Ultramarine, inc.

Offshore Engineering Software

...for the next Millennium

In the past, Ultramarine's software fell into two different classes: OSCAR/OTIS® and MOSES™. Since 1978, the OSCAR/OTIS system was used worldwide to analyze and design all types of floating structures. Until the present, most deep water structures employed OSCAR in some facet of the analysis, design, fabrication and/or installation process. MOSES, which stands for Multi-Operational Structural Engineering Simulator, is the OSCAR/OTIS replacement for today's user.

MOSES is a general purpose simulation program for the analysis of almost anything which will be placed in the ocean. It has many features, not all of which everyone needs to accomplish their tasks. As a result, there are several different capabilities of MOSES which are priced separately. In essence, the basic capabilities are free of charge. However, they only allow one to generate a model and perform simple analyses. To get more sophisticated results, extra cost options are needed.

Our purpose here is to describe precisely what each of the extra cost MOSES options allow one to do. We begin by saying that the basic MOSES capabilities allow you to do everything documented in the Reference Manual, except the commands discussed here that are considered "extra cost" options. This may be misleading; e.g. structural post-processing is included in the basic capabilities, but it does you no good unless you have the structural analysis capability.

The extra cost options are of three categories:

- the ability to add extra things to the model,
- the ability to use different hydrodynamic theories, and
- the ability to perform different type analyses.

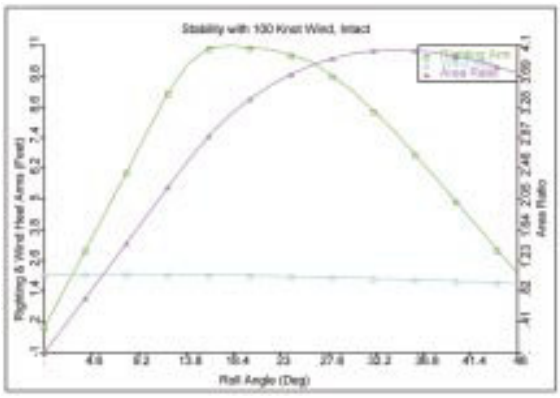
The following pages serve as a "list" of MOSES capabilities which begins with the Basics, then explains the extra cost options such as the Connector Elements, the Hydrodynamic Theories and concludes with the Analysis Types.

Basic Capabilities

- **Powerful Command Language** enables the user to create macros and take advantage of the modeling capabilities.
- **Model Generation** of a structure is treated as one or more hulls and a set of tubular and/or plate elements which are assembled into a single body. Generation options and interactive graphics allow easy modeling of unusual shapes, semisubmersibles and tension leg platforms.
- **Automatic Mesh Generation** of hydrostatic, hydrodynamic and plate meshes. The program refines a coarse mesh and calculates the intersection, union and difference of defined polygons used for mesh generation.
- **Versatile Graphics Capabilities** enable the user to interactively generate X-Y graphs of results and 3D views of models.
- **Post Processing** of results is easy and can be customized by the user via macros, or in batch or interactive modes.
- **SI, English or Metric** units can be used, seamlessly switching from one system to another.
- **Vortex Shedding** in wind or water is computed.

- **Automatic Ballasting** computes the ballast necessary to maintain equilibrium, given vessel configuration (draft, trim and heel) and loads. Tanks can also be ballasted interactively, automatically correcting system weight and inertia.
- **Minimum Ballast Movement** required to achieve a new vessel configuration is calculated.
- **Jacket Loadout Calculations** are made using the above computations.

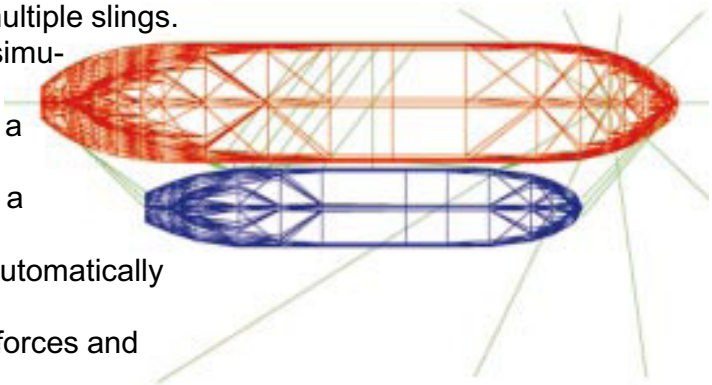
Hydrostatics



- **Curves of Form** can be generated for a set of drafts and trim angles and include displacement, waterplane area, locations of buoyancy center and center of flotation, transverse and longitudinal KM, load to change draft and moment to change trim.
- **Intact and Damage Stability** with righting arm curves can be generated for a range of drafts and trim angles. Results include righting arm, wind heel arm, area ratio and minimum height of down-flooding points.
- **Single Body Equilibrium** is easily found. MOSES computes an equilibrium position given the load and ballast of the vessel.
- **Longitudinal Strength** shows bending moments and deflections of a loaded, ballasted vessel.

