Orcina
Professional software for engineering professionals

OrcaFlex Brochure

www.orcina.com

OrcaFlex is global dynamic analysis software for long & slender objects, primarily in water. ***Typical systems include:***

Riser Systems	TTRs, SCRs, hybrids, flexibles, umbilicals, offloading & floating hoses, etc.
Installation & Decommissioning	Risers, moorings, anchors, pipelay, lift dynamics, subsea hardware, floatover, etc.
Moorings & Global Performance	Coupled systems, permanent & mobile moorings, SPMs, spread / oceanographic / jetty moorings, etc.
Pipelay & Pipelines	S-Lay (rigid, hinged and articulated stingers), J-Lay, lay over chutes, on-bottom stability, spanning, VIV assessment, trawl impact, etc.
Renewables	Wave power systems, offshore wind farm installation, floating wind turbines, power cable take-off.
Towed Systems	Bundles, seismic arrays, towed fish, etc.
Other applications	TLPs, fishfarms, booms, sea-fastening, minesweeping,...

Orcina

- is a UK-based, independent and owner-managed company
- has been developing professional software since 1986, including OrcaFlex, OrcaLay and OrcaBend (for further details, see www.orcina.com/SoftwareProducts)
- is totally focussed on the development and support of OrcaFlex – activities which are much the biggest aspect of our business
- offers best-in-class client support, User Group Meetings, training programs and an actively maintained website
- is supported by agents in N. America, S. America, S.E. Asia, S. Korea, India & Middle East and China – see last page for details.

Useful Links

OrcaFlex release info at:
www.orcina.com/Support/OrcaFlex

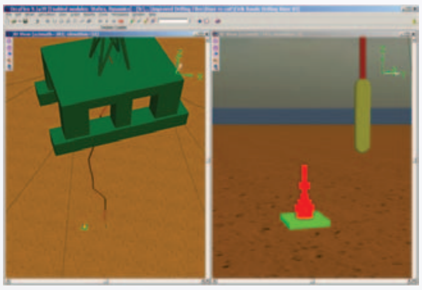
OrcaFlex User Group Meeting info at:
www.orcina.com/Support/UserGroup

OrcaFlex training info at:
www.orcina.com/Support/SoftwareTraining

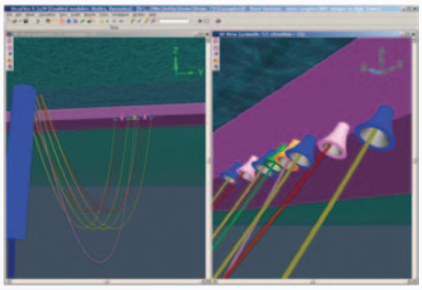
Other resources at:
www.orcina.com/Resources

Some typical OrcaFlex Applications....

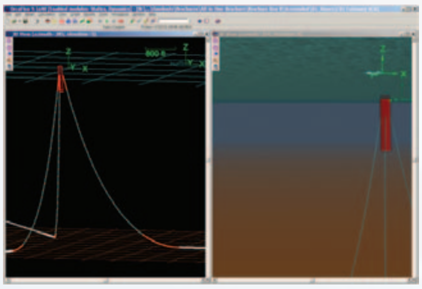
Riser Systems



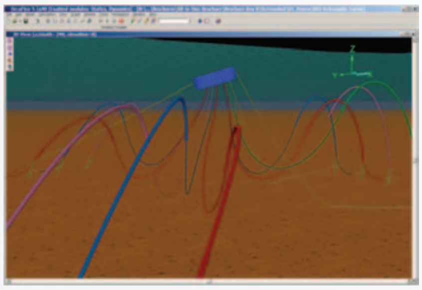
Here OrcaFlex is used to model the emergency disconnect of a drilling riser. Critically the recoil of the riser must be correctly modelled to ensure accurate determination of the magnitude of the travelling stress wave so as to estimate the potential for damage / injury on the drill rig. It is also very important to assess whether the disconnected riser makes contact with the wellhead equipment.



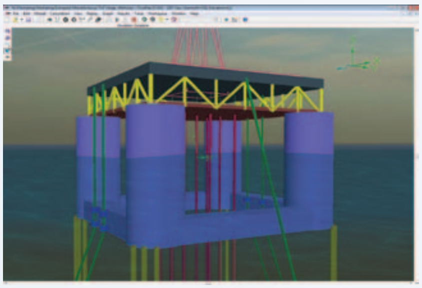
The above shows jumper lines between a riser tower and an FPSO riser gantry. The coupled dynamics of the system are fully modelled as is the bellmouth interaction. Clearances between lines are critical, especially with normal current flow and lines with different specific weights - clearances are a standard results variable in OrcaFlex.



