STRUCTURAL DIGITAL TWINS FOR NET ZERO 2050
WHAT IS A DIGITAL TWIN?

VIRTUAL DIGITAL TWIN
Digital geography of entire environments

PROCESS DIGITAL TWIN
Digital mapping of a physical process

STRUCTURAL DIGITAL TWIN
Fully parametric physics based model
BIGGER
Unlimited size

FASTER
1000x speed up

BETTER
10x more accuracy
CREATING VALUE FOR CUSTOMERS AROUND THE WORLD

Designing & Protecting infrastructure across the energy industry

- Protecting 10 $bln/year production
- Ultimate accuracy for predictive maintenance
- Reducing steel weight by up to 30%
- Extending life by >5yrs
CORE TECHNOLOGY **ENABLES ~1000X ACCELERATION COMPARED TO LEGACY APPROACH**

**RB-FEA**

**PARAMETERIZED COMPONENTS**
Each component pre analyzed across all relevant parameters (material, thickness, loads etc.)

**FULL MODEL**

**PATENTED SOLVER METHOD**

**~1000X SPEED ON FULL MODEL EVALUATION**

RB-FEA solve in seconds
In full detail
FROM: local models & slow computation

FROM: SLOW & LIMITED MODELS
RISER/UMBILICALS TO HOLISTIC MODELS IN NEAR REAL-TIME

- Wind Turbines
- Pressure Vessels
- Rotating Machinery
- Fixed Structures
- Floating Structures
- Riser/Umbilicals
DIGITAL TWINS FOR LEGACY ASSETS (O&G)
The trajectory of oil demand for Net Zero 2050 means that no exploration for new resources is required and no new oil fields are necessary. However, continued investment in existing sources of oil production are needed.
AKSELOS HAS SUCCESSFULLY SPED UP WORKFLOWS FOR FLOATING IN SHELL

- Compress 6 months workflow to 48 hours
- Accuracy up 10x
- Fully validated by LR

BEST-IN-CLASS FOR FLOATING OFFSHORE

INCREASE SAFETY
LOWER OPEX
HIGHER ROI

2021 BEST PAPER AWARD
@ OTC
Akselos accelerates and “scales up” FEA via a new solver type: 
RB-FEA (Reduced Basis FEA)

• Component-based reduced order modeling

• Two-phase approach gives ~1000x speedup compared to FEA:
  (1) Component Pre-analysis and (2) Model Evaluation

• Components are parametrized: change material properties, thicknesses, geometry, load
ASSET LIFE EXTENSION

Beam model with SCF

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<th>Akselos Model with 3D Joints</th>
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Fatigue life below 50 years (according to Standards-based calculation and with 5x safety factor)

CONTINUE OPERATIONS FOR ANOTHER 20 YEARS

AGREEMENT FROM REGULATORS

OPTIMIZED STRUCTURAL INTEGRITY

PREMATURE ASSET REPLACEMENT

DECOMMISSION

OVERLY CONSERVATIVE MAINTENANCE PROTOCOLS
CASE STUDY

OIL AND GAS TECHNOLOGY CENTER
DIGITAL TWIN OF PRESSURE VESSEL

Joint Industry Project
IMPROVE INDUSTRY PRACTICE FOR INSPECTION AND MAINTANANCE OF PRESSURE VESSELS

INCREASE ACCURACY/SPEED

REDUCE COST/CONSERVATISM

HIGHLY PREDICTIVE FRAMEWORK THROUGH A PHYSICS-BASED INTERPRETATION OF INSPECTION DATA.

FACILITATED BY AKSELOS STRUCTURAL DIGITAL TWIN TECHNOLOGY

PROJECT DRIVERS

45% REDUCTION IN EQUIPMENT DOWNTIME

25% MAINTENANCE COST REDUCTION
ACCELERATED WORKFLOW WITH AUTOMATED STEPS

DATA INPUTS

SHELL COMPONENT

2D UV MAPPING

SCAN PLAN

AUTOMATED RE-ANALYSIS AND REPORTING

THICKNESS MAPPED TO DIGITAL TWIN

THICKNESS PROFILE
DIGITAL TWIN IMPLEMENTATION

Digital Twin model creation for Pressure Vessel Fitness - For Service evaluations based on API 579/ASME FFS-1[1]

Full digital thread scenario and automation

REPORT

API 579-1 Fitness-for-Service
Level 3 Assessments of Metal Loss

AUTOMATICALLY
REPEATED
**EXAMPLE EVENT**

**EVENT**
Upstream supply issues force unplanned turn/shutdown

**LEVERAGE ‘CONNECTED’ DATA FEEDS**
Process (and sensor) data stream to digital twin

**ANALYSE**
Akselos digital twin processes data in near real-time (onsite server or cloud)

**DECIDE/ACTION**
Control room receives notification to increase or decrease speed of reactor vessel cooldown
Info can also be accessed through Akselos dashboard 24/7 globally

Akselos output can be integrated into local DCS

Akselos digital twin

- Wall thickness, cracks
- Pressure, temperature, throughput
- Strain gauges, additional temp.sensors

Inspection data

Process data

Sensor data

Instant dashboard updates

Akselos digital twin calculates max cooldown rate

- Event
- Leverage ‘Connected’ Data Feeds
- Analyse
- Decide/Action

Example:
Akselos output can be integrated into local DCS
Instant dashboard updates
DIGITAL TWINS FOR NEW ENERGY
HYPERGROWTH FOR OFFSHORE WIND TARGETS

Offshore Wind Annual Installation Targets

Global Wind Energy Council
IEA Net Zero

2020 Worldwide Capacity

GWEC
GLOBAL WIND ENERGY COUNCIL

International Energy Agency
Reduction in Cost of renewables is a Game Changer

Source: Lazard's LCOE Analysis

Graph showing the cost of energy from various sources over time, with a focus on Fixed and Floating Offshore Wind.
INCREMENTAL INNOVATION IN WIND
VS.
SPEED AND SCALE REQUIRED FOR ENERGY TRANSITION

“LCOE of offshore wind must still come down by more than 60%.”
DESIGNING THE NEXT GENERATION OF RENEWABLE POWER INFRASTRUCTURE

Policy:
- Site Surveys
- Permitting
- Tendering
- Offtake Agreement

Technology:
- Turbine Design
- Project Design
- Certification
- Prototyping & Testing
- Installation

Yr 1 Yr 2 Yr 3 Yr 4 Yr 5 Yr 6 Yr 7 Yr 8

TODAY

TO

COLLABORATION
- KNOWLEDGE IS DISPARATE
- IMPROVEMENTS COME FROM ACROSS THE INDUSTRY

PROVEN METHODS
- FASTER DEPLOYMENT
- 90% REDUCTION IN ENGINEERING TIME

TIME REDUCTION IN DEPLOYMENT
POWERFUL NEW INNOVATION CURVE

OFFSHORE WIND
0.3% OF GLOBAL POWER GENERATION TODAY

FEA
INCREMENTAL INNOVATION

RB-FEA
DISRUPTIVE INNOVATION

SCALABLE SYSTEM DESIGN FOR THE ENERGY TRANSITION

POTENTIAL TO POWER THE WORLD 18 TIMES OVER
ENABLING TECHNOLOGY FOR FLOATING OFFSHORE WIND

TETRASPAR PROJECT

OBJECTIVE
ENABLE LARGE SCALE FLOATING OFFSHORE WIND

ACCELERATE VALIDATION
PROVE INDUSTRIALIZATION

RAMP UP TO 1000'S
FASTER @ LOWER COST