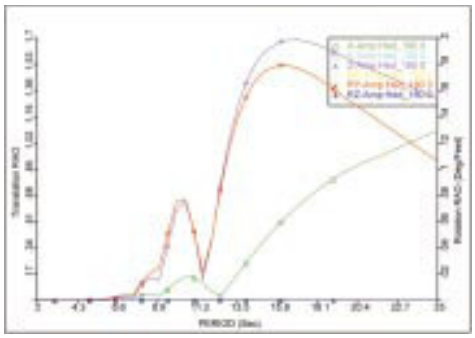
Equilibrium

- **Multibody Equilibrium** automatically includes wind, wave and current forces.
- **Bodies** can be lifted, lowered or upended with multiple slings.
- **Connectors** can be activated or deactivated to simulate breaking or rerigging.
- **Anchors** can be automatically moved to achieve a specified tension.
- **Connector Lengths** can be changed to achieve a specified tension.
- **Multiple Bodies** can be repositioned with lines automatically adjusted to achieve equilibrium.
- **Interactive Status** of the configuration, applied forces and connector forces.

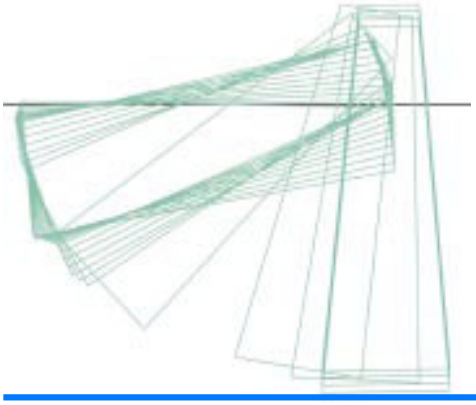


Frequency Domain

- **Frequency Domain Analysis** can be used for structure response to a set of waves of given period and direction. Reports include structure added mass and damping, pressures on the hulls and resultant total forces and moments.
- **Morison's Equation** can be used for a combination of plates and tubes with hulls to form a structure, or simulate a semisubmersible or self-floater.
- **Strip Theory** is fast and efficient for traditional hull shapes.
- **3D Diffraction Theory** captures bottom effects and hull interaction.
- **Response Amplitude Operators** (RAOs) are calculated for motions of any point on the structure and for inertial forces on bodies attached to the structure.



- **Statistics** can be generated, using RAOs, and a variety of spectra; ISSC, JONSWAP, or user-defined. Results are the RMS, significant, average of 1/10 and 1/100 highest response, or maximum responses, based on statistical multiplier or storm duration.
- **Nonlinear Slowly Varying Wave Drift Forces** can be included in the frequency domain.



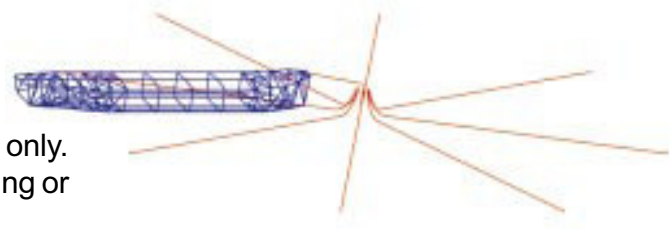
Jacket Upending

- **Upending** or lifting of a structure can be simulated via a user defined installation sequence.
- **Lifting and/or Flooding** can be simulated for upending.
- **Hook** can be held at a constant elevation or load while flooding or pumping.
- **Slings** can be used for lifting purposes.
- **Environment** can include current and wind.
- **Database** capability allows restart at any event within an installation sequence.

Connector Elements

These different options react in a synergetic fashion. For example, one can create a model of several bodies and find equilibrium with the basic capabilities, but unless these bodies can be connected together, the results are the same as if the bodies existed independently. Thus, we have the first set of extra cost options, **connectors**, which allow one to connect bodies together or to ground. With the addition of connectors, one has extended the basic capabilities into a "mooring" program which can do static or frequency domain analysis.

