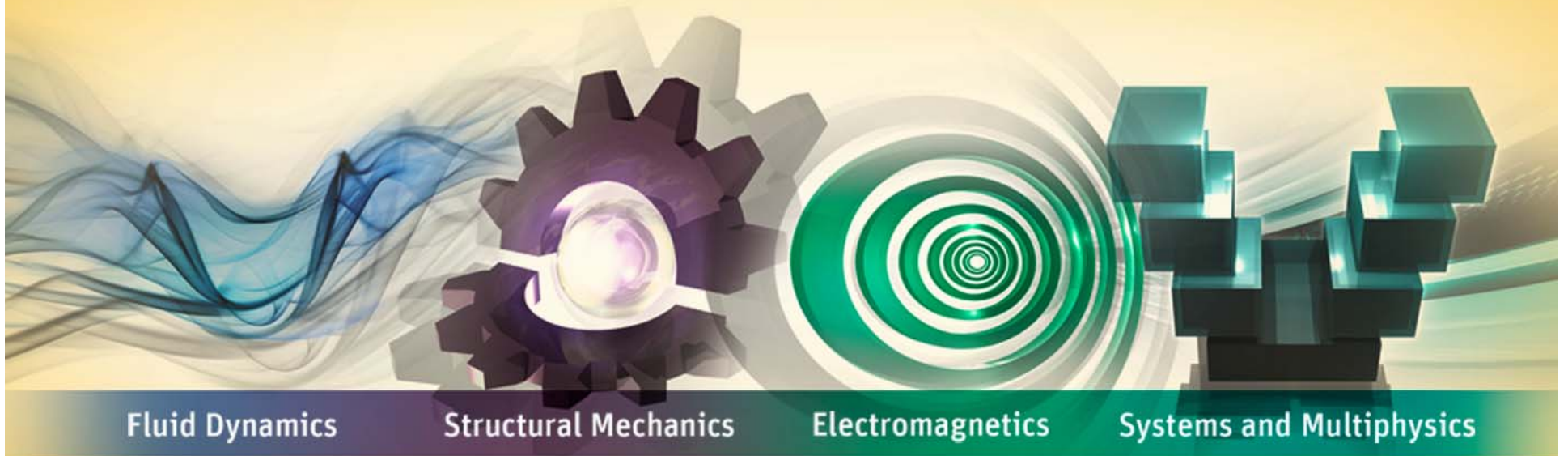


ANSYS Aqwa Review



Fluid Dynamics

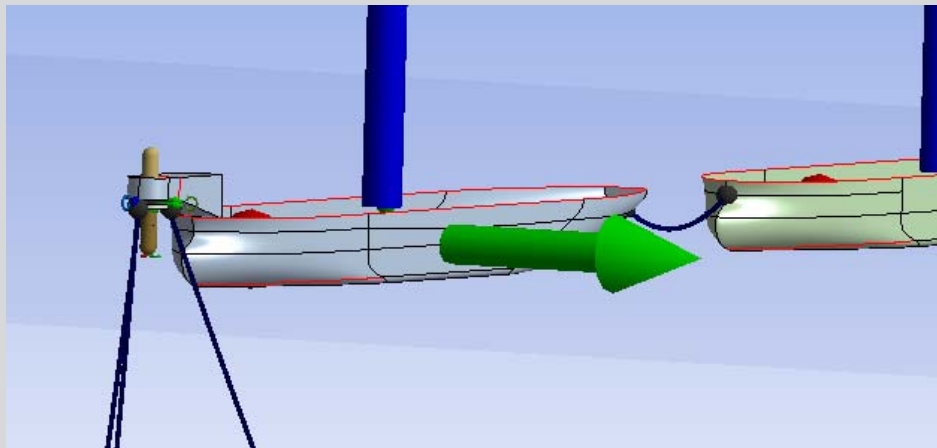
Structural Mechanics

Electromagnetics

Systems and Multiphysics

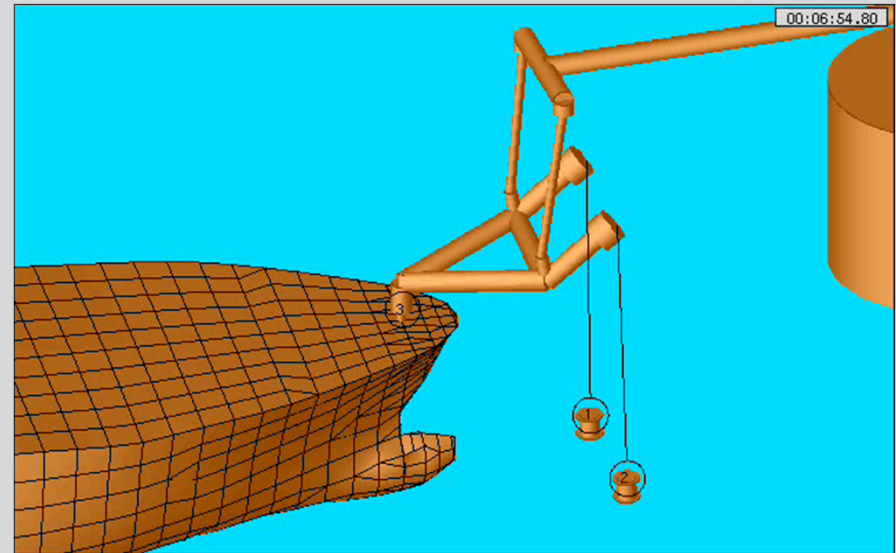
Paul Schofield – ANSYS Houston

- ANSYS Aqwa for hydrodynamic analysis and vessel motions
