Developing Surfaces in *FastShip*
For use in Intergraph VDS/ISDP

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1.0 Introduction/Scope

The scope of this document is to define the development of FastShip surfaces that are to be imported into VDS/ISDP. This will include file relationships, surface types, features, boundary conditions, and required cleanup in VDS. The FastShip hull and appendage surface definition is developed using NURBS surfaces which are cubic (4^{th} order) in the U and V directions.

2.0 File Relationships

The VDS hull form is composed of several files that have associative relationships. These file relationships allow the user to change the hull form and have the down stream applications update to the new hull. Figure 1 shows the relationship between the FastShip surface files and the VDS hull model. The single headed arrows in Figure 1 denote non-associative file relationships, and the double-headed arrows show the associative relationships.

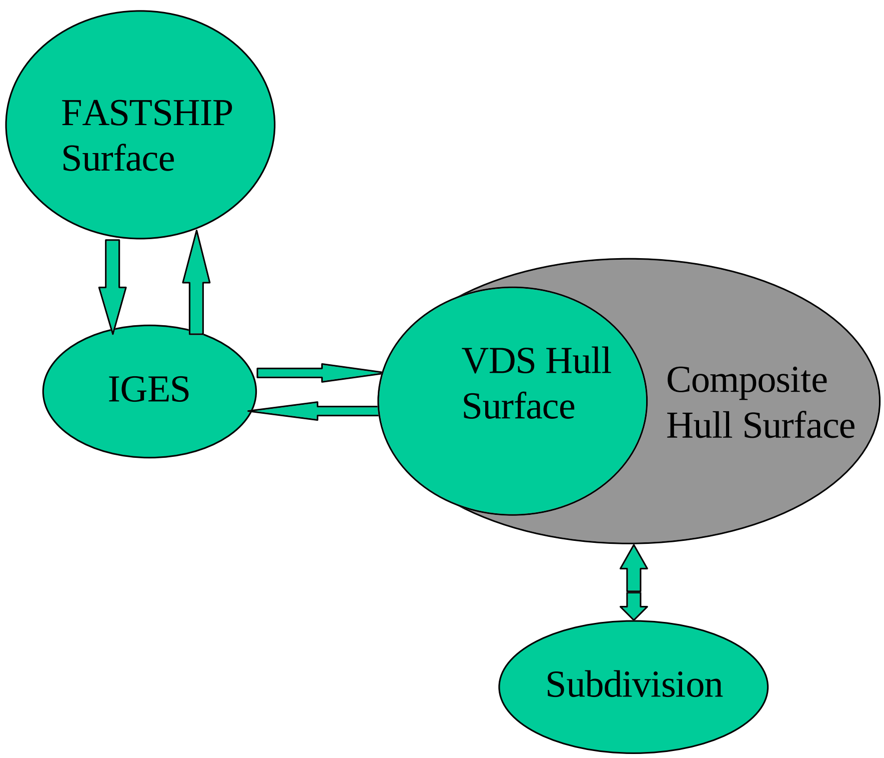

Figure 1: File Relationships

The chain of events is to create the hull model in FastShip, then export the surface(s) as an IGES file from FastShip. The Intergraph IGES product is used to convert the FastShip IGES file to a VDS model file. An associative surface is created which wraps all of the non-associative surfaces that comprise the hull; this hull model is called the Composite Hull. This Composite Hull is actually a VDS macro that points to the non-associative surfaces brought in from IGES. These non-associative surfaces are replaced when an updated IGES file is read in. All down stream VDS applications reference the Composite Hull Surface and are nearly unaffected by swapping out the non-associative hull surfaces.

3.0 Surfaces

The FastShip surface file contains the faired surfaces. These surfaces are generally 4^{th} order untrimmed NURBS surfaces. The FastShip surface file is produced by either fitting the surfaces to the offsets for reverse engineering cases or, by using the FastGen macros to parametrically develop a new hull form from an existing one.

The number of surface components that make up a ship hull must be kept to minimum. For example, there should be one surface for hull port, and one surface for hull starboard, and one surface for the transom. While this is not always possible or desirable, it will mitigate the problems that structural engineers will have when placing plates and stiffeners on the molded hull surface.

