AVEVA **Initial Design**

For contract and structural design with naval architectural calculations and cost estimates

AVEVA Initial Design™ is an integrated suite of advanced, yet cost-effective and practical ship-design tools developed for naval architects and design engineers. The application is best used as the front end of the complete, integrated AVEVA Marine solution, but it can also be used on its own for the conceptual parts of the design.

Initial Design is a tool for rapid definition and analysis during the contract and the structural design phases of a project. Its close integration with other AVEVA Marine applications ensures smooth and rapid design development on projects taken into basic and detailed design.

Geometry

Lines is a hull fairing tool which can be used to create virtually any form of marine vehicle, including multi-hulls, chined and asymmetrical hulls. The hull form is initially represented as a loosely-connected mesh of curves that is used to semi-automatically create a surface comprised of B-spline patches and bounded planes with tangential (C1) continuity.

Advanced mathematical techniques are incorporated for automatic curve fairing and surface smoothing. The quality of the surface can be assessed using isophotes to visualise fairness and continuity.

Graphical display of compartment arrangement
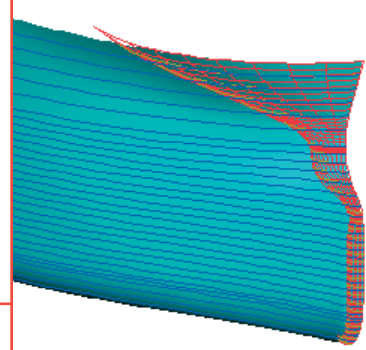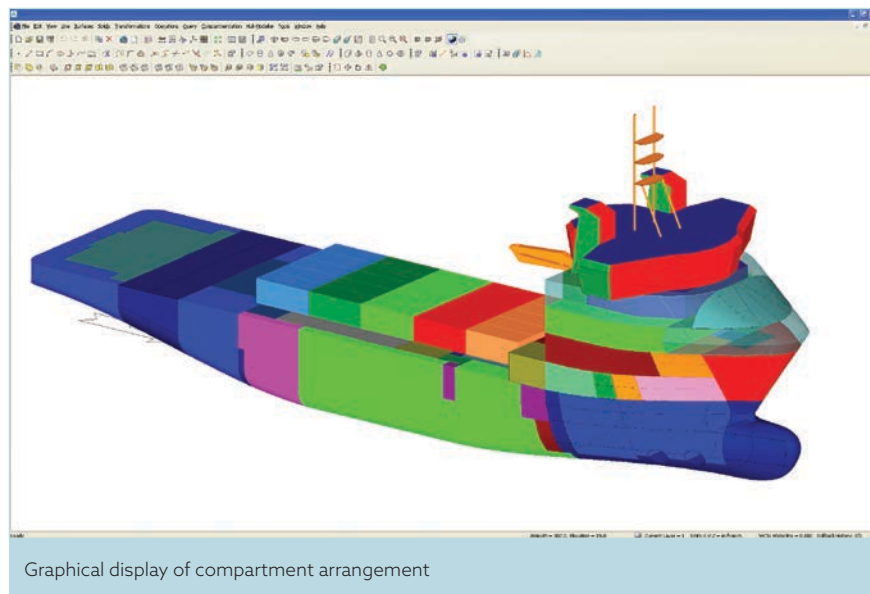
Business Benefits

▌ Rapid concept development. Advanced mathematical modelling and analysis techniques including full surface topology enable quick design evaluation.

▌ Flexible application capable of configuration to suit customer needs; means that users can work in the most efficient way that suits them.

▌ Graphical user interface that provides an intuitive way of working that helps achieve high productivity quickly.

▌ Fully integrated with hull and outfitting design, reduces error and the need to re-create data.