- Applications include:
 - Hydrodynamic Diffraction and Radiation
 - Moored multi-body systems
 - Sea keeping (eg ship performance)

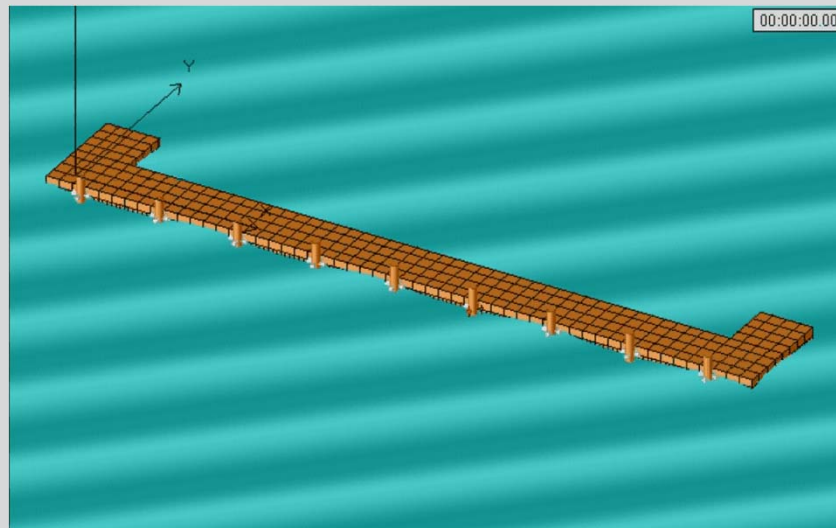


ANSYS® and specifically

- Connect /offloading /disconnect scenarios
- Floatover installations
- Launching installations
- Transportation
- Ports and harbors