All hull form models must be created to meet the requirements of the VDS software suite, so that all downstream applications (i.e. struct, sman, route, etc.) can work in the most efficient manner. These requirements are driven by the VDS software and may be in conflict with some FastShip practices.

NOTE: The FastShip user must pay particular attention whenever net lines are merged.

3.1 General Surface requirements

All hull surfaces will be created as NURBS surfaces that are cubic (Forth Order) in the U and V direction.

NOTE:
Both FastShip and VDS have the capability to create surfaces that are not cubic. Be careful about mixing the order of the surfaces in some cases we have seen invalid intersections in VDS. Most notably there was a cubic hull surface intersected with a linear longitudinal bulkhead that either failed to intersect or gave the wrong intersection curve in VDS 2.3.

3.1.1 Multiple Surfaces

VDS and the Space Management module have the capability to handle multiple surfaces in the hull form definition. However the STRUCT package is at a disadvantage with multiple surfaces since it can not drive structure across surface boundaries.

Switching the number of surfaces in the hull surface file may invalidate large portions of structure in the Structural Application.

3.1.2 Chines and Knuckles

Chines and knuckles can be incorporated into the FastShip hull surface in many ways; the following two methods are the only ones that are valid in VDS.

1. Break the surface at the discontinuity and have multiple surfaces.
2. Use tripled up knots interior to the surface to develop discontinuity in a single surface.

NOTE:
VDS will not be able to create associative intersections with any other combination of techniques. The most notable of the forbidden techniques is the general FastShip practice of merging 3 net lines to produce a knuckle or chine.

3.2 Interaction between Deck and Hull

Due to past difficulties in intersecting the weather deck to the hull the FastShip hull form model should be extended up 2 inches or 5 cm above the weather deck height. Once the intersection is established the hull form model can be trimmed back to the weather deck.

3.3 Boundary Conditions

Attention to the boundary conditions at the edges of the surface is required in order to get the correct physical shape for any hull form. The next two sections describe the boundary conditions commonly used in the ship fairing process.

As a general point, any time two surfaces are connected and the intersection does not form a discontinuity then the two surfaces should have curvature continuity as well as tangency continuity across the intersection. The method of placing the net lines and their relation to each other is described in the FastShip documentation.

There are two critical areas on surface ships that require the developer to spend time to carefully set up the boundary conditions for the surfaces comprising the hull model. These are the forefoot and the waterline endings at the stem.

3.3.1 Fore-Foot Boundary Condition

The forefoot treatment (G2 MIX in FastShip terminology) guarantees that there is spatial curvature continuity from the edge of the surface that makes up the baseline to the edge of the surface that makes up the stem. Additionally we get curvature continuity in the transition region. The method of wrapping the corner of the surface using G2 Mix is described in the FastShip documentation. The FastShip user needs to pay particular attention to this area of the surface when a flat of bottom curve present. Typically a flat of bottom curve is merged into the centerline of the ship in the bow region. In order for the FastShip surface to translate to VDS the flat of bottom will have to be given a finite width (~2mm) with each net line collapsed on the centerline being space it out between the centerline and the flat of bottom. See Figure 2.