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Geometry (continued)

Lines can be used for rapid hull form creation in preliminary design, or for full production fairing.
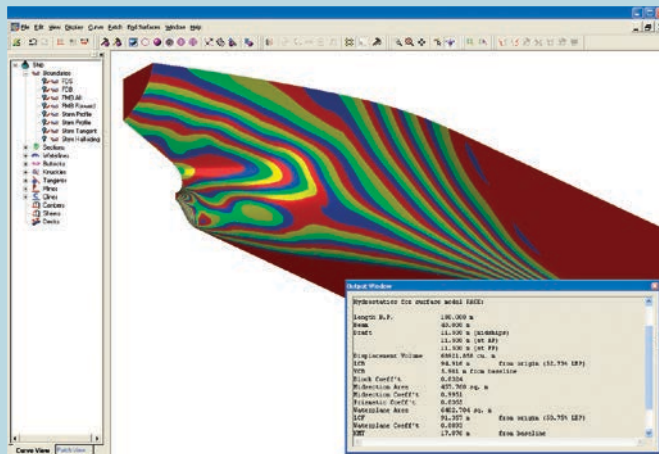
Features include:

- Interactive point and curve editing.
- Traditional 2D or advanced 3D fairing.
- Automatic curve fairing and data reduction.
- Special handling of waterline endings and frame feet.
- Hull form hydrostatics.
- Sectional area curve distortions and scaling.
- Deck creation with gunwale definition.
- Lines plans and loftbooks.
- Surface generation with automatic smoothing and manual editing.
- Assessment of surface fairness.
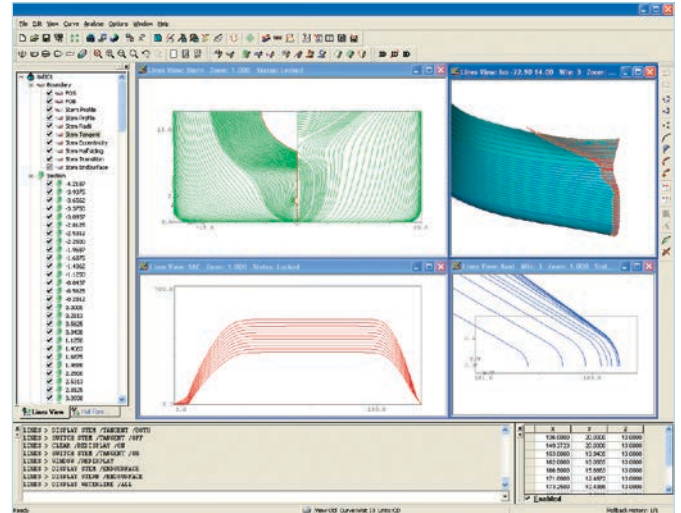
Modelling of hull curves

Surface is principally used to model features of the main hull and its appendages, such as rudders, anchor pockets and thruster tunnels.

At its core is a 3D solid modelling kernel that can be used to create many additional ship features. Its rich functionality can be equally applied to ship superstructures or offshore structures.

Display of hull surface using isophotes

Features include:

- Primitive creation – plane, block, pyramid, cylinder, cone, sphere, toroids.
- Curved surfaces creation – swept, extruded, rotated, skinned surfaces, 3 or 4 boundary interpolated patches, tube.
- Curve primitives – polylines, splines, lines, arc, ellipse, NACA sections.
- Surface operations – subtract, unite, solid intersection, intersect, imprint, join, combine, blend, scale, move, rotate, align, reflect, copy, concatenate, control point editing.
- 2D operations – join, trim, cross, offset, fillet.
- Visualisation – principal curvature, curvature tufts, Gaussian, isophotes, transparency, lights.
- Lines plans and loftbooks.

Compartment facilitates the quick definition of transverse and longitudinal bulkheads, decks, compartments and superstructure. All features are stored topologically and can be rapidly regenerated to accommodate design changes with minimum effort. Functional descriptions can be assigned to bulkheads and decks, to enable automatic generation of steel in Hull Structural Design.

Analysis tools are incorporated for calculation of mass properties with facilities for preliminary weight analysis. Compartment also provides automatic generation of container bays.

