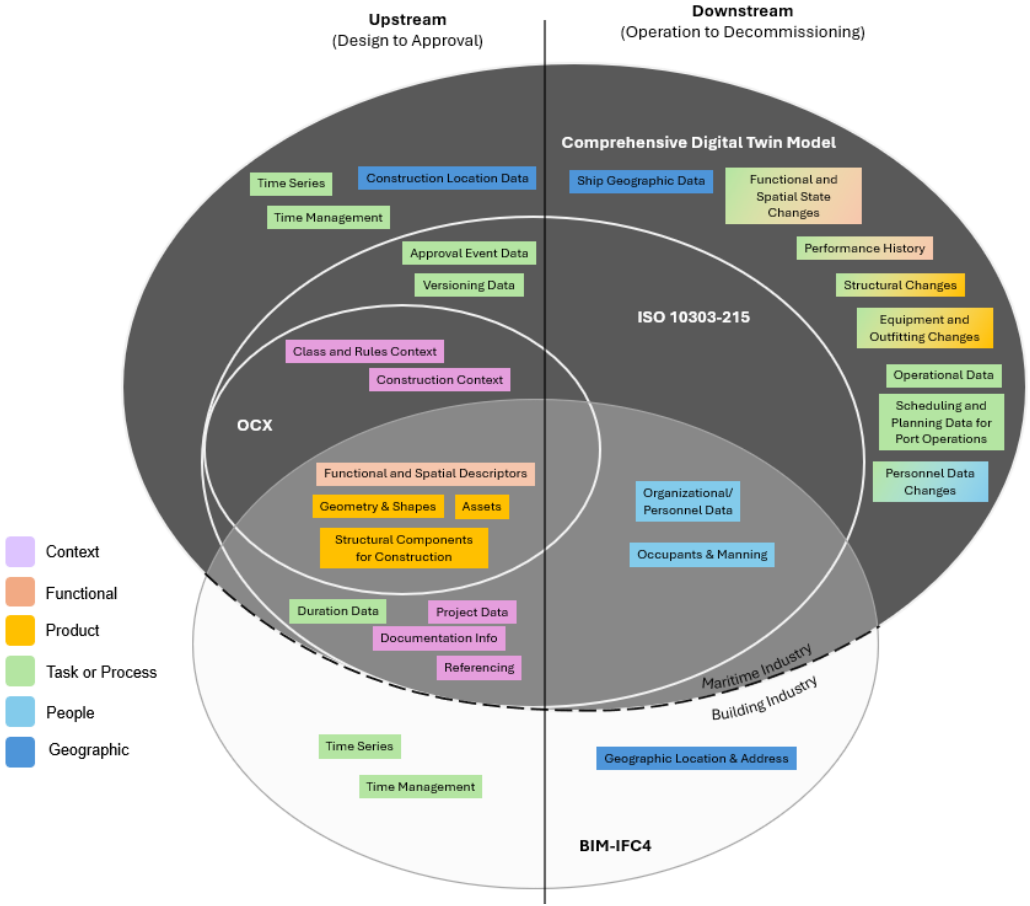
Information in the Published state is contractual information that has been accepted as a deliverable by client

(The Institution of Structural Engineers BIM Panel, 2021)

Are these practices transferrable in the shipbuilding industry?

Open Standards	**Collaboration mandated by BIM:** Standards for Controlled Data Exchange Required Data Federation practices (ISO 19650)	Implementation of **industry-acceptable data modeling and data exchange standards** designed for shipbuilding needs
Formalized Data Model	**Structured & Federated Information Model Required:** IFC for 3D Model (Neutral file exchange)	
Development Workflow	**Defined Process Required:** Defined execution of BIM with Common Development Environment (CDE)	Development of an **IPDE/CDE and workflow** for managing the revision and changes of model
Adoption Strategies	**Mandated by client or government**	Enforcement bodies vary, high reliance on legacy processes due to low-risk appetite

Are these practices transferrable in the shipbuilding industry?