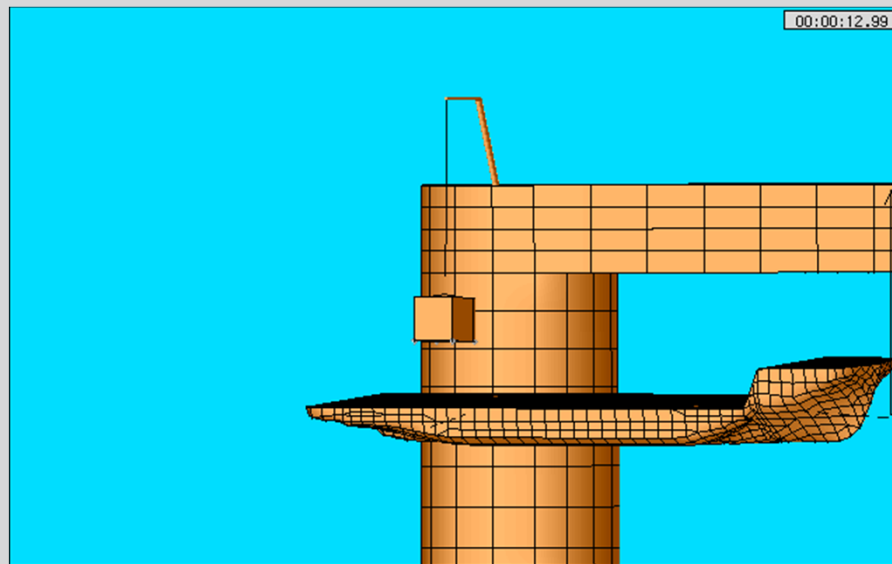


Courtesy of SBM

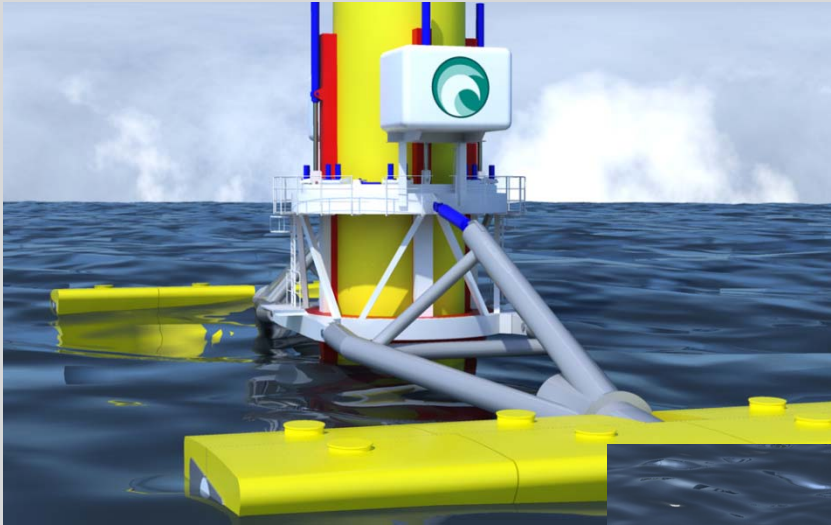


.... and specifically

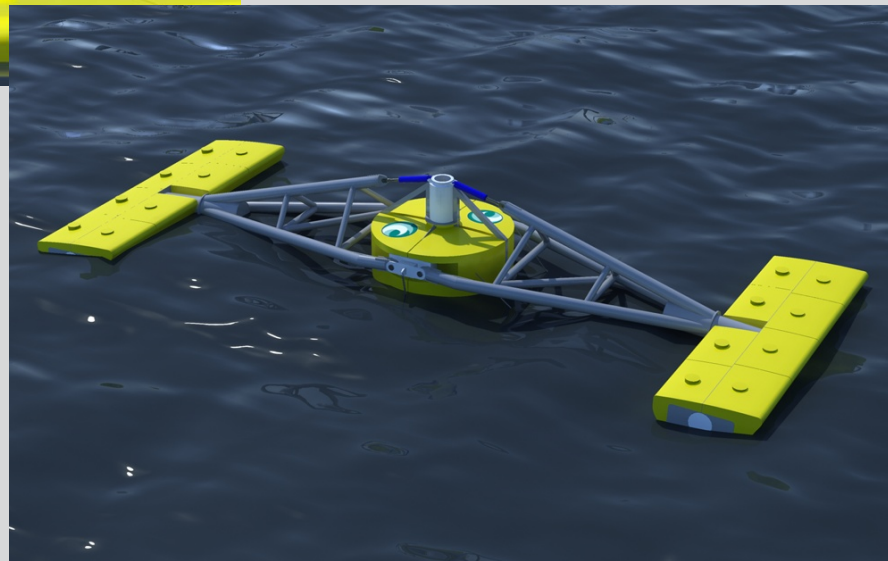
- Lifting operations
- Failure conditions
- Air gap
- User definable functionality eg DPS



