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Newsletter

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OrcaFlex 9.3 (Aug '09)...
...another feature-rich release!

With the release of **OrcaFlex v9.3 in August 2009** it's time for another newsletter setting forth some of the great new features it contains. Although we have embarked on the next development round leading to v9.4, a release provides a good opportunity to see what has been achieved.

We're pleased to note that despite recent turmoil in world markets and the oil price more than halving, our business continues to hold up. As a software house (with most of our revenue from this source) it is particularly gratifying for us to see that software sales and leases continue apace, though it's also interesting to note that our consultancy team is busier than ever! Predictions are always hard to make, however most client sentiment about the future remains positive, although perhaps the forward order book is looking slimmer than it did 12 months ago.

So, over to OrcaFlex: released in v9.3 are several major features, which include the advent of ***text data files*** and ***extreme response statistics***. We now have the ability to ***save static results***, to add ***coatings and linings*** to a line type and to have ***non-linear material for bend stiffeners***. The longstanding ***interface to Shear7*** has seen a major overhaul, the ***API RP 2RD stress code checks*** have been added and there are some improvements to the ***random wave discretisation*** process. Our major article focuses on the various options for determining vessel motion response, in particular to draw attention to the ***fully coupled vessel/line*** capability.

The recently included OrcaFlex Applications page features again, as does the new Agents page. As ever we hope that we achieve a useful balance in these newsletters. We always welcome suggestions for improvements / future content so please do drop us a line.

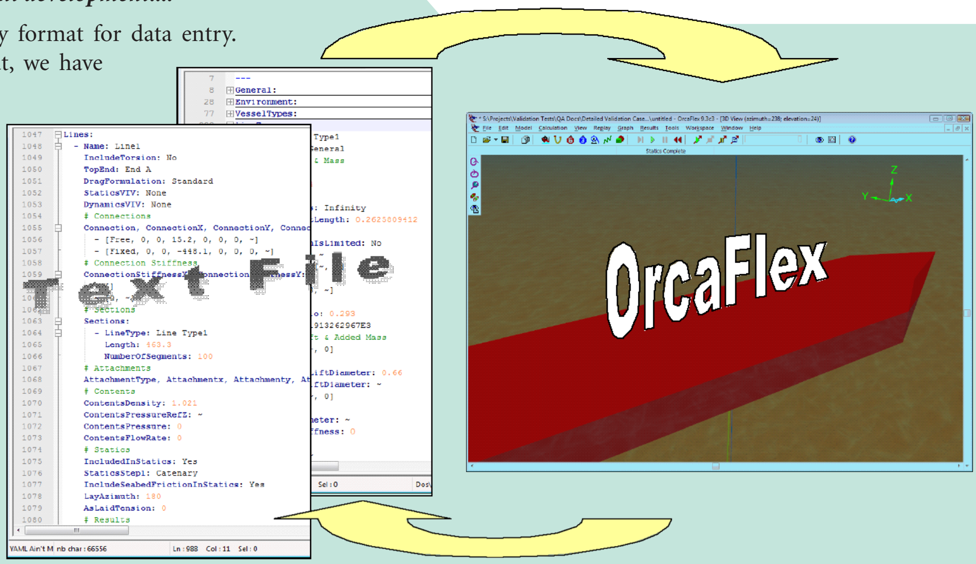
In This Month's Newsletter

TEXT DATA FILES

The advent of Text Data Files for OrcaFlex is a significant development....

OrcaFlex has, until v9.3, relied on a proprietary binary format for data entry. New for v9.3, and alongside the existing binary format, we have introduced the option to use text data files as a means of generating human readable input data.

We do not intend that the text file format will replace the binary format. Rather the two will work together, each to be used to achieve slightly different aims. In considering this new capability, several points are worth noting:



a) The binary data format has excellent version compatibility (old programs read new datafiles and new programs read old datafiles). Achieving the same level of compatibility is hard to do with text files.

b) You need OrcaFlex to understand the binary format, which means having a paid up licence (although the OrcaFlex Demo version can help). In principle, the text file format allows manual creation of, or amendments to, an input file.

c) With the binary format, printing, checking and archiving input data is not as easy as it might be. A full licence is needed (not just the Demo version) to export in the current binary format. A well structured text file format makes all of these activities much easier.

d) The text file is not a 'Keyword' type file (typified by '# Keyword' followed by a sequence of numbers representing the input data). These files have the advantage of brevity but lack QA rigour as each number is then not uniquely referenced. The OrcaFlex text file has each input number uniquely referenced to the variable's batch script name. This makes the file more verbose, but also far more readable hence producing much stronger QA.

Mindful of these thoughts, here's how we see the two formats complementing each other: we think that most users will want to use the GUI for datafile preparation because, for all but the most trivial models, it will be far more productive to use the GUI. However, the text file is much better for printing and checking input data, comparing different datafiles (File | Compare Data facility already in OrcaFlex) and certain mass modifications and automation tasks. Though, depending on your requirements, the last two tasks can often be easily accomplished using the existing facilities in OrcaFlex.

One point to note: comments added to the text datafile will not 'round trip', ie, if a text datafile with comments is imported into OrcaFlex and the text file subsequently re-saved, comments from the original will be lost.

For those who like their input data as text data files and for those who want improved QA, we hope that this feature will be a big advantage.

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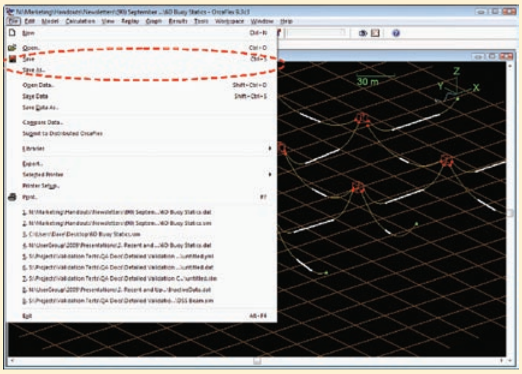
SAVING STATICS

This new feature removes a long standing 'niggle'....



In previous versions of OrcaFlex there was no way of saving the results at the end of a Statics calculation. For simple models and ones which converge quickly, this was not a particular problem. However, with complex models and / or where the solve took a long time, this limitation could be frustrating. There were two workarounds: (i) run a very short dynamic simulation with no excitation, and (ii) use the OrcaFlex post-processing spreadsheet, specifying the .dat rather than .sim file. Both approaches were a little cumbersome.