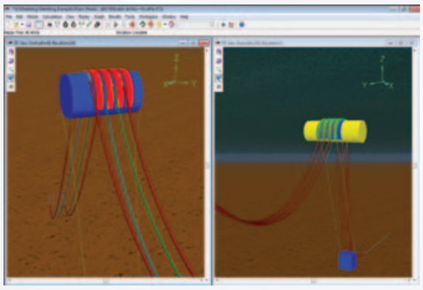
The above screenshot shows 3 SCRs hanging from a SPAR host. The critical issue here is fatigue damage in the hang-off and touch-down areas. OrcaFlex is used to find the dynamic stresses in these locations and then to post-process these using built-in fatigue analysis facilities. Cumulative fatigue damage in any region is thereby easily determined.



Here OrcaFlex is used to model a disconnectable turret system. The configuration of the flexible risers, key mooring lines and turret is shown just after disconnect. Of interest are the riser curvature, particularly in the sagbend, contact between the lines and seabed, and clearance / contact between the risers and moorings – which can all be checked during the simulation and / or replay.

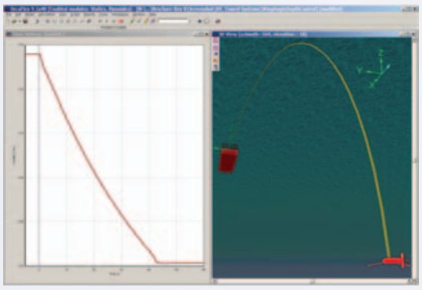


Above is an OrcaFlex model of a Tension Leg Platform. Inclusion of second order sum frequency hydrodynamic load terms are key, as is proper tendon modelling. The fully coupled solver option correctly determines the resulting motion of the highly coupled system.

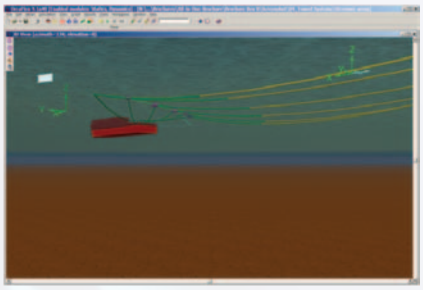


OrcaFlex is pre-eminent in modelling mid-water arches. Multiple lines are easily handled and each object's separate coordinate system makes extraction of key results very straightforward. This flexibility means you can model MWA systems in whatever level of detail is appropriate for your analysis.

Towed Systems

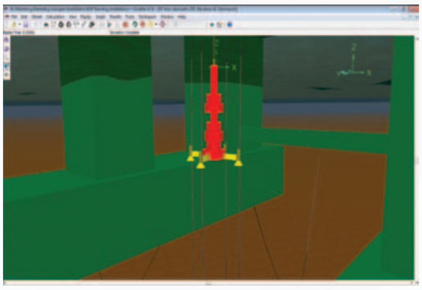


In towed fish problems, it's very useful to control wing orientation with time to achieve some desired objective (eg., proximity to other structures or below the sea surface / above the seabed). OrcaFlex models this with a PID controller- the user specifies target depth and the controller sets wing angle to achieve this.

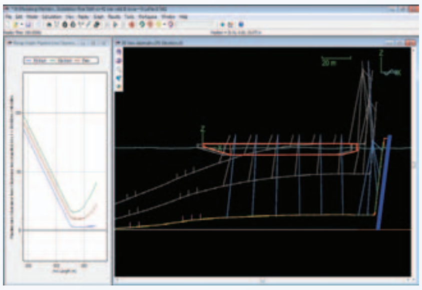


The above screenshot shows the port side of a 12 streamer array. As well as the streamers and guns, all the connection rigging and the 'diverter' are fully modelled. Key issues are the maintenance of diverter lift to keep the spread, especially whilst turning. Loads within the rigging are also important – failure here can lead to a collapse of the array and significant levels of downtime.