The presentation aims to explore:

1. Current Challenges to a Comprehensive Multi-domain Model
2. Introduction and Insights from 4D BIM
3. **Adoption Potential in Shipbuilding Industry**

Use Cases of OCX with SEUS (NTNU)

Use Cases for SEUS Platform

Focus: **Levels Of Detail (LOD) Management**

1. Change Management
2. Maturity Management
3. Design Reviews
4. Requirements and Compliance Management (Rule Checks)
5. Design Trade-off or Design Space Analysis
6. Systems Integration
7. Simulated Planning

Temporal data & revision workflow management

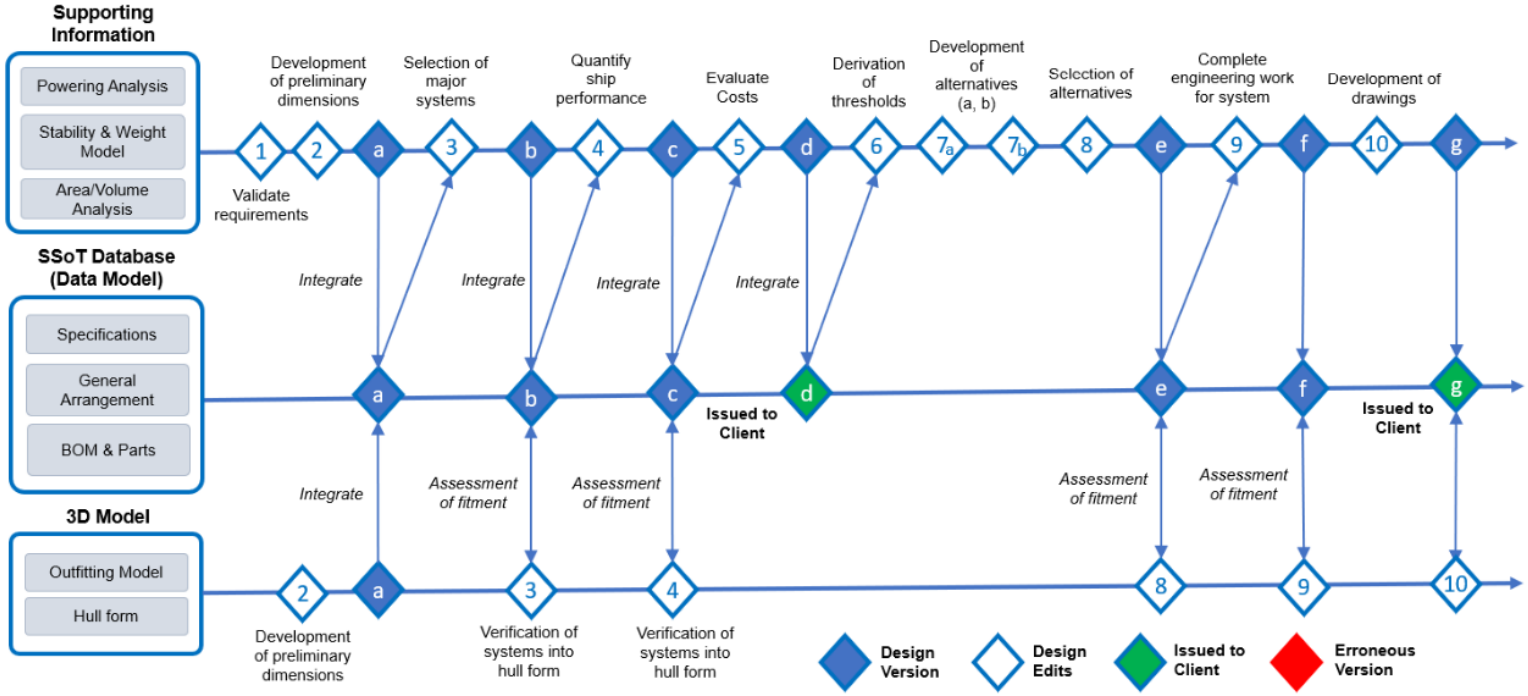
Use Cases for the OCX

Focus: **Class Approval**

1. End-2-end process coverage
2. Configuration and change management
3. Traceability of exchanges
4. Comments and Annotations