Now, however, it is possible to directly save the results at the end of the Statics calculation. The Static results are saved as a simulation file. File | Save (CTRL+S) at the end of Statics will now save filename.sim which holds all the static results.

So a simulation file potentially now has two 'sets of results': (i) as before, the results for a dynamic simulation, (but which now, because of these developments, also include the static state results) and (ii) it can now also hold the results just from the static solve. Not only is this feature useful for those only interested in statics results, but a 'Static' .sim file can be loaded into OrcaFlex and the dynamic simulation started from that state.

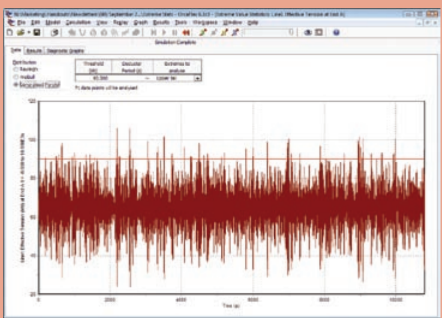
Note that we deliberately decided not to create yet another file name extension to add to those already in use (.dat, .sim, .sct, .ftg, .xls). Instead we expanded the idea that a .sim file holds any results from OrcaFlex.

We think that that allowing static results to be saved will be a major advantage, probably in ways we haven't yet anticipated.

EXTREME RESPONSE STATISTICS

To the extremes of analysis...

We are often in the position of wanting to define a characteristic design value to use, based on an irregular time history of that result. DNV (OS-F201) calls this the expected or most probable extreme for a storm of given duration (eg. 3 – 6 hours) – based on the assumption of a stationary random process. Typically this translates to wanting to predict the maximum line tension, bend moment, etc, in a 100-yr storm simulation. (Note that this requirement is distinct from the extreme values of an ensemble of 'stationary' events; computations such as this are typically done by the metocean community to yield (eg. the 100-yr return period wave height.)



As an example the screenshot shows a tension time trace for a 3-hr random wave simulation. The question is then what single value of tension do we use in our design? We could repeat this run (eg. 10 times) each with a different random wave seed and then (say) take the average of the maxima. Alternatively one very long simulation could be created and take the average of the maxima. Either of these options are acceptable, but require long simulation times.

To reduce the simulation time and introduce some 'justification' for identifying design values, an alternative is to identify and fit the peaks of a single shorter irregular simulation using standard statistical methods for 'extremes'. Such methods then allow prediction of extreme values for the return period of interest. This is what we now provide in OrcaFlex as shown in the screenshot.

There are three statistical methods available for this extrapolation – Rayleigh, Weibull and Generalised Pareto (GPD). Rayleigh is often used for a time history which is stationary and Gaussian. Where these assumptions break down, the Weibull and GPD are used with the latter being preferred by the statistics community. Use of the Weibull and GPD methods also allows estimates of the confidence interval for the given return period. Diagnostic graphs are provided which allow the assessment of goodness of fit, appropriateness of the selected method, etc.

This approach would not typically be used with simulations incorporating low-frequency floater motions, or to estimate (eg) 100-year return levels on response parameters. Although this can be done in principle, the length of simulation required to capture enough data for good fitting and extrapolation is typically quite high.

We know that some users have been taking OrcaFlex results to other packages to obtain the extremes, so we hope that for them, and all other users, this somewhat overdue feature is of some considerable use.

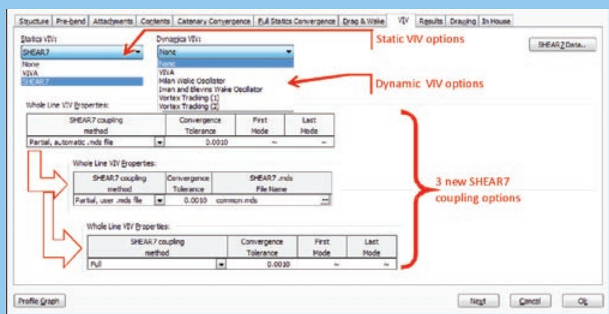
IMPROVED SHEAR7 INTERFACE

Making life for SHEAR7 users even easier....

One capability offered in OrcaFlex is the interface to SHEAR7 for the analysis of vortex induced vibration (VIV). Previous versions of this interface generated the necessary SHEAR7 structural input datafile for a given static configuration and the SHEAR7 mode shape (.mds) input file (or the user could rely on SHEAR7 to generate the modes). SHEAR7 was then manually run with these files for the VIV analysis. The new SHEAR7 VIV coupling involves:

1) OrcaFlex line statics with Cd as initially specified in the line type data.
2) SHEAR7 is then called to determine any drag enhancement due to VIV.
3) OrcaFlex then recalculates line statics using these new Cd values.

Steps 2 and 3 are then repeated until the static position has converged. Performing this 'coupling' by dropping out to SHEAR7 each iteration was time consuming and error prone. The big advantage of the new interface is that SHEAR7 can be run directly from OrcaFlex with SHEAR7 results automatically returned to OrcaFlex. In this respect it is very similar to the long-standing interface with the VIVA software also used for VIV predictions. As well as the manual option to run SHEAR7, the three new options are (see screenshot):



a) ***Full (coupling):*** Each iteration produces a new mode shape file for use with SHEAR7.
b) ***Partial + auto .mds file:*** The OrcaFlex generated mode shapes from the initial static configuration are used and kept constant for each subsequent VIV coupling iteration.
c) ***Partial + user .mds file:*** The user-specified (on the data form) mode shape file is used and kept constant for all subsequent VIV coupling iterations.

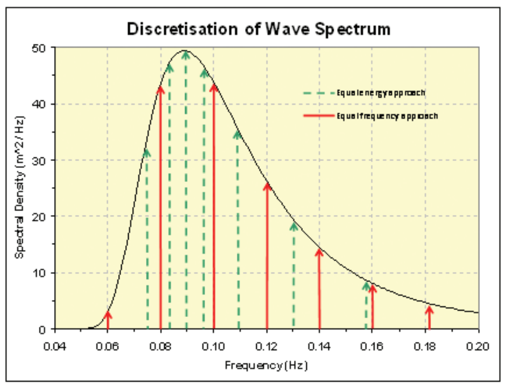
Informal experience suggests that there are not many cases where the full coupling option makes a significant difference compared to partial coupling, however, it is noticeably more time consuming to run. So, whilst the sensitivity of the model to full coupling should be understood, for most cases partial coupling will be the better option.