ANSYS Aqwa – Wave Energy Systems



Wave Treader – Courtesy Green Ocean Energy Ltd



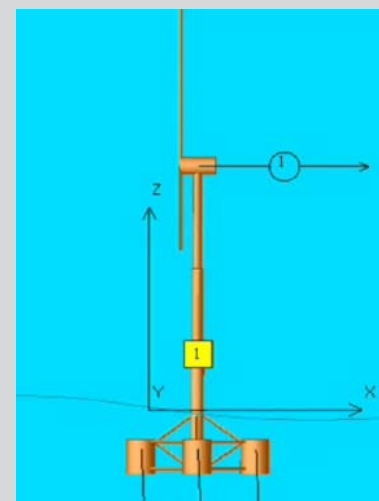
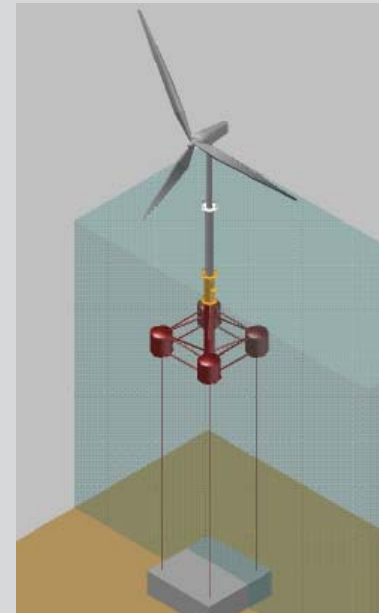
Ocean Treader – Courtesy Green Ocean Energy Ltd

- **Challenges:**

- To validate the patented concept of the wind turbine foundation called SeaBreeze[®] Floating with approx. dimensions:
 - Nacelle Height : 72.75m
 - Rotor Diameter : 90-100m
 - Water Depth : 50m plus
 - Wave Height : 20m!
- To compare simulations with extensive model testing

- **Key Features:**

- Special Tether elements (i.e., pre-tensioned mooring lines with bending stiffness) incl. stress & fatigue
- Capabilities to take into account 2nd order effects in hydrodynamic analysis for large and/or steep waves, including effects of intermittent wetting and mean/slow drift

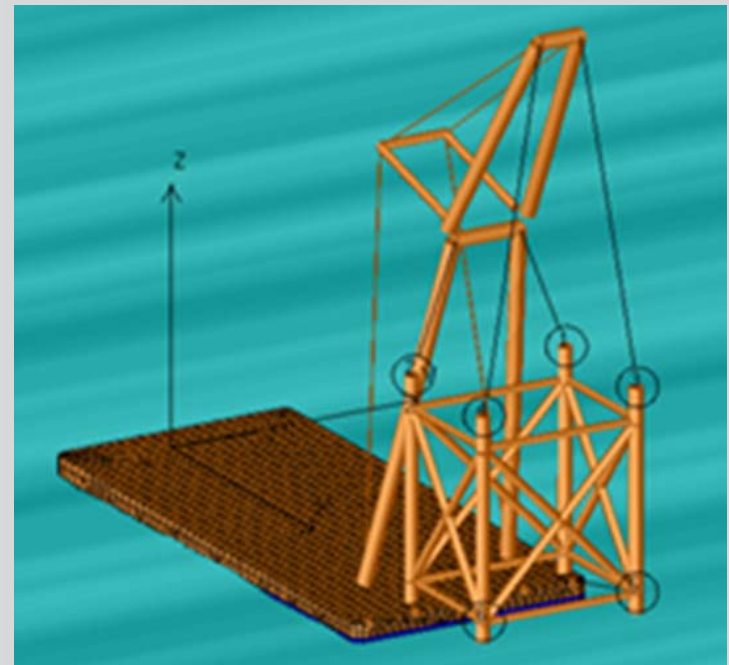


Aqwa- Transport & Installation of Offshore High Voltage Station

- **Challenges:**
- **To determine the loads in the lifting rigging and the motions of the jacket during both transport and installation.**
- **With these values, the allowable weather conditions are defined for multiple wave headings**

Key Features:

- **Multi-body motion analysis both in frequency and time domain**
- **Various connecting accessories (e.g., *winch*, fender, ball/socket, hinge connectors, pulley)**
- **Mixed model of Morison and diffraction elements in time domain**