Basic Connectors



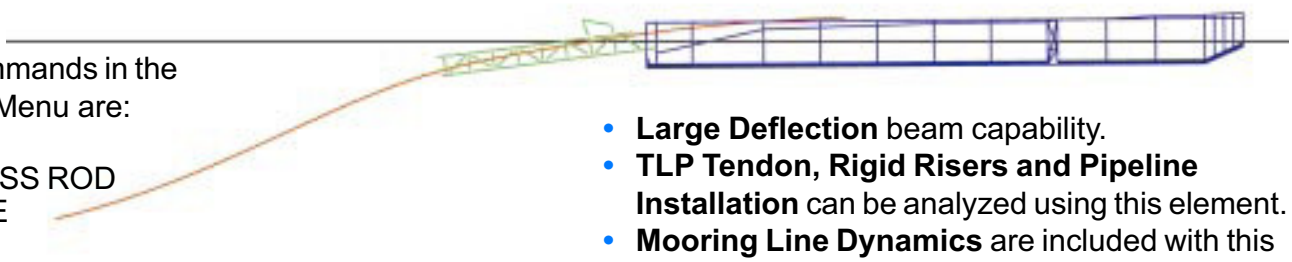
- **Catenary Mooring Lines** can have up to 30 segments separated by buoys or clump weights.
- **Nonlinear Springs** can act in tension or compression only.
- **Force Elongation Behavior** can be specified for spring or mooring lines.
- **Gaps, Pins and Lines** provide constraints to motion.
- **Multiple Sling Assemblies** can be used to hold or lift bodies.
- **Connector Design Menu** expedites design of piles, mudmats, mooring lines and lift slings.
- **Spectral Fatigue** in connectors can be accumulated.
- **Cycles of Tension** in connectors can be counted.
- **Reposition Menu** allows easy adjustment of connectors to change position or achieve equilibrium.

The commands that one buys with Connectors in the MEDIT Menu are:

- CONNECTOR
- LLEG
- T-H_DEFINITION
- PULLEY

Pipe and Rod Element

A more sophisticated connector, the "**pipe and rod**" element, allows one to consider the structural dynamics of mooring lines and to analyze pipe laying. If one is using a connector with this type of element, it is no longer a simple connector. Instead, these connectors are an assembly of nonlinear, large rotation beam elements and they have forces which act on them: buoyancy, drag, wave excitation, added inertia, and inertia. This is another extra cost option.



The commands in the MEDIT Menu are:

- ~CLASS ROD
- ~PIPE

- **Large Deflection** beam capability.
- **TLP Tendon, Rigid Risers and Pipeline Installation** can be analyzed using this element.
- **Mooring Line Dynamics** are included with this element.

Hydrodynamic Theories

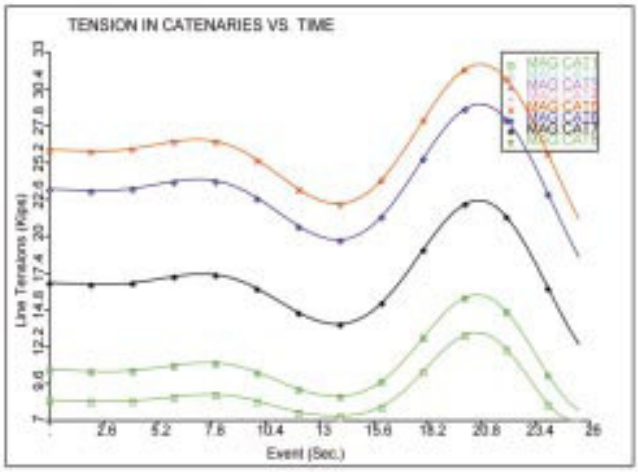
The next class of extra cost options is hydrodynamic theories. **Strip Theory** (two dimensional diffraction theory) and **3D Diffraction Theory** are two options which may be purchased independently. As described above, the basic capabilities and connectors allow you to perform mooring with hydrodynamics modeled via Morison's equation. With Strip Theory, you can use a hydrodynamic theory which will yield good results for the mooring of ships. If you are interested in semi-submersibles or TLPs, you need 3D diffraction to get good results. Without these extra cost options, you are limited to Morison's equation with all analyses. Consequently, MOSES will abort if you ask it for Strip or 3D diffraction Theory and have not purchased it.

Analysis Types

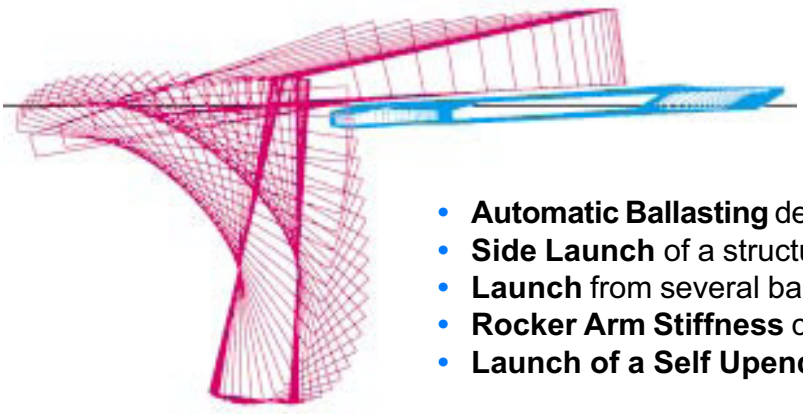
The final class of extra cost options is different types of analyses. Carrying the mooring example a bit further, suppose you had a highly nonlinear problem. Here, frequency domain analysis may be subject to question, so you may need the time domain capability. Alternatively, you may need to investigate the stresses inside the structure so you would need the structural solver capability.