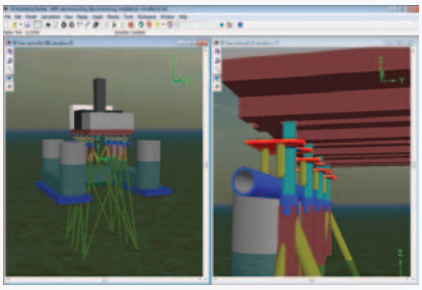
Installation, Decommissioning & Pipelay



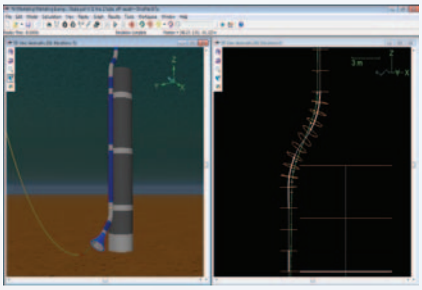
In this example, OrcaFlex is being used to model the lowering of marine equipment to the seabed, guided by a system of tensioned wires. The guide system is fully modelled allowing the interactions between the guides and guide wires to be realistically accounted for. All the results of interest eg., line tension, lateral loads on the guide wires, loads on the object, etc., are then readily obtained.



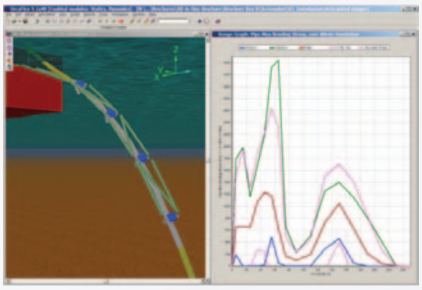
Here OrcaFlex is being used to model the installation of an assembled riser. The laydown of the seabed section and the line rising up the jacket leg are treated in a coupled fashion. The interaction of the section along the seabed critically affects the positioning of the jacket section. Accurate modelling of the total process is essential for efficient and cost-effective installation.



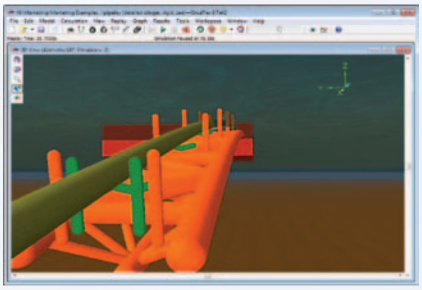
Here OrcaFlex is being used to model the interaction between a floating decommissioning structure and the topside of a fixed jacket. OrcaFlex's extremely robust contact algorithm was the key to success in this model. OrcaFlex is equally applicable to the process in reverse, ie., floatover mating.



The analysis of a J-tube pull-in in OrcaFlex is very straightforward. Here we show a pull-in from a surface vessel with a requirement to keep the line off the seabed. The large-scale axial movement of the line inside the J-tube, including friction, is modelled, allowing determination of all results, including the stresses in both the line and the J-tube.

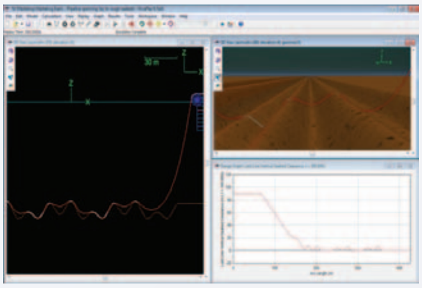


Here a 3-stage articulated stinger is modelled in OrcaFlex - a rigid hinged stinger is a simpler variant of this example. The relative movement between the pipe and stinger is fully accounted for, with intermittent roller lift-off and contact handled as a matter of course. Roller boxes can be set up with arbitrary geometry and full information on clearance, contact load and contact energy is provided as standard output.

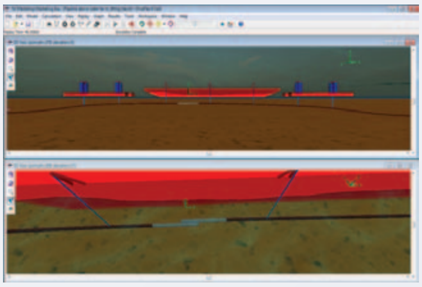


This model shows a detailed rigid stinger model. Simple V-shaped rollers are shown, though any roller configuration is easily modelled. Two lateral restraints are shown at the end of the stinger. The contact algorithm easily handles the interaction between the pipe and the contact elements.