It should also be noted that there are specific OrcaFlex batch script commands to produce the SHEAR7 .out and .plt files – indeed, if OrcaFlex is run from the batch form, these files are produced automatically.
Consequently, the main advantages of this new feature are (i) to allow full coupling to be easily checked, and (ii) considerably more straightforward file handling and automation by allowing SHEAR7 to be run from within OrcaFlex.

BETTER CONTROL ON RANDOM WAVE DISCRETISATION

We have added more user control for wave spectrum discretisation...

A wave spectrum is traditionally discretised in one of two ways: (i) by dividing it into a number of equal energy intervals, or (ii) to divide it into equal frequency intervals. Both are shown schematically in the chart (though with coarse intervals for clarity).



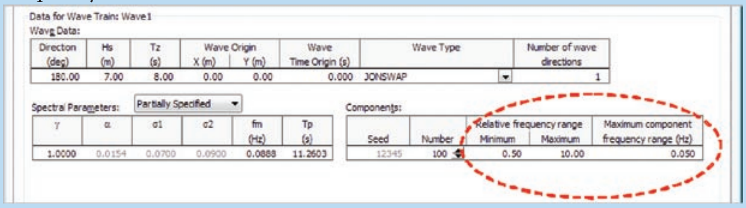
Although there are pros and cons to both methods (there is little published work on this, though see, for example, DNV OS F201, Appendix D, Section C), OrcaFlex only uses the equal energy approach for the following reasons:

a) The equal energy component frequencies are not related to each other in a multiplicative way, which means that the repeat period of the resulting wave train is effectively infinite. To avoid a short repeat period with the equal frequency interval approach many more components are required.

b) The equal energy approach automatically gives finer discretisation around the spectral peak, a generally desirable feature. The equal interval approach can achieve the same, but because the same interval is used throughout the rest of the spectrum, more frequency components are required.

Since simulation runtimes increase with more components, the equal energy approach is generally more efficient. The exception is if you pre-compute the wave kinematics when using the equal frequency spacing approach. As described in the DNV reference this can be more efficient, but this approach then requires justification of the spatial interpolation scheme that is subsequently required.

However, the main disadvantage of the equal energy approach is that the intervals in the tails of the spectrum can be quite large. Potentially, a system resonance might be missed, or excited, in a non-realistic way because the frequency component is assigned to the middle of quite a large interval. Consequently we have added user control to set the maximum component frequency interval that the discretisation will use – see screenshot.



This means the maximum size of the energy interval can be controlled, ensuring that that the frequency discretisation is fine enough in the tails. Note that if this upper limit is chosen realistically it will not usually affect the level of discretisation around the peak as this is normally at much finer resolution. In most cases the default values suggested will be perfectly adequate.

We have also introduced user control over the minimum and maximum frequencies considered during the discretisation. Previously these were hardcoded at 0.5fm and 10fm respectively so these values are set as the default on the dataform.

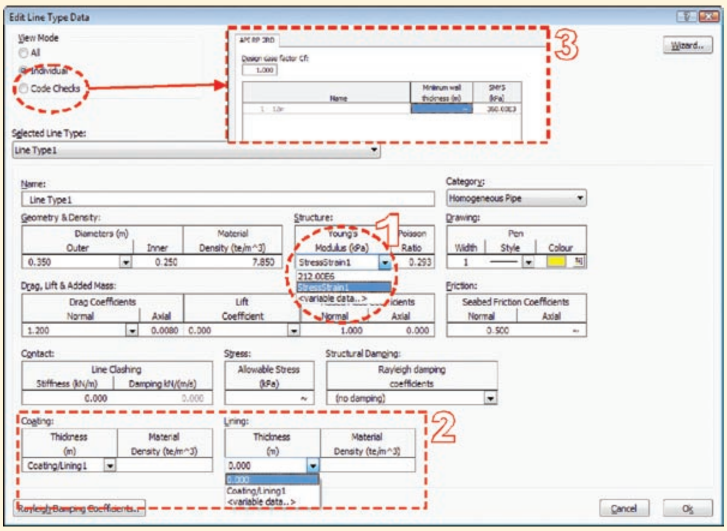
These changes mean that the Waves page now has a new option called 'Spectrum Discretisation Method'. This is either 'Legacy' (ie, discretisation as per v9.2 and earlier) or 'New' (as described here). We recommend that the 'New' option is used for all new analyses, but the 'Legacy' option is retained to allow the same wave realisations as earlier versions of the program to be reproduced.

MORE LINE IMPROVEMENTS

The OrcaFlex Line object gets yet more functionality (neatly seen on the screenshot)...

NON-LINEAR STRESS-STRAIN RELATIONSHIP (1)

In v9.2 we introduced the Homogeneous Pipe category of line type, retaining the previous line data entry approach as the General category. This distinction was created to ease the modelling of line sections with diameter profiles (eg, tapered stress joints and bend stiffeners). Of course, this feature also had the benefit of making it simpler to model steel pipes.



In v9.2 this implementation only supported linear material properties ie, a constant value of Young's Modulus (E). For elastomeric bend stiffeners, in particular, it can be important to include the non-linear material properties and v9.3 now allows that.

COATINGS AND LININGS (2)

For many 'homogenous pipes', it is common to define various coatings and linings in addition to the strength section. These are typically used with steel pipes to model the additional mass and displacement of concrete coatings, plastic linings, etc. In v9.2 and before, these effects could be included but only after an off-line calculation to generate 'equivalent' line properties.

For the Homogeneous Pipe line type category, v9.3 removes the need for off-line preparation of equivalent properties by allowing the definition of any number of coatings and linings. OrcaFlex then does the sums and uses the equivalent set of properties, though remember that coatings and linings do not contribute strength, nor are they assumed to be load bearing.

This new capability makes data specification easier and clearer for coatings and linings without 'losing' the source data. This has very obvious QA benefits, but also allows much clearer parametric variation of the coating/lining data.