Features include:

- Creation of transverse and longitudinal bulkheads, decks and compartments with topological referencing.
- Non-planar bulkhead/deck options including cranked, corrugated, upper and lower stools.
- Creation of compartments from bulkhead, deck and hull form boundaries, or from merging of compartments by addition and subtraction.
- Creation of internal structures from operations (subtraction, intersection, etc.) on primitives (plane, block, pyramid, cylinder, cone, sphere, toroids).
- Calculation of mass properties – volume, surface area, LCG, TCG, VCG.
- Preliminary weights and centres of gravity analysis.
- Automatic container bay arrangements.
- Integration of internal surfaces (transverses, longitudinals and decks) throughout AVEVA Marine for early structural steel design and full topological modelling.

Hydrostatics

The Hydrostatics module provides a comprehensive toolkit of naval architectural assessment routines, including the calculation of hydrostatics, tank calibrations, trim tables, loading conditions, loading and discharging sequences, intact and damage stability, critical KGs, longitudinal strength, inclining experiment, freeboard, floodable length, tonnage and launching.

Particularly sophisticated routines are included for damage stability assessment, using both deterministic and probabilistic methodology, as well as more specialised calculations covering grain stability, water on deck, and so on. The SOLAS harmonized probabilistic regulations for passenger and cargo ships, also known as SOLAS 2009, are incorporated
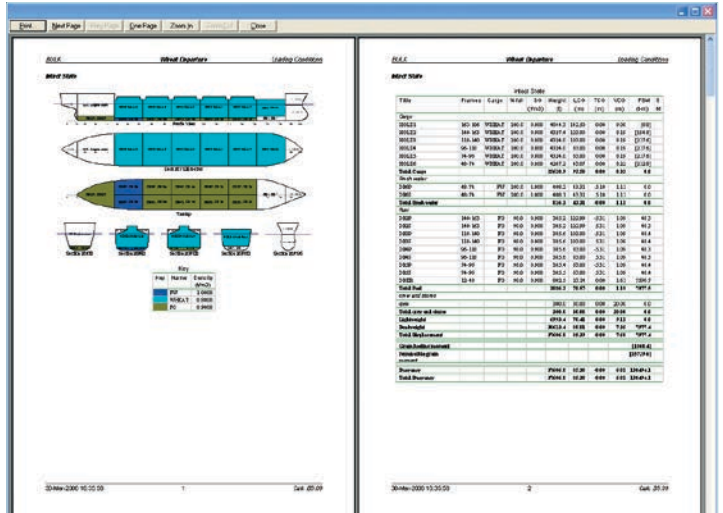
Comprehensive graphical and tabular output is available throughout, in a form directly applicable to obtaining both owner and regulatory approval for a new design, and for use in standard documentation such as tender responses, stability booklets and damage stability assessments.

A significant feature of the analysis module is that the overall process is, itself, report format oriented. Reports can also be exported in HTML or XML format to enable further customisation by the user.

A loading condition report

Features include:

- General particulars.
- Tankplan and loading diagram.
- Definition of openings, strength limits, etc.
- Lightweight definition.
- Container arrangement.
- Visibility check.
- Tank calibrations.

- Grain calibrations and permissible grain moments.
- Hydrostatics, cross curves, sectional area curves and deadweight scale.
- Trim tables.
- Intact and damaged stability with critical KGs.
- Probabilistic stability assessment according to SOLAS 2009.

- Continuous flooding simulation.
- Loading conditions with stability and longitudinal strength.
- Tonnage measurement, freeboard, floodable length and equipment number.
- Static and dynamic launching calculations.
- Inclining experiment analysis.

Hydrodynamics

The Hydrodynamics module consists of a wide range of analysis tools for the prediction of the hydrodynamic performance of vessels.

Powering
A range of methods based on widely-employed standard regression analysis methods can be used to estimate powering for single- and twin-screw vessels. Actual resistance results from towing tank experiments can be substituted for the empirical estimates.