Pipelines

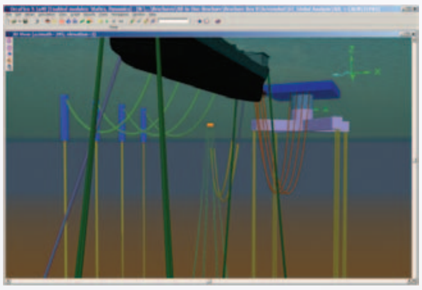


In this example OrcaFlex is being used for a dynamic analysis of the installation of a pipe on an uneven seabed. The lock-in of frictional tension effects is fully captured, giving the correct tension distribution in the line. This allows a proper determination of line spans and natural frequencies, and hence the VIV effects.

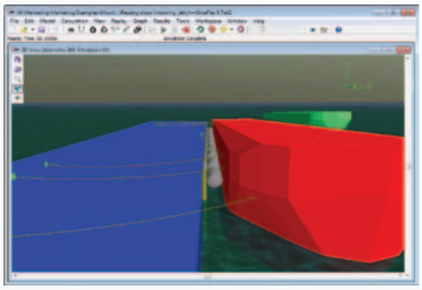


Here OrcaFlex shows a pipeline being reconnected after a cut-and-repair project. In such shallow water it's imperative to get the right geometric arrangement of supporting infrastructure to recover, mate and re-lay the pipe safely back to the seabed.

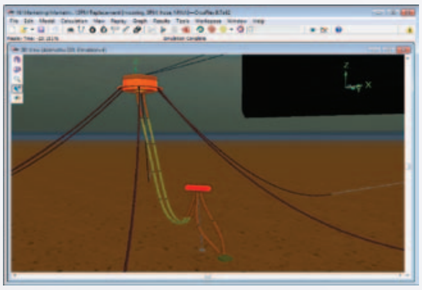
Moorings and Global Performance



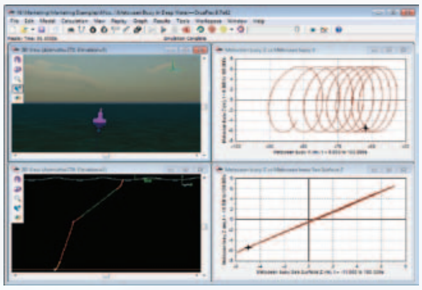
The above screenshot shows a fully coupled model of a TLP, a spread moored FPSO and an offloading CALM system. Modelling of this level of detail allows accurate assessment of the relative clearance of these structures as well as the loads throughout the system.



Here a jetty mooring is being modelled in OrcaFlex. As well as the mooring lines, the berthing dolphins all interact with the floater. The hydrodynamic loads from a passing ship are also considered in this example, although these loads are not calculated by OrcaFlex, but are imported and imposed as time histories.

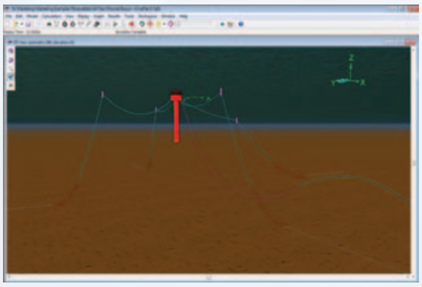


Here the OrcaFlex model shows a shallow water CALM buoy with an offloading tanker connected. The dynamics of this fully coupled system are all accounted for, allowing ready determination of the loads and clearances in the mooring lines, hoses and connection tethers.

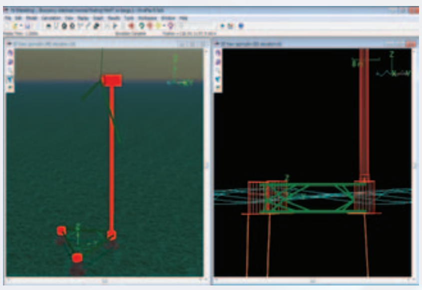


This model shows a single-leg oceanographic mooring system. Monitoring instrumentation exists on the buoy and partially down the mooring leg. One purpose of the analysis is to determine the dynamic loads on the instrumentation so they can be designed to withstand them.