API RP 2RD STRESS CHECK (3)

The API RP 2RD code includes a von-Mises type strength check. Implementation is not completely trivial, so we've built it into OrcaFlex. (Note: 2RD contains errors, most of which were corrected in a recent errata).

As seen in the screenshot, implementing this code check required a new View Mode and data page. This page contains data necessary for the code check but not required by OrcaFlex for a dynamic simulation. Two new results (API RP 2RD Stress and API RP 2RD Utilisation) are now available.

We hope that this proves a significant convenience to all users of 2RD. At the moment this is the only code check supported in OrcaFlex, but we intend to add other widely used codes, so please let us know if you have any candidates.

DEFINITIONS

System: the combined floater and connected Lines (risers, moorings, etc).

Motion: the time varying position of the floater.

Offset: the time invariant position of the floater.

RAOs: Response Amplitude Operators are derived from model tests and / or diffraction programs and describe vessel response to waves in the wave frequency regime. These are generated in both the displacement and load form.

QTF: Quadratic Transfer Function loads are computed from diffraction programs. They describe vessel response to waves in the low frequency regime, and only arise in an irregular seastate. The QTF leading diagonal is derived from 1st order wave diffraction analysis. Off-diagonal terms are either computed by the diffraction program or derived with Newman's approximation.

Wave Loads: are the forces and moments on the floater from wave action. They induce floater motions which, depending on the analysis approach, may be used as motions or offsets. Wave loading is traditionally thought of in three loading 'regimes' – mean, wave frequency and low frequency. The real system has no knowledge of these artificial distinctions, but this industry-wide approach makes analysis more understandable and tractable.

Mean Wave Loads are sometimes called steady drift, mean wave drift or (rarely) zeroth order wave loads. They are time invariant loads which only arise in an irregular seastate. They cause a moored floater to take up an offset known as the mean (or steady or wave drift) offset.

Wave Frequency (WF) Wave Loads are sometimes called 1st order wave loads, and are characterised by RAOs. They arise in both regular and irregular waves and induce WF (or 1st order) floater motions and offsets. These are time varying effects, with periods typically in the range of 3s to 30s.

Low Frequency (LF) Wave Loads are also called 2nd order wave, or wave drift, loads and are characterised by the QTF. They arise only in an irregular seastate and cause low frequency (or 2nd order) floater motions and offsets. These loads are much smaller than the WF wave loads and are only significant when they excite a system resonance period. This might be of the order of 60s+ depending on the system.

In ***De-coupled analysis*** the floater motion is solved in the time domain, with the moorings and risers included quasi-statically. This means that all other coupling effects (eg, current loads on lines) need to be separately assessed and included.

Coupled analysis: Here the complete equations of motion for the system are solved in the time domain. This means that all coupling effects are automatically included in the analysis, including the dynamic loads from the lines.

TO COUPLE OR NOT TO COUPLE - THAT IS THE QUESTION

It's obvious really, but such systems respond to environmental loads (wind, wave, current, VIM) in complex ways and all (excepting VIM) act both on the floater and the line. In what follows we concentrate on the different contributions to total vessel motion from wave loads.

Despite the complexity, various approaches to the analysis of such systems exist, each with different levels of approximation. The precise approach(es) used depend on the system type, and the results of interest (eg, floater displacements, mooring tensions, risers stresses, etc).

The following gives a high level description of the most common approaches to system analysis. Several variants on the 'naming' of different approaches exist and there is nothing sacrosanct about the names used below.

Option 1: Quasi-Static (QS) Analysis: here floater motions due to wave loads are 'translated' into representative floater offsets for each of the mean, WF and LF regimes. These offsets are then combined to give a total floater offset considered representative of the total floater motion in waves. Firstly the system's static equilibrium offset under mean (wind, wave & current) load effects is found. A further offset is added representing the WF and LF motion offset components. Line statics are solved for at this total offset, yielding the quasi-static solution. Typically this approach is used in the early stages of mooring design, though some simple systems can be designed entirely by this method (noting the requirement to use higher safety factors). However, most systems have an element of dynamic analysis; for highly non-linear systems the dynamic analysis typically forms the biggest part of the analysis.

Option 2a: Imposed WF floater motions + imposed mean and LF offsets: as per the QS approach, the mean offset is solved for, and the LF dynamic floater motions are imposed as a further floater offset in addition to the mean offset. At this offset the wave frequency dynamics are then represented using the displacement RAOs. Consequently the vessel acts as a boundary condition which 'drives' the line motion.

Option 2b: Imposed WF floater motions + calculated mean and LF motions: the LF and mean floater motions are computed directly in the time domain by solving the system equation of motion including LF wave loads. This generates a steady (mean) + slow varying floater motion (the latter assuming some system resonance is excited), onto which the WF floater dynamics are superimposed using the displacement RAOs.

Option 3: De-coupled solution (full floater motion solution + no line dynamics): here the floater equation of motion is solved directly in the time domain, including mean, WF and LF order wave loads. Line load effects are included from a look-up table of quasi-static line loads or with non-linear springs. This approach is traditionally used for the global analysis of floater motions. Lack of coupling with lines is a significant limitation, though estimates of the missing damping effects can be made and included. This approach is more efficient than coupled analysis, allowing much longer / more simulations.