Time Domain Simulation

- **Simulation** determines the time-history response of the system.
- **Ocean Conditions** can consist of current, irregular waves, wind or any combination of these.
- **Frequency Domain Results** are transformed into the time domain.
- **Multiple Body Motions** can be analyzed. A typical example is a tanker attached to a mooring buoy.
- **Restart Capability** allows continuation of analysis.
- **Post Processing** of results is easy and can be customized by the user.
- **Statistics** of results can be computed.
- **Tanks** can be dynamically flooded based on value properties and actual, differential headings.
- **Tanks** can be emptied by defining an air compressor.
- **Docking analysis** of offshore structures can be performed.



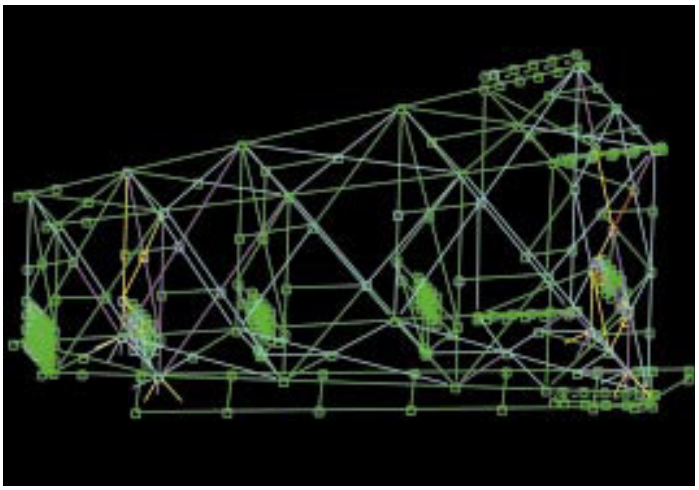
Jacket Launch



- **Dynamic Simulation** in time domain treats all bodies with 6 degrees of freedom.
- **Parametric Studies** are easily performed, simplifying the task of finding the optimum draft and trim condition.
- **Automatic Ballasting** determines desired draft and trim prior to launch.
- **Side Launch** of a structure can be analyzed.
- **Launch** from several barges can be investigated.
- **Rocker Arm Stiffness** can be included.
- **Launch of a Self Upending Jacket** can be performed.

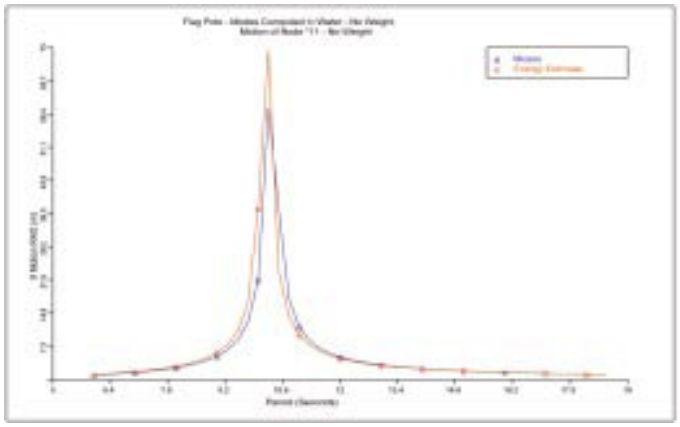
Structural Solver

- **Frequency Domain Stress Analysis** allows member and joint checks to be considered spectrally.
- **Nonlinear Structural Solution** accounts for all nonlinearities.
- **Environmental Loads** are computed automatically with no need for wind and wave loads files.
- **API and AISC** code checks are provided.
- **Automatic Resize** of members with the optional database update.
- **Spectral Fatigue** can be considered for beams, plates and joints. SCF's are computed for tubular joints using Kwang & Smedley, API, Marshall or Efthymiou, or the user can supply them.
- **Eigenvalues and Eigenvectors** can be extracted by a subspace iteration technique.
- **Joint Crushing** can be evaluated.
- **Deflected Shape and Modes** can be plotted.



Generalized Degrees of Freedom

- **Eigenvectors** can be used as generalized degrees of freedom in all MOSES analyses



- **Generalized Degrees of Freedom** can be used to:
  - Consider the effect of structural dynamics on the integrity of the structure
  - Quickly include the effect of flexibility in loadout analyses
  - Include the effect of deformation on the amount of buoyancy
  - Consider hydrodynamic interaction between two vessels
  - Consider the effect of deformation on frequency response