Renewables

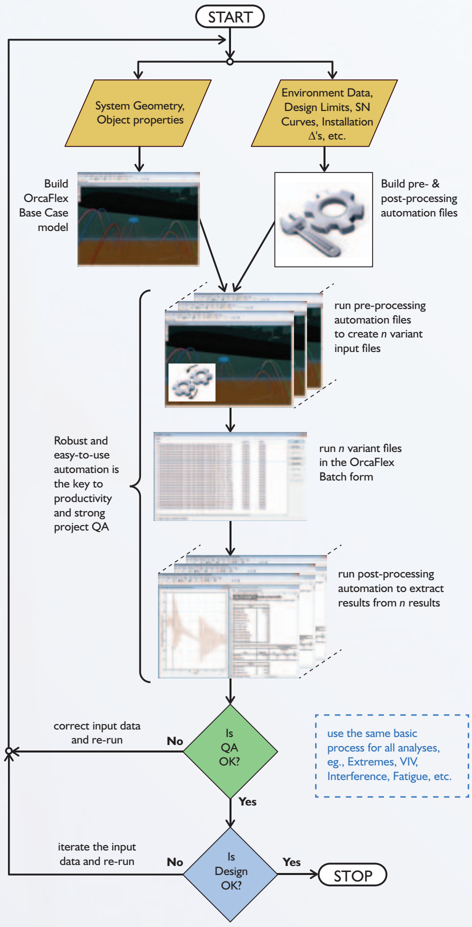


This model shows a moored point wave energy converter. The floater, mooring lines and the power cable are all modelled in this fully integrated analysis. For some WECs an initial estimation of energy production can also be made in OrcaFlex, though this depends on the precise conversion mechanism.



OrcaFlex is used for floating wind turbine structures. The floater, moorings and any power cables are fully coupled in the model. OrcaFlex can account for the aerodynamic loads in a simplified fashion, or, through a coupling with NREL's FAST program, can perform much more sophisticated aerodynamic modelling.

Flow Chart of Main Analysis Steps



OrcaFlex version 9.7 Technical Specification...

Summary of Key Orcaflex Modelling Features

- 3D, non-linear, large displacement analysis
- Fully coupled tension, bending & torsion
- Accurate, efficient and proven FE formulation
- Robust line compression / snatch modelling
- Robust *external* line-on-line clash & sliding contact
- Robust *internal* line-in-line impact & sliding contact
- Modelling of post-contact behaviour
- Line slug flow and free-flooding effects
- Implicit and explicit time integration
- Fully coupled vessel / line analysis
- Comprehensive vessel load modelling
- Multi-body hydrodynamic coupling
- Full sum and full difference QTFs
- Vessel wave shielding (sea state RAOs)
- Water entry / exit slam loads
- Full description of wind, wave and current
- Flat, 2D or 3D seabed profile
- Linear elastic / non-linear hysteretic / P-y soil
- Binary and / or text input files
- Fatigue analysis
- Extreme value statistics
- Modal analysis
- VIV and Interference analysis
- Pipelay and Riser code checks

Summary of Key Orcaflex Productivity Features

- Comprehensive range of automation tools
- Complete Matlab, Python & DLL interfaces
- Parallel processing on multi-core hardware (at no extra cost)
- Batch processing for volume analyses
- Distributed OrcaFlex optimises multi-licence use
- Full GUI with wire frame / shaded views

Major Changes in Last Two Releases

(full details for all releases are at www.orcina.com/Support/OrcaFlex)

Version 9.7 (Sept-13)

- Multi-body hydrodynamics
- Re-implemented hydro data import
- Sea state RAOs (vessel wave shielding)
- Code checks (API RP 1111, DNV OS F101, DNV OS F201 and PD 8010. API RP 2RD has been in since v9.3)
- Post-calculation actions (allows scripts to be executed in batch)
- Tool to convert older text data files to current version
- Lots of other enhancements to automation and UI

Version 9.6 (Oct-12)

- 64-bit OrcaFlex (can use more memory, esp. for multi-processors)
- New Line Contact model for PiP, PoP, J-tube pulls, Bend Stiffeners, etc
- Full sum- and difference-frequency QTFs
- Mode loads
- Different static EI from existing dynamic EI
- P-y can now be off-vertical
- Fatigue added to text file automation

Features now high on the list for 9.8 and beyond

- Pipelay stinger and roller setup interface
- Software licencing (dongle-free)
- Parameter study and custom results
- Line results at nodes
- Line payout
- Varying added-mass & damping near boundaries
- Frequency Domain
- Restarts
- Better lateral seabed modelling

Modelling Objects

OrcaFlex's inherent stability and robustness allow sophisticated models to be easily built and analysed