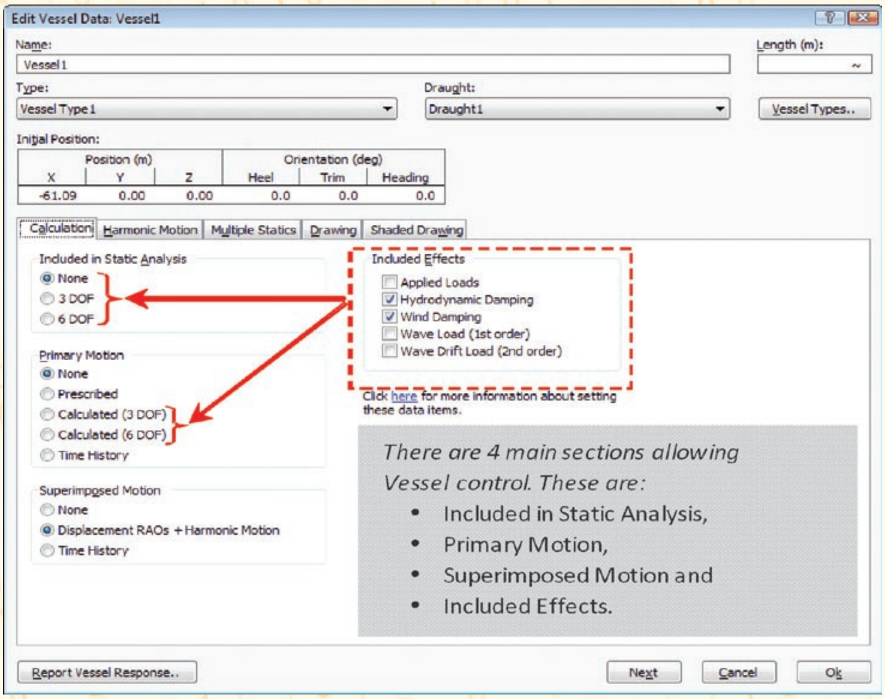
Option 4: Coupled solution (full floater motion solution + line dynamics): the floater motion is calculated as per the de-coupled approach, but now also includes the dynamic loads from any attached lines. It is considered the most accurate approach, but also the most time consuming (depending on the level of detail included for the lines). Therefore, it is common to work in two stages: (i) Determination of the floater global response - lines are initially of secondary importance, but are included with sufficient detail to give acceptable floater motions from any coupling effects. (ii) Then re-use the floater motion time history from (i) as an imposed boundary condition, together with a much more detailed model of the line(s) of interest.

OK, so how can OrcaFlex be used to implement the above? The Vessel data form screenshot (shown on the next page) shows the available options for determining Vessel motions. The options, and approach to setting them might seem a little bewildering at first, but hang in there...

Basically there are three options for determining the motion of the Vessel: (i) to impose Vessel motions, (ii) to calculate Vessel motions, and (iii) a mix of (i) and (ii). By 'impose' vessel motions we mean that the floater equation of motion is not solved to give floater displacement - the floater motion comes instead from some pre-determined method. By 'calculate' vessel motions we mean that the floater equation of motion is solved to yield a time history of the floater motion.

The table below identifies which options on the form impose Vessel motions and which ask OrcaFlex to calculate the vessel motions.

Calc Options:	To 'impose' Vessel motions, select:	To 'calculate' Vessel motions, select:
Vessel initial position	specified	n/a
Included in Static Analysis	None	3 DoF or 6 DoF
Primary Motion	None or Prescribed or Time History	Calculated 3 DoF or Calculated 6 DoF
Superimposed Motions	None or Disp. RAOs + Harmonic Motion or Time History	n/a



The Included Effects section (see screenshot) turns on various loadings to be applied when the vessel motion is to be calculated, ie, they only apply when the vessel's static position is to be determined, and / or when either of the Calculated options for Primary Motion are selected.

OK, having seen what OrcaFlex has, how do these map onto the common approaches to the determination of floater motions outlined earlier? The table on the right attempts to clarify this.

Initial position	Included in Statics (& Included Effect)	Primary Motion (& Included Effect)	Superimposed Motion
1 Quasi-static analysis (done in 2 stages. 1st solve for static equilibrium with mean loads. Offline, add to this a pre computed offset representative of WF and LF motions. 2nd re-do static line solve with vessel initial position = total offset.)			
Nominal[1]	Yes (Hydro Damping, Wind Damping, Wave Drift)	n/a	n/a
2a Imposed WF floater motions + imposed mean and LF offsets			
mean + LF offset	None	None	Displacement RAOs
2b Imposed WF floater motions + calculated mean and LF motions (note that for technical reasons this option can only be run using the explicit integration scheme)			
Nominal[1]	Yes (Hydro Damping, Wind Damping, Wave Drift)	Calculated (2nd order wave load)	Displacement RAOs
3 De-coupled analysis (OrcaFlex solves for floater motions, but 'lines' only included with non-linear springs – no facility for use of pre-prepared look-up tables)			
Nominal[1]	Yes (Hydro Damping, Wind Damping, Wave Drift)	Calculated (1st and 2nd order wave load)	None
4 Coupled analysis (Floater motions solved as in the previous option, but the dynamic loads from the lines are also directly included in the solution)			
Nominal[1]	Yes (Hydro Damping, Wind Damping, Wave Drift)	Calculated (1st and 2nd order wave load)	None

[1] 'nominal' means that the initial position should probably be set as something sensible, but where specified above it is only used as a starting point for the mean calculation

So with the correct selection of vessel controls, OrcaFlex can perform any of the commonly accepted analysis approaches. Even the less 'routine' coupled analysis has been available in OrcaFlex since v8.5 (Jun-04), though it was not until v9.0 (Sept-06), when frequency dependent added mass and damping were included, that comprehensive coupled analysis was fully realised.

Though coupled analysis is seen as the most accurate option, it suffers from being computationally the most demanding. There are several analysis strategies to reduce computation times, all involving various approximations to the inclusion of line loads. However, software advances can also make a big difference in reducing computation time and OrcaFlex helps in this regard by:

- Implementing a very efficient single solve for the coupled solution
- Being one of the quickest solvers in its peer group
- Having multi-threaded batch capability (as standard, ie. at no extra cost!)
- Offering Distributed OrcaFlex (as standard, allowing networked, OrcaFlex-licensed computers, to transparently run OrcaFlex jobs using spare processor time)

The collective effect is to massively enhance the speed at which large numbers of coupled solutions can be performed. As an illustration a three-hour irregular-wave (100 components) global floater motion simulation with very simplified models for 12 mooring chains and three rigid risers took approximately 30mins on a single thread on a modern workstation. Based on this, 100 load cases running on a quad core machine becomes tractable for an overnight run! Clearly very good news, but of course there is usually then a second round using the motion time histories from the above with more detail in the line models. However, this does show that coupled analyses are very much more tractable than they have ever been.

So, great as this all is, there are nonetheless some features missing from OrcaFlex which we'd like to add in the future. These include: use of the full QTF, 2nd order high frequency terms, hydrodynamic coupling between vessels, wave drift damping and frequency domain. In the usual way, please let us know how important these terms are relative to other competing feature requirements.