Features include:

- Propeller optimisation.
- Resistance calculations.
- Ship powering characteristics.
- Use of resistance ratios from model tests.

Manoeuvring
The manoeuvring characteristics of ships in deep or shallow water, under even keel or trimmed conditions, can be assessed. This analysis can rapidly estimate the effect of changes in ship conditions, and takes into account nonlinear coupling effects of hull forces and moments developed by the rudder.

Features include:

- Crash stop calculation.
- Zig-zag manoeuvre.
- Turning manoeuvre.
- Reverse spiral calculation.

Seakeeping
Seakeeping is analysed using standard strip theory. Added mass and damping coefficients are calculated and combined with wave excitation forces to calculate the vessel's responses in regular and irregular seas. Responses at any location along the vessel may be calculated and combined to provide subjective motions, deck wetness, propeller emergence and slamming. Short-term irregular response can be extended to long-term performance prediction when combined with seakeeping criteria and wave statistics provided by third parties.

Features include:

- Sectional hydrodynamic coefficients.
- Regular wave responses (RAOs)
- Added resistance due to waves and dynamic loads.
- Short-term, irregular vessel responses (RMSs).
- Long-term seakeeping performance predictions.

Dynamic Positioning
The Dynamic Positioning module makes it possible to design the thruster system of any vessel which requires a station-keeping capability with three or more thrust units.

Features include:

- Thruster requirements for a given environment.
- Environment calculation, including a rosette of holding capability.
- Environmental Regularity Number (ERN) calculation.

AVEVA Hull Structural Design

AVEVA Hull Structural Design™ is licensed separately from Initial Design. Hull Structural Design is used for the preliminary geometry definition and arrangement of the principal structural members of a vessel, and provides the framework for associated design guidance.

Hull Structural Design is used for the production of classification drawings, steel material estimates, weld lengths and weights and centres of gravity reports.

Hull Structural Design supports XML-based interfaces to classification societies' software packages for rules checking and structural analysis. General FEM-based strength analysis software packages are also supported by these interfaces.

Summary of Process Coverage

The table shows the modules within Initial Design and their purpose within the process.

Although it is a separate product, Hull Structural Design is also shown in the table, in order to provide a complete picture of the early design activities covered by the AVEVA Marine solution.

Process	Geometry	Hydrostatics	Hydrodynamics	Hull Structural Design
Contract Design				
Hull form design	✓			
Compartments and internal geometry	✓			
General arrangement, tank plan, loading diagram	✓	✓		✓
Major appendage creation	✓			
Speed and power prediction		✓		
Hydrostatics, stability and section area curves		✓		
Trim tables		✓		
Damage stability		✓		
Continuous flooding simulation		✓		
Loading conditions and intact stability studies		✓		
Longitudinal strength		✓		
Weight estimation	✓	✓		
Tank calibration and capacity tables		✓		
Grain calibration and permissible grain moments		✓		
Container bay arrangement and loading	✓	✓		
Drawings and documentation	✓	✓		
Generic export (DXF, IGES, SAT) for CAD systems	✓	✓		
Structural Design				
Structural design for classification	✓			✓
Cost-related information, including weight, bill of materials, welding lengths and painting area				✓
Production planning	✓			✓
Generation of drawings	✓			✓
Generic export to analysis systems				✓
Generic export of DXF for general CAD systems				✓
Statutory compliance				
Intact and damage stability evaluation for all existing regulations		✓		
Generation of limiting GM/KG curves		✓		
IACS longitudinal strength		✓		
Shear force corrections		✓		
Inclining test		✓		
Grain stability		✓		
Freeboard, tonnage and floodable length		✓		
Report generation ▮ Trim and stability booklet ▮ Damage stability booklet		✓		
Performance				
Power prediction			✓	
Seakeeping analysis			✓	
Manoeuvring			✓	
Dynamic positioning			✓	