LINE OBJECT

- Fully coupled bending / torsion, and axial stiffness
- Bend Stiffener / Tapered Stress Joint model generation
- Centrifugal internal flow effects included
- Slug flow and free flooding options for line contents
- Multiple coatings and linings can be defined
- Equivalent pipe setup tool
- Bending stiffness, drag and added mass can be non-isotropic
- Axial, bending and torsional stiffness can be non-linear
- 3D hysteresis model available for bending
- Rayleigh damping options
- Line CofG may be displaced from geometric centre
- Pre-bend can be modelled (eg, spool pieces)
- Clumped line attachments, drag chains or flex joints
- Non-isotropic Coulomb friction with seabed and elastic solids
- Two line-to-line contact models including post-contact behaviour:
  - Line Clashing for external clash modelling between lines
  - Line Contact for pipe-in-pipe, piggybacks, J-tube pulls, bend stiffeners, sliding connections, etc., allowing smooth modelling of large relative axial motion including friction
- Hydrodynamic and aerodynamic loading
- Wake Interference (Huse, Blevins, User Specified)
- Partially submerged lines (eg, floating hoses) handled robustly
- Line drag and lift coeffs can vary with *Re* & seabed proximity
- Compressibility specified by bulk modulus

VESSEL OBJECT

- Imposed vessel displacements:
  - First order *displacement* RAOs
  - Prescribed and / or Harmonic Motion
  - time history motion files
  - externally calculated
- Loads for calculated vessel motions:
  - First order *load* RAOs
  - Applied Loads (thrusters, ice, etc.)
  - 2nd order (low freq.) difference QTFs: Full and Newman
  - 2nd order (high freq.) sum QTFs
  - wave drift damping
  - Added Mass and Damping with convolution
  - 6DoF 'other' linear and quadratic damping
  - manoeuvring, current and wind loads
  - loads from attached lines (coupled analysis)
- Multi-body hydrodynamic coupling between floaters
- Sea State RAOs (vessel wave shielding, wave jetting, etc)

BUOY OBJECT

- Full 3D and 6D modelling of buoys
- Lumped option with overall properties
- SPAR option for co-axial cylinders, each with own properties
- Fluid loads calculated based on the instantaneous wetted surface
- Water entry / exit slam loads (per DNV H103)
- Attach wings for lifting surfaces
- Impose user-defined loads
- Compressibility specified by bulk modulus
- Coulomb friction with seabed and elastic solids

SHAPES, WINCHES AND LINKS

- Many features to model boundary surfaces and control lines
- Shapes have elastic stiffness and friction for line contact
- Plane, cuboid, cylinder (solid/hollow), and bellmouth options
- Trapped water option for moonpool modelling
- Winches with several length or tension control options
- Links (springs) with linear or non-linear stiffness and damping

Environmental Description

Wide range of options to apply environmental loads directly on Lines and boundary control objects (Vessels and Buoys)

SEA

- User-defined water density, kinematic viscosity, temperature
- User-defined horizontal and vertical density variation
- Temperature can be constant or vary with depth
- Kinematic viscosity can be constant or vary with temperature

SEABED

- Horizontal, sloping, 2D or 3D seabed surface (smooth or linear)
- Choice of soil models:
  - linear elastic, or
  - non-linear hysteretic (trenching, suction and re-penetration)
  - P-y models (API RP 2A Soft Clay, API RP 2A Sand & user-defined) for vertical and near-vertical line penetration
- Non-isotropic Coulomb friction in both statics and dynamics

WIND

- User-defined air density
- Wind velocity can be constant, or API or DNV spectra
- Wind can also be a time history file of speed and direction
- Vertical variation factor specified as a profile

WAVES

- Regular: Airy, Stokes' 5th order, Dean Stream Function, Cnoidal
- Irregular: ISSC, JONSWAP, Ochi-Hubble, Torsethaugen, Gaussian Swell, User Defined, Time History
- Multiple wave trains for combination sea states
- Wave kinematics at all locations in wave profile
- Fluid stretching models (Wheeler, kinematic or extrapolation)
- Equal-energy discretisation (user-defined bounds and interval)
- Irregular waves have directional wave spreading option
- Preview and selection of irregular wave profile

CURRENT

- 3D, non-linear
- Both magnitude and direction can be time varying
- Horizontal variation factor on magnitude

User Interface

The OrcaFlex Graphical User Interface (GUI) gives the user unrivalled flexibility in model building and analysis

GRAPHICAL USER INTERFACE (GUI)