References

'F201': DNV-OS-F201, Dynamics Risers, Jan-01 (amended Oct-03),
'302': DNV-OSS-302, Offshore Riser Systems, Oct-03 (amended Apr-09).
'F205': DNV-RP-F205, Global Performance Analysis of Deepwater Floating Structures, Oct-04 (amended Apr-09).
'E301': DNV-OS-E301, Position Mooring, Oct-08 (amended Apr-09).
2SK': API RP 2SK, Design and Analysis of Stationkeeping Systems for Floating Structures, 3rd Ed., Oct-05.

The intention of this new section is to give readers an understanding of some of the more unusual models and applications we've seen with OrcaFlex…..

DESIGN OF STRUCTURES FOR FISHING INTERACTION USING ORCAFLEX

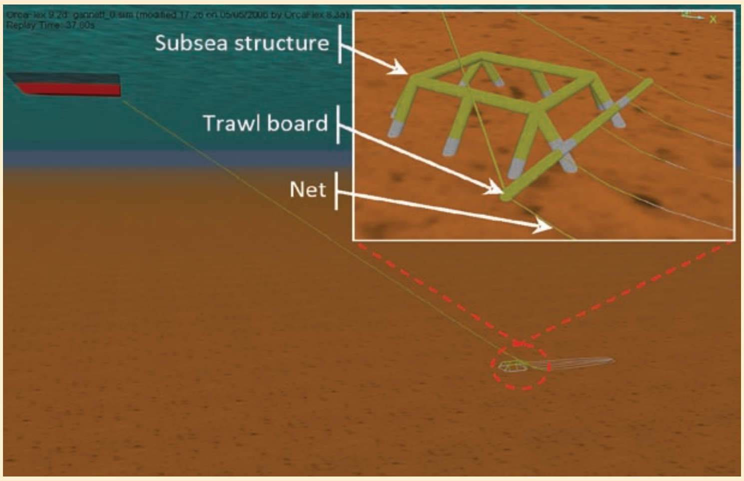
An application through thinking out-of-the-box by Jonathan Jury, Senior Consultant, RiserTec Ltd.

It appears that in the available literature there is no attempt to use analysis tools for evaluating the dynamic loads caused by fishing gear on structures. The main reference *(Wellhead Protection at Gannet B, D Heal and L Naughton Underwater Technology Vol. 17 No 4,1991)* uses small-scale model testing from some time ago; other load data is based on similar scale testing or calculations based on energy methods and warp breaking loads. Consequently RiserTec undertook in-house research to assess the possibility of developing a tool to assist in the layout and design optimisation of subsea structures.

We've used OrcaFlex routinely for riser-to-riser and riser-to-vessel impact assessment during operation and installation. It therefore seemed possible, if a challenge, to use the software to consider snagging and impacts from fishing gear. The analyses shown here consider impacts from Beam Trawls but Otter Trawl systems could be similarly modelled.

Typical vessel data for beam trawlers was used (assumed displacement of 750 Tonnes and trawl speed of 5 knots). The trawl beam was 9m long, weighing around 5T. The rigging arrangement was typical for this vessel type, producing a warp angle of ≈25° when towing at constant speed. The arrangement is shown in the screenshot with a net model included. The structure shape was taken from a Central North Sea Protection Structure designed by Genesis Oil and Gas with 55° rake on the braces. The model could be more detailed but it is a reasonable representation of the problem.

The key issues with fishing interaction are the impact loads on the side members, structure pullover loads and snag loads if the trawl gear becomes entangled. The results predict a side brace impact force of 65T with an impact energy of 20KJ, a pullover force of 17T and a maximum warp snag load of 80T at 30° to the horizontal. They compare well against standard design



values where for example maximum side impact energy is commonly taken as 15KJ, the extreme impact as 30KJ, the pull over force as 15T and peak net captured snag load as 100T.

Sensitivities: reducing the side angle from 55° to 45° reduces the clash force and energy by ≈45%. Introducing a 1m high skirt angled at 45° (eg, by a concrete shaped block) provided a similar substantial reduction in side impact energy.

Conclusions: it appears possible to model fishing interaction with a 3D analysis package such as OrcaFlex. This allows the designer to assess in a rational manner the efficiency of alternative structure design & layout, water depths, deflectors and prospective changes in fishing gear and vessel size.

Acknowledgements: thanks to Duncan Warwick at Genesis Oil and Gas Consultants for providing assistance on typical structure layouts and design loads, and for challenging me!

A WAVE ENERGY CONVERTER WITH ORCAFLEX

An application for a new but growing market area for OrcaFlex by Bil Stewart[1], Stewart Technology Associates (STA)...

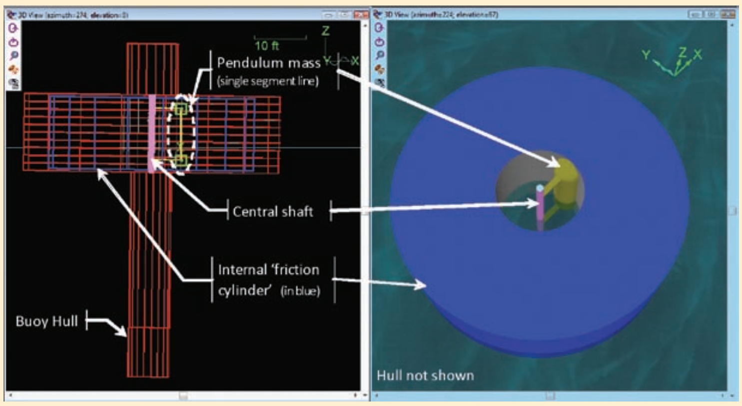
STA, who are one of Orcina's joint US Agents, has been involved with numerous marine renewable energy projects. One of the most interesting WEC concepts involves an eccentric rotating "pendulum" mass turning around a central vertical shaft inside a surface floating buoy (see screenshot). OrcaFlex can be used to model the buoy motions and the pendulum rotation in any sea state. The buoy motions cause the pendulum to rotate and this rotation strongly influences the buoy motions. The direction of pendulum rotation may change and the pendulum may stall, depending upon the power take-off load. The system is non-linear and sensitive, demanding time domain solutions.

In prototype systems the rotating pendulum may drive pure electrical generators via direct drives, or via hydraulic systems. Electromagnetic power generation is also possible. In OrcaFlex friction can be used to simulate power take-off.