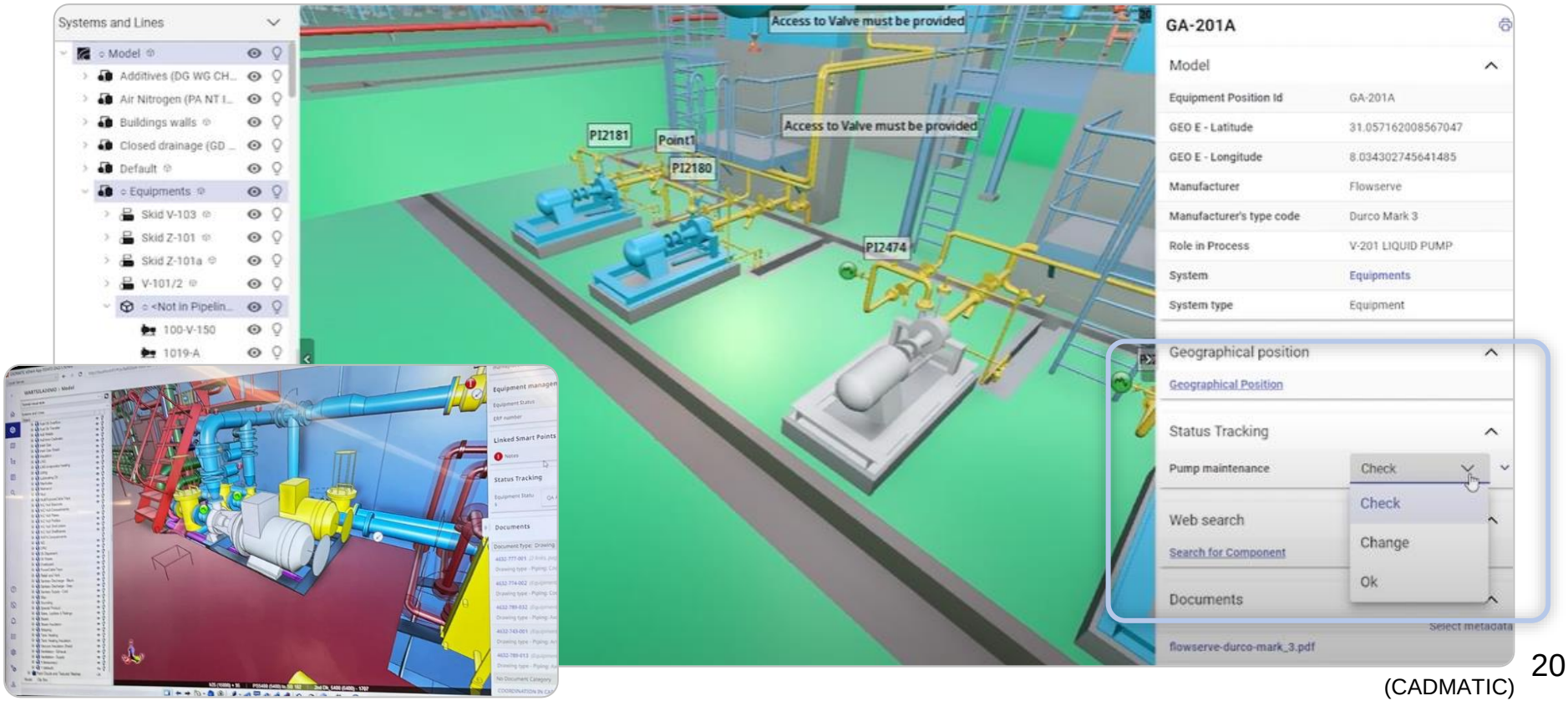
Use Cases of OCX with SEUS (NTNU)

Theoretical exploration of a workflow combining LOD Management and Approval/Feedback process. Could we apply similar design and revision states as BIM via 3D models and other data in an information container?



Use Cases of OCX with SEUS (Cadmatic)

Exploration of 3D model annotations and status tracking during the design and construction process.



(CADMATIC)

Thank you for listening!
Questions?

SEUS
Smart European Shipbuilding

OCX

https://www.ntnu.edu/seus

Norwegian University of Science and Technology

References

Autodesk, n.d. *Define Project BIM Standards for AEC Projects (According to the ISO 19650 Series).* [Online]
Available at: https://www.autodesk.com/learn/ondemand/course/bim-standards-management-for-aec-projects-using-autodesk-construction-cloud/module/2DiCp3pZZrB1s8EczTo5Hj
[Accessed 21 January 2024].

Azhar, S., 2011. Building Information Modeling (BIM): The Benefits, Risks, and Challenges for the AEC Industry. *Leadership and Management in Engineering,* 11(3), pp. 241-252.

CADMATIC, 2023. *CADMATIC™ eShare for Process Industry – Status tracking.* [Online]
Available at: https://www.youtube.com/watch?v=2fyK6We-N7g
Gaspar, H., Sepällä, L., Koelman, H. & Agis, J. J. G., 2023. Can European Shipyards be smarter? A proposal for the SEUS Project.

OCX Consortium, 2021. *The Open Class 3D Exchange Format.* [Online]
Available at: https://3docx.org/
[Accessed 21 January 2023].

The Institution of Structural Engineers BIM Panel, 2021. *An Introduction to Building Information Modelling (BIM),* s.l.: s.n.