ANSYS Aqwa – review

- **How we got where we are today**
- **Progress in ANSYS Workbench integration**
- **Current developments**
- **Thoughts about the future**

ANSYS Aqwa – some history

- **1975 – 2001: developed by WS Atkins**
- **Technology acquired by Century Dynamics in 2001**
- **Century Dynamics acquired by ANSYS in 2005**
- **v5.7d (Q1 2008) was the last to be issued under the old Century Dynamics system. Equivalent to ANSYS 11.0**
- **12.0 (Q2 2009) Aqwa was included in the Ansys release system. Adopted ANSYS compiler, build process, QA, licensing etc.**
Stand-alone prototype Workbench look-alike: AQWAWB
- **12.1 (Q4 2009) Aqwa-Line included in Workbench as “Hydrodynamic Diffraction” analysis system**

Hydrodynamics in Workbench

13.0

- **Link to Designmodeler for geometry generation**
- **Hydrodynamic Diffraction and Time Response systems**
- **Animation of RAO motions and wave surface from Diffraction analysis**
- **Mooring connections**
- **Numerical graphical results from Time-History**

14.0

- **Fender and articulation (joints) included**
- **Aqwa Reference Manual now part of standard ANSYS Help System**

Hydrodynamics in Workbench

14.5 (Current Release)

- Time–history animations available
- Improvements to user interface

- **Bending stiffness and non-linear axial stiffness for catenary mooring lines enables modelling of SCRs and synthetic mooring lines**
- **Additional stiffness between structures enables mooring systems to be modeled in a diffraction/radiation analysis**
- **ISO wind spectrum**

Technology - 14.0

- **Multiple wave spectra with 2nd order interaction in Aqwa-Librium and Drift. Enables simulation of spread seas in time-domain.**
- **Linearization of TUBE drag in Aqwa-Line. Enables RAOs of tubular structures to be more accurate**
- **Bending Moment and Shear Force improvements in AGS**
 - **TUBEs included**
 - **Distribution along vertical axis**
 - **Enables bending moment calculation and plotting for Spars**
 - **Aqwa-Line stage 5**
- **Wheeler stretching in Aqwa-Naut, gives more accurate surface elevation and wave pressure.**

Technology - 14.5

- **Multiple wave spectra with 2nd order interaction in Aqwa-Fer**
- **Linearization of Morison drag in Aqwa-Line now includes DISC and STUB elements**
- **Linearization of Morison drag in Aqwa-Fer for TUBE, DISC and STUB elements**
- **Bending Moment and Shear Force improvements in AGS DISC and STUB elements included**

ANSYS Aqwa 15.0

Current priorities

- **Improved meshing – exposure of more of the meshing technology available in other parts of Workbench**
- **Animation of wave surface for Time History analyses**
- **Completion of drag linearization**
 - Hull drag
 - Multiple structures in Aqwa Line
- **Coupling with Wind-Turbine analysis programs**
- **Improved documentation, starting with theory manual**

ANSYS Aqwa 15.0+

Please add your suggestions on the questionnaire.

- **Continuing improvements in Workbench**
 - Additional features (next slide)
- **Improvements in core technology**
 - Hydrodynamics
 - Cable dynamics
 - Time history simulations
- **Improving performance – parallel processing**
- **Improving links to other ANSYS applications, especially load transfer to structural model**

Hydrodynamics in Workbench

Future enhancements to be worked on ...

- **Symmetry**
- **Tethers**
- **Aqwa-Librium**
- **Aqwa-Fer**
- **Cable-dynamics stand-alone analysis**
- **Graphical post-processing as in AGS**
- **Import of old databases**

ANSYS Aqwa – further integration potential

- **Use of ANSYS tools for parallel processing**
- **More robust import of CAD models**
- **Provide hydrodynamic loads to structural analysis**
- **Use CFD to generate drag coefficients for use in Aqwa**
- **Use Aqwa cable models in other systems; e.g. Rigid Body Dynamics, CFD of floating structures**
- **Use Aqwa to provide boundary conditions for CFD analysis ??**

ANSYS Aqwa – the future

- **ANSYS vision for Simulation Driven Product Development**
- **Integrated environment for multi-physics analysis to support improved and faster design**
- **Aqwa has a role, both as supplier and receiver of data**