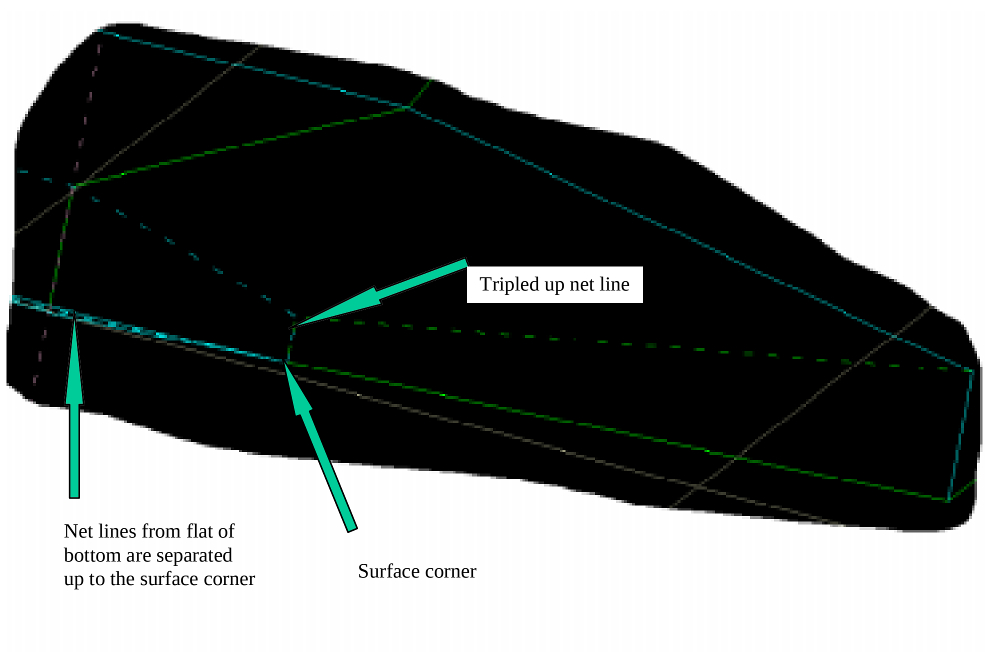

Figure 2 - G2 Mix Boundary condition showing Flat of bottom fix.

3.3.2 Perpendicular Waterline Endings

When perpendicular waterline endings are desired the FastShip user must position the first interior net line from the stem, perpendicular to the surface edge that describes the stem. See Figure 3.

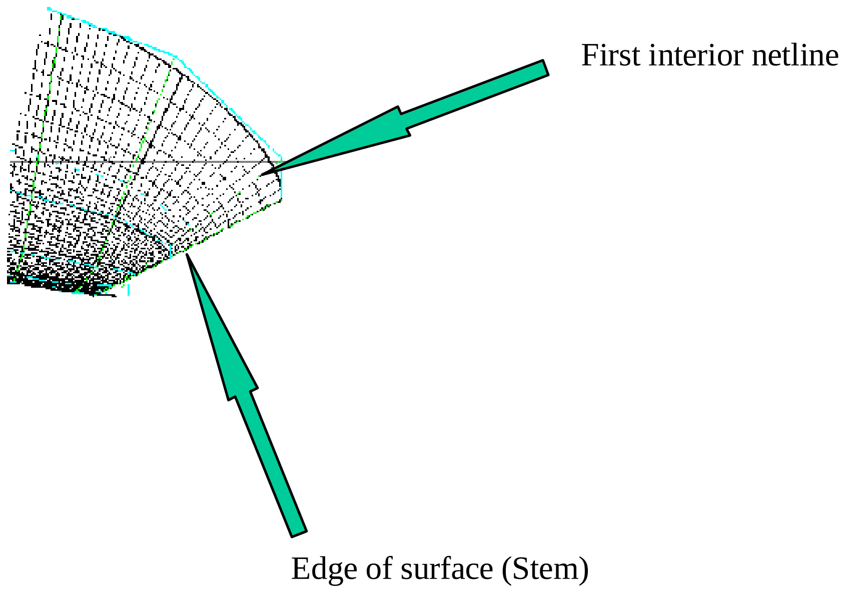

Figure 3 - Perpendicular boundary condition

3.4 Z Validate Surface

This command was developed by Intergraph to take surface files with tripled up poles and convert them to tripled up knots. If the command cannot replace the tripled up poles with a triple knot it will spread the pole apart using an increment of 10x basetol. This command is used on hulls that were translated into VDS from third party systems.

Warning this command can and will change the surface definition, and boundary conditions. The user must carefully review the resultant surface to see if it still meets the project requirements. This command will undo the G2 Mix boundary condition in all cases, depending on the exact net configuration in FastShip the difference may or may not be noticeable. In all cases of the flat of side not being treated as in 3.3.2 the bow was severely distorted.

