

# Marine Vessels Insulation Package

## Optimization from 2D Cabin Layout Drawings

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### Introduction

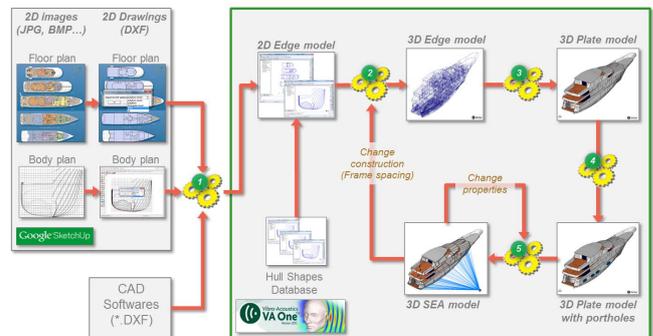
Accurate interior noise predictions are important at every stage of vessel design. Stringent targets set by owners of luxury vessels and by legislation in the case of industrial or military vessels dictate the insulation package content and its distribution. Current use of empirical models result in poor interior noise predictions due to changes in construction techniques and new materials not reflected in outdated empirical formulae. This in turn results in additional expense due to over specified sound insulation packages. Furthermore, complex sources and noise transfer paths require accurate noise prediction models to design sound insulation specifications that meet demanding cabin noise targets. Noise prediction models must be capable of being deployed at an early stage in the proposal process for initial sound insulation cost estimates and later in the design process to accurately predict interior noise levels. Predictive noise models must be built quickly from 2D drawings of the cabin layout for each deck to enable rapid response to initial assessment of interior noise levels and sound insulation specifications. This paper presents recent developments in automating the process of building predictive SEA models and optimizing the insulation package at either an early design stage such as proposal phase, feasibility stage or a more later stage where details can be added to the existing simplified model to ensure that the insulation package designer has the right model at the right time.

### Introduction

Numerical simulations of noise and vibration have been increasingly used in the marine industry to predict interior noise in cabins or underwater radiated noise [1,2,3,4,5,6]. Today's bottleneck in the prediction process lies in the creation of SEA models that can be quite time consuming. This paper presents a process that allows a user to create a SEA 3D geometry model in a few days.

### Description of process

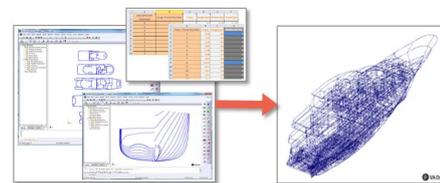
Figure 1 show the global process to build a 3D geometry model from a 2D drawing. The use of a simple software to define cabin boundary is recommended and a DXF format has been used to import the cabin edges into the commercial software VA One. The following step is to define the frame spacing, deck height and location of bulkheads and girder and a script will automatically create a 3D edge model. Finally, an algorithm scan the whole edge network to find all possible plates that can be created in the edge network.



**Figure 1:** Process description from 2D to 3D full SEA model. The process involves defining cabin floor and body plan edges, build up a 3D edge model and finding all possible panels that can be created. Finally, physical properties of panels and fluids can be applied.

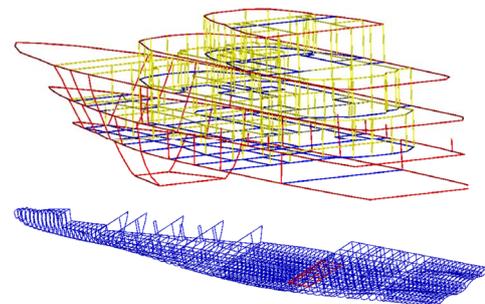
### From 2D drawings to 3D edge model

An algorithm creates the network of edges in 3D based on a cabin layout and a body plan as illustrated in figure 2.



**Figure 2:** Process description from 2D edges to 3D edge model. The process involves using floor layout, body plan and an excel sheet specifying frame spacing, deck height to create a 3D edge model.

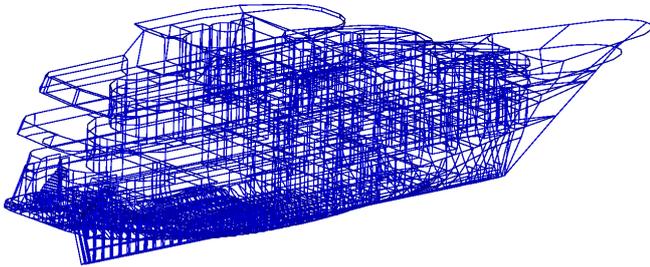
Figure 3 shows the resulting edge network for the hull lower part and the cabin boundaries.