- Fully interactive native user interface
- Visualisation as wire frame and / or shaded graphics
- Shaded has perspective, lighting, hidden line, etc.
- Moving camera option to track large-scale object motion
- Powerful dockable Model Browser to:
  - organise and manage complex models
  - group objects in logical collections
  - copy / paste objects or groups within or between files
  - Show / Hide, Move and Locate objects or groups
  - compare object data
- Compare data files with built-in or user-specified compare tools

GUI DATA INPUT

- Readable, structured and self-documenting text files
- Binary files with strong version compatibility
- Drag-and-drop model import from other OrcaFlex files
- Auto import for AQWA and WAMIT hydrodynamic data
- Generic text file import for other diffraction data
- Graphical RAO realism checks
- Generic line properties through built-in properties wizard
- Wizard for (hysteretic) non-linear moment-curvature data
- Variable Data structure for non-constant data (drag vs. Re, etc.)
- External functions admit user-defined calculations
- Time history data import for:
  - vessel motions
  - wave elevation
  - wind speed & direction
- SI, US or user-defined units
- Full and comprehensive context sensitive help

GUI RESULTS

- Unlimited simultaneous 3D views, results graphs & tables
- Workspace facility to manage windows
- Replay wizard to animate multiple simulations
- AVI file export of animations
- Results displayed at run time and / or simulation replay
- Results storage optimised to minimise file size
- GUI output can be:
  - graphical (time histories, range and X-Y graphs)
  - values (in Excel spreadsheet format)
  - statistical analysis (incl. extreme statistics)
- GUI graphs and 3D views can be copy / pasted
- Raw data and results readily exported as spreadsheets
- Vessel spectral response reported at any point

Automation & Productivity

OrcaFlex offers a wealth of automation, multi-threading and productivity-enhancing features

- OrcaFlex comes with 32- and 64-bit executables
- OrcaFlex Excel spreadsheets for:
  - pre-processing for parametric variations of input data (either binary or text files)
  - post-processing to extract results from many output files
- Fully multi-threaded, unattended, batch processing for:
  - data files (binary or text) for static analysis
  - data files (binary or text) for dynamic analysis
  - batch script files
  - fatigue analysis
  - OrcaFlex post-processing spreadsheet
  - post-processing with Python or command script
- Batch processes above in correct order in case of dependencies
- Low level programmatic interface, targeting C, C++ or Delphi (allows integration with 3rd party applications)
- High-level programmatic interface, targeting Matlab or Python
- Automated execution of SHEAR7 from OrcaFlex
- Conversion of storm scatter tables to regular wave scatter tables
- Automation for model building, including:
  - wave search facility
  - Line Type and Plasticity Wizards
  - Line Setup Wizard
- Automation for results, including:
  - vessel response reports
  - fatigue analysis
  - extreme value statistics
- Distributed OrcaFlex optimises use of spare processor time:
  - only of benefit in a multi-licence environment
  - server program co-ordinates and allocates jobs to clients
  - clients can be set to accept or reject jobs
  - client jobs run at low priority (min. impact on other tasks)
  - client jobs can be aborted and server will re-allocate
- Orcina Licence Monitor allows monitoring of OrcaFlex use

Fatigue Analysis

Comprehensive fatigue analysis for all applications

- Fatigue calculations are all multi-threaded
- Regular, rainflow & spectral fatigue analysis options
- Use S-N curve damage calculations for:
  - homogeneous pipe sections
  - stress factors for different layers in the cross-section
- Use T-N curve damage calculations for mooring lines
- S-N and T-N curves can be:
  - piecewise linear (tabulated)
  - set parametrically (equation)
- S-N curves have option of 3 mean stress models
- Easily collates & presents SHEAR7 damage results
- Analysis at multiple circumference points on ID and OD
- Analysis at multiple line positions, each with different:
  - stress concentration factors
  - thickness factors
  - S-N curves (or T-N curves for moorings)
- Damage results as tables and / or graphs for:
  - overall damage
  - damage from individual cases

Vortex Induced Vibration

OrcaFlex provides the most comprehensive set of VIV analysis tools available in one riser design program

OVERVIEW
- Uses the leading methods for the analysis of VIV
- All methods are coupled solutions applying VIV loads to the line
- Generalised to 3D behaviour (not just 2D)
- Highly efficient as all VIV models use same FE model
- Tested and fully documented SHEAR7 and VIVA interfaces
- Quality assured implementation of time domain models
- Consistent results comparison from different VIV models