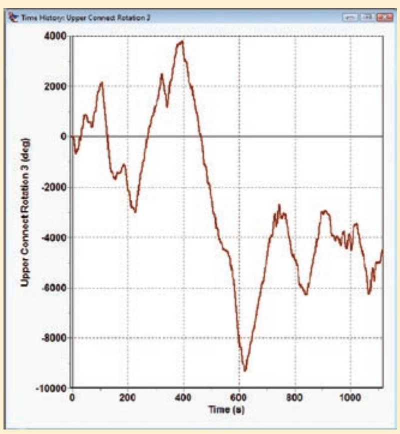
Upper and lower horizontal arms attach the pendulum mass to the central shaft in the buoy. OrcaFlex single segment line elements are used to model the arms and pendulum mass. Two 6D OrcaFlex buoys (green cubes in the wireframe drawing) connect the upper and lower shafts to the pendulum.

The line element simulating the pendulum mass can be seen inside the friction cylinder, pushing onto the inside face of the cylinder. The stiffness of the cylinder and the pendulum line element are arranged to give a sensible contact force. The friction coefficient between the cylinder and the pendulum line element is adjusted to simulate varying power take-off scenarios.

The graph shows rotation of one of the arms around the central shaft. Power take off is found by integrating the distance travelled by the pendulum around



the inside of the friction cylinder and multiplying by the friction force. Account must be taken of the reversals in direction and in the mechanical and electrical losses in efficiency this will cause.



Many mechanical variables may be investigated for any given buoy geometry and mass distribution, including pendulum mass, horizontal arm length, and friction coefficients.

[1]*Bil Stewart is Chairman of the ASCE COPRI Marine renewable Energy Committee.*

Agents News

Whilst our agents are mostly geographically remote from us, we have very close working relationships with them, often with daily contact. With most we have long standing relationships going back many years. This engenders strong technical communication which is very important in seeking to serve our clients in the best way possible.

We hope that this page will keep you abreast of the latest developments with our agents so as to better understand what they do and hence get the most from your use of our software.

Our list of our agents and their contact details are shown in the table to the right:

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NEWS FROM SOUTH AMERICA.........

Our South American agent is SUPORTE Consultoria e Projetos Ltda., who have been working with Orcina since 1998. Our main contact there is the company president Nelson Szilard Galgoul, who holds a Dr.-Ing. Degree from Germany and who is also a full professor at the Fluminense Federal University and an associate professor at the Federal University of Rio de Janeiro.

The Brazilian market has been very active since the mid-80s in shallow waters, and in deep waters since the mid-90s. In this market OrcaFlex is the most successful software for flexible lines, thanks to its application in several different analysis types.

SUPORTE is a general offshore design company with more than 100 employees. They have been very successful using OrcaFlex for rigid subsea pipeline design, for structural installation analyses (dynamic impact simulations) as well as for analysis of flexible lines.

On the engineering side SUPORTE started off in 1986 performing only consultancy work related to structural and naval architecture. This encompassed platform structures including construction and installation analyses plus subsea pipelines. After a while it was only natural for SUPORTE to gradually undertake other disciplines as well, so the company now develops multi-discipline projects for the offshore industry, not only in Brazil, but also in Latin America (Mexico, Peru, Ecuador and Argentina) and in the Middle East (Emirates and Iran).

The company has fully designed over 30 fixed platforms in water depths up to 200m and has re-analyzed over 70 other existing structures because of problems such as lack of strength, insufficient foundations or fatigue failure. SUPORTE has also participated in over 20 floating platform projects, including FPSOs, semi-submersibles and pipe-lay barges.

Rigid subsea pipeline courses, in which OrcaFlex is the main lecturing tool, have become part of the curriculum of both graduate and postgraduate level courses, which are being taught not only by Nelson, but also by 4 other professors of these same universities (both in Rio de Janeiro) and who work at SUPORTE. This has greatly enhanced the knowledge of the software in the Brazilian offshore market. In addition to these courses SUPORTE provides normal training courses to the local market and technical support to local users.

On a personal note, in addition to Nelson's academic activities (which have led to over 100 published papers) and his professional role as SUPORTE´s main structural consultant, he has also published several books in the religious field.

....AND FROM S.E. ASIA

Zee Engineering Consultants Pte, Ltd (ZEE) is a multi-disciplinary consulting engineering company specializing in the offshore oil and gas industry. ZEE was established in 1986 (becoming an agent for Orcina shortly thereafter) and to date has successfully completed over 200 projects in the Middle and Far East region. During this time ZEE has been very successful in building a versatile team of engineers for offshore installation especially in Submarine Pipelines. In 2003 ZEE enhanced its capabilities by forming a joint venture with PT Indonesian Service Bureau (ISB) for projects in Indonesia.

Besides submarine pipeline engineering ZEE has also been engaged in design & simulation of offshore floating structures, such as SPM's, moorings, FSO's, FPSO's etc. In all these projects ZEE has used OrcaFlex as the main design tool.

Over the years, during which we evolved from punch card operated programs to modern full graphic modelling computer simulations, ZEE has utilized a number of industry approved proprietary software packages. During the last few years ZEE has carried out a number of studies comparing OrcaFlex to other packages and have arrived at the following conclusions:

a) OrcaFlex gives realistic results especially for large diameter pipe in very shallow water for pipelay using a minimum facility Lay Barge. In a particular instance the installation contractor was able to reduce the minimum tensioner requirements by approximately 20%.

b) In OrcaFlex the start-up (including 'bow line'), lay-down, and davit lift can be simulated as a continuous operation, whilst in other packages this needs to be broken down to a number of stages.

c) The behaviour of the lay barge can be simulated in OrcaFlex by giving precise barge characteristics such as RAOs, QTFs, and damping at required orientation.

d) In OrcaFlex, support rollers can be modelled very easily and the reactions are calculated based on line clashing forces which will provide accurate roller reactions.

e) OrcaFlex has the capability to model heave compensators. This will result in the lowering of the system stresses.

f) OrcaFlex has superior graphics for modelling and reviewing results. This makes it easy to model and to understand the integral behaviour of the barge and the line.

ZEE has switched over to OrcaFlex for all pipeline installation work. Zee engineers have been given the encouragement and the resources to research and to implement all the features in OrcaFlex, resulting in a much better value added solution. Our in-house experience is passed on to other OrcaFlex users in the region through normal technical support, seminars, presentations and workshops. The greater awareness of OrcaFlex in the region, and the presentation of results to the major oil companies particularly in Malaysia and in Indonesia, has meant in some cases OrcaFlex being specified as the preferred software in tender documents.