**Figure 3:** Top: cabin layout is used to create extra edges to extrude cabin shape to the next upper deck. Red = deck outer edge and their projection, Blue = cabin interior edges, Yellow = blue edges projected to next upper deck. Bottom:

lower part of hull is modeled in details based on excel sheet inputs and body plan lines.

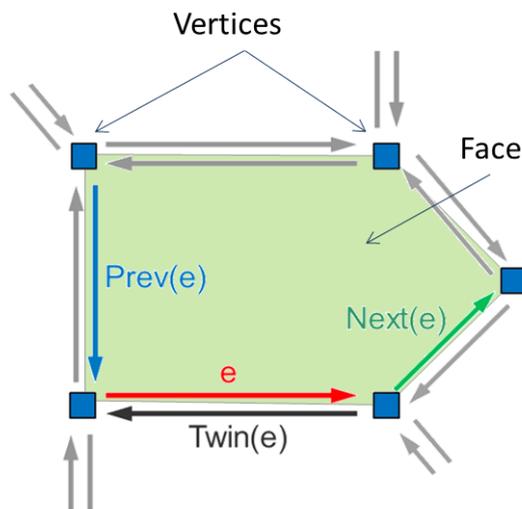
The resulting 3D edge model is shown in figure 4. Note that at this stage, manual edits of the edge network can be performed to add stairs, inclined planes...



**Figure 4:** Resulting 3D edge model ready for search of all possible plates.

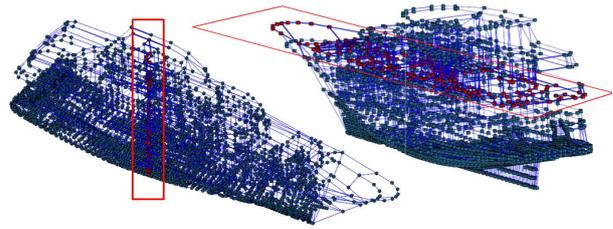
### From 3D edge to 3D panel model

To find all possible panels in the 3D edge model, a DCEL approach has been adopted. This data structure provides an efficient manipulation of the topological information associated with vertices, edges, faces. Connected or disconnected graphs are possible and it is used to find all possible closed faces within a plane. The 3D edge model is broken down in planes and for each plane, an algorithm travels along the edges until it closes a face (Figure 5). If an end is open (ex: because edge travelling in another direction, algorithm ignores the current face).

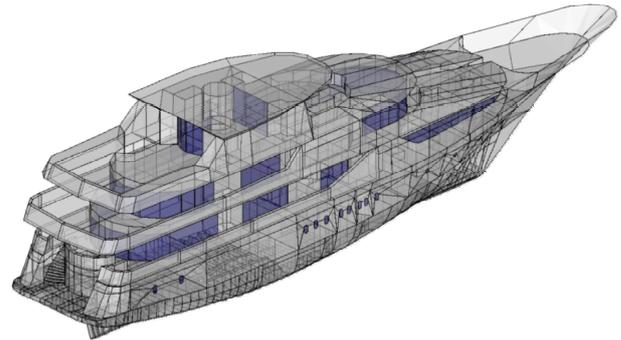


**Figure 5:** DCEL (Doubly Connected Edge List) diagram showing how an algorithm can travel from one node to the other through oriented edges and find closed faces laying within a single plane.

The algorithm loops through all the possible planes in the 3D edge model (Figure 5). Once all the planes have been scanned and all the closed faces found, the SEA panels can be created. Figure 6 shows the resulting SEA geometry model where portholes have been added. This model is ready for physical properties assignment, creation of fluid cavities, underwater radiation model implementation and acoustic and vibration isolation measured definition.



**Figure 5:** DCEL (Doubly Connected Edge List) method requires that the nodes lie in a plane. The edge nodelist is ran through and each possible plane is scanned for closed faces.



**Figure 6:** Resulting 3D plate where portholes have been added

### Conclusion

This process has been tested on various SEA model from 40 to 70m in length. The time needed to convert the drawings into edges is approximately 4 hours and the creation of the geometry model is done overnight. This process is therefore cutting the model building time by a factor of 30.

### References

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