SHEAR7 INTERFACE
- Export SHEAR7 input data to run SHEAR7 off-line from OrcaFlex
- Call SHEAR7 directly from OrcaFlex with either a user-specified or OrcaFlex-derived mode shape file
- Automatically selects transverse modes for mode shape file
- OrcaFlex statics couples with SHEAR7 enhanced drag coeffs
- SHEAR7 results (incl. fatigue) collated & presented in OrcaFlex

VIVA INTERFACE
- VIVA called directly from OrcaFlex through the VIVA DLL
- OrcaFlex statics couples with VIVA enhanced drag coeffs
- Enhanced drag coefficients output as results

WAKE OSCILLATOR MODELS
- Milan or Iwan and Blevins wake oscillator models
- Model VIV suppression by turning off for selected line sections
- In-line drag enhancement included

VORTEX TRACKING MODELS
- Two approaches which model the physics of VIV
- Both in-line and transverse VIV effects included
- Boundary layer theory for stagnation and separation points
- Inviscid Navier-Stokes eqn. used outside the boundary layer
- Much less computationally demanding than full CFD

Analysis And Numerical Procedures

The numerical basis of OrcaFlex makes it the most robust and hence widely applicable in its peer group

NUMERICAL PROCEDURES
- Finite element with 6 DoF at each node
- Optional 3 DoF line element for optimal performance
- Element formulation is extremely robust and accurate
- Element is proven and widely applicable
- Implicit (constant or variable Δt) or explicit integration
- Integral parallel processing for multi-core / processor hardware
- FFT reconstruction of wave field from wave elevation time history
- Fluid forces based on Morison and cross-flow assumptions

ANALYSIS
- Full 3D, non-linear, time domain modelling
- Non-linear large displacement analysis
- Extremely quick and robust static analysis
- Dynamics ramped-up (to eliminate starting transients)
- Robust line compression and snatch load modelling
- Line and system modal analysis (shapes and loads)
- Contact, clashing and clearance analysis
- Fully coupled tension, bending and torsion
- Vessel manoeuvres (forward speed and turn rate)
- Coupled and uncoupled vessel / line analysis
- Surface piercing fully modelled
- Setup Wizard to set line length for target end conditions
- Pressure effects on Line EI can be separate for statics & dynamics
- Code checks (API RP 2RD, API RP 1111, DNV OS F101, DNV OS F201 and PD 8010)

Commercial Options

The commercial structure of OrcaFlex is widely recognised as the most cost-effective in its peer group

- OrcaFlex is not modular - all features are integral to the program, including multi-threading
- Comprehensive Maintenance, Upgrade & Support (MUS) contract with very responsive client support
- Very competitive pricing, with highly attractive tiered multi-copy discounts on purchases and MUS
- Group Agreements allow Affiliates to pool their licences achieving greater multi-copy discounts
- Purchases always include a free MUS period (1 year for 1st purchase); later purchases include pro-rated MUS
- Very flexible leasing, inclusive of MUS, with a 1 month minimum lease period
- Attractive lease-to-purchase conversion option, allowing most of any lease charges over the last 3-years towards a purchase
- All licensing is on a world-wide basis – clients are free to move licences at will to best suit their purposes

At Orcina we have a policy of continual product development in order to give the best service to our clients. Consequently products may differ from the descriptions herein - up-to-date information can be found on our website.

Orcina Limited

Daltongate, Ulverston,
Cumbria, LA12 7AJ,
United Kingdom

Tel: +44 (0)1229 584 742
Fax: +44 (0)1229 587 191
Email: orcina@orcina.com
Web: www.orcina.com

Orcina is supported by the following Agents

USA & Canada: Paul Jacob (pj@jtec-tx.com, +1 713 398 9595) & Bil Stewart (info@stewart-usa.com, +1 713 789 8341).
Malaysia, Indonesia & Singapore: Herman Perera (herman.perera@zee-eng.com, +60 (03) 7877 8001).
South Korea: Eui Choi (eui@sacsko.com, +82 2 421 8018).
South America: Nelson Galgoul (nsg@nsg.eng.br, +55 21 99995 9212).
India and Middle East: Tarun Rewari (info@aryatech.net, +91 11 46 01 81 02).
China: Betty (Xuan) Zhang (xzhang@richtechcn.com, +86 21 6485 0066–8063).