News in *Short….*

ORCAFLEX USER GROUP MEETINGS, 2009

The most recent round of OrcaFlex User Group Meetings was held between September and December 2009. We were delighted to see over 250 colleagues registering, especially given the current climate. In addition to the standard 'What's New in OrcaFlex', the 2009 topics (see www.orcina.com/Support/UserGroup for available presentation materials) included:

Hydrodynamics: an introduction to the hydrodynamics of relatively simple geometries as exemplified by piles and surface piercing buoys. With some of the principles understood, deriving hydrodynamic properties for more complicated geometries should be more straightforward for the user.

Fatigue: we look at the fatigue life of an SCR with and without the non-linear seabed. For the non-linear soils model we examine the effect of varying mudline shear strength and suction ratio independently, and then including both effects. We also show how the fatigue life of an unbonded flexible is affected by the choice of the bending stiffness model employed (linear, nonlinear-elastic and hysteretic).

Advanced Automation: before dealing with the advanced topics, the existing automation facilities were outlined. Then the new Python interface was introduced, showing how this can be used to efficiently automate both the pre- and post-processing. We have also just developed a new Matlab interface and a brief demonstration of this was given.

Our **guest speakers** were again all well appreciated. They included:

- Aberdeen: David Fielding & Neil Botterill, Prospect Flow: *VIV of Drill Casing with OrcaFlex and CFD*
- Perth: Prof. Dave White and Zack Westgate, UWA: *Non-linear Seabeds*
- KL: Cecep Hendra, ZEE Eng: *Lay Analysis*
- Houston: Jamie McClellan & Chris Mungall, KBR: *Application of Automation in a Project*
- Stavanger: Anders Rødstøl, JP Kenny: *Using OrcaFlex for tie-in and in-place behaviour at a manifold hub*
- Rio: José Pedrosa, Subsea7: *Installation Analysis of Short Dual Flexible Jumper at Campos Basin*
- Paris: Cecile Melis, SBM: *Generating Models suitable for Purpose*

We'd like to say a big thank you to all those who kindly contributed as guest speakers to the UGM events. Their efforts are very much appreciated by Orcina and other attendees alike, and without their continued support this slot would simply not happen.

We also exhibited at OTC'09 in May and Offshore Europe'09 in Aberdeen in September. These ran pretty much to form with most of the usual crowd present – as far as we could tell, the mood was one of quiet optimism about the future. It was great to catch up with old friends and to make a few new ones (though at Offshore Europe we did nearly fall out with the audio system on one of the nearby stands ;-)).

In November our Houston Agents Bil Stewart and Paul Jacob presented a paper at the PECOM 2009 conference in Villahermosa, Mexico. The paper was titled '*The Role of Dynamics in Subsea Systems Installation Analysis*'. The focus was on illustrating the benefits that accrue by undertaking dynamic studies prior to going to field. Examples included vessel motions, flow line installation, package resonance and flying lead operations.

IN THE NEXT NEWSLETTER

Although OrcaFlex version 9.3 went out in August 2009, what with holidays and the preparation for, and delivery of, the User Group Meetings we've not completely finalised our priorities for 9.4. However, features which are high on our list include:

- Pipe-in-pipe, piggybacks
- Slug flow, contents density variation along arclength, free-flooding lines
- Py and Tz curves for vertical risers
- Multi-threading for the OrcaFlex post-processing spreadsheet
- Restarts
- Fatigue: T-N curves, mean stress
- Built-in hinge/articulation modelling element
- Better splash zone modelling, slamming
- Full QTF, sum freq. QTF
- Whole system modal analysis
- Line payout, especially for modelling inertia and drag on winches
- Pipelay code checks

Clearly not all of these will appear in the next release (v9.4), but is likely that most of these will at some stage! As ever, if you have any feedback on existing features, or planned new ones, then we'd be delighted to hear from you.

Did you *Know….*

a) ...that a Bend Stiffener Attachment does not appear as a separate object in the Model Browser, but it does appear as a separate object in the Results form. As the bend stiffener and product line can have different properties this allows OrcaFlex the big advantage of being able to extract separate results for each!

b) ...that (for some time now) 6D Buoys can be connected to other 6D Buoys. This allows multiple 6D Buoys to be treated as a single rigid body - particularly useful for modelling more complex shapes than the stacks of co-axial cylinders that Spar Buoys and Towed Fish allow!

c) ...that the OrcaFlex spreadsheet can accept static-state simulation files and therefore extract static results much faster than before. As always, we strongly recommend using the latest version of the OrcaFlex spreadsheet, supplied with each OrcaFlex release. See "About OrcaFlex Spreadsheet" on the spreadsheet Orcina menu for your spreadsheet version.

d) ...that OrcaFlex batch script can place the resulting output files into existing directories. For example: SaveData "pathname\Case01.dat", where pathname can be absolute (eg, N:\Projects\Analyses\P101\OrcaFlex\Results\", or pathname can be relative to the directory from which the script file was loaded (eg, Results\). The latter is usually more convenient.

e) ...that the contact vertices for spar buoys' interaction with shapes and the seabed are based on square cylinders, even if the 'Draw circular cylinders' option is used. The contact vertices can be seen by selecting 'Draw square cylinders' from the drawing page of the spar buoy data form. Lumped Buys with no vertices have no interaction effects.

f) ...as the author of this Newsletter discovered while preparing this edition, the fonts used for x- and y-axes graph labels and ticks can be set by the user! The preferred setting can also be set as the default. Particularly useful when copying graphs into documents as the text on the axes can sometimes be hard to see :-)

Orcina - out and about

Exhibitions, User Group Meetings and Training Courses:

The normal round of OrcaFlex User Group Meetings and associated Open Training courses now regularly occurs during the September – December period each year. The most up-to-date info on these can be found at: www.orcina.com/UpcomingEvents. In addition to these annual events we have firm plans to attend:

- **OTC2010:** 3-6 May, 2010 at the Reliant Park, Houston. See www.otcnet.org for more details.
- **Oceanology International 2010:** 9-11 March, 2010 at the Excel Centre, London. See www.oceanologyinternational.com for more details.

We are also looking at attending some other events during 2010, particularly in emerging market areas.

Orcina

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