4.0 Composite file

The hull form composite file is an intermediate file between the actual hull form surface file and any file that references the hull form for associative attachments. Associative macro commands require that the object id of an element (which cannot be seen or manipulated by the user) remain constant for updating purposes. Because a new hull form file is created every time the IGES processor is run, new object id's are created for each surface. It is therefore impossible to retain associatively to the hull form. The solution to this is the creation of a hull form composite surface file, which contains an associative composite surface macro referencing the surfaces in the actual hull form surface file. This hull form composite surface macro is later modified to reference new hull form surfaces as they are created.

4.1 Create New Composite Hull File

The following procedure is for creating a new hull form composite surface macro in a hull form composite surface file. It assumes that a hull form composite seed file is being used.

1. Ensure that the normal of each surface in the actual hull form surface file are pointing in the direction of the "plate", i.e. the side of the surface on which the thickness of the steel plate will lie. (On steel surface ships, this is outward from the hull, on submarines it is inward.) This is mandatory for the first surface to be entered into the composite macro and recommended for all other surfaces for consistency.
2. Create a new PDM part for the hull composite macro using the hull form composite seedfile.
3. Set the active path to one of the "hull*" paths.
4. Attach the hull surface file. Ensure that the "Include in Structure" toggle is OFF.
5. Set the active path to the "hull" path.
6. Using the Associative Create Composite Surface command, identify the individual hull surfaces. The recommended order is the port hull surface, the starboard hull surface, and then the transom if applicable. This order is not mandatory; however, whatever order is used must be retained throughout the life of the macro. The normal of the resulting composite surface will point in the same direction as that of the first surface chosen.
7. Save and exit the hull composite file. Check the file into PDM.

4.2 Updating Hull Composite File

The following procedure is used to update an existing hull composite file. Ensure that the normal of each surface in the actual hull surface file are pointing in the direction of the "plate", i.e. the side of the surface on which the thickness of the steel plate will lie. (On steel surface ships, this is outward from the hull, on submarines it is inward.)

1. Retrieve the hull composite PDM file.
2. Set the active path to a "hull*" path that is empty.
3. Reference the new hull file.
4. Set the active layer to one that is empty and turn off all layers.
5. In the upper left isometric window, turn on the layer containing the hull form surface reference file that is to be replaced.
6. In the lower left-hand isometric window, turn on the layer containing the new hull form surface reference file.
7. In the upper right hand isometric window, turn on the layer containing the composite surface macro.
8. Start the Modify Macro command and identify/accept the composite surface macro. A form listing the constituent surfaces will display and the first constituent will be highlighted. Identify/accept the corresponding surface in the new hull form reference file. Continue identifying the new hull surfaces in the order promoted and execute the form when finished.
9. Detach the old hull form surface reference file.
10. Save and exit the file and check it back into PDM.

The order of the surfaces and the direction of their normal must be maintained in the macro, or associative macros referencing the composite may return unpredictable results (i.e. the subdivision file could turn "inside out" if a normal switches direction.) Additional surfaces may be added to the end of the macro, but the order in which they are added must be maintained throughout further macro updates. Deletion of surfaces from the macro may invalidate dependent elements in other files.

5.0 Translation from FastShip to VDS

Translating a hull form from FastShip to I/VDS utilizes the commercially available IGES translators for both products.

5.1 Export FastShip

From within FastShip, select the export surfaces IGES from the file menu bar. The user is prompted to select the part(s) to be exported, enter "/top..." and press return. FastShip will then prompt for the name of the IGES file to be output.

5.2 Import into VDS

The VDS IGES translator is a separate program that is executed from the UNIX prompt as 'ciges'. The user will be presented with a form that contains several keyin fields and push buttons. Enter the appropriate data into the Directory, IGES File, EMS File, and Log File keyin fields. Click on the Options button and a new form will open. Enter the name of the hull seedfile in the seedfile keyin field. Click on the Accept button on the options form. Then, click on the Add to Queue button to accept the keyin values. Next, click on the Accept button on the main form. The form will disappear and the IGES translator will process the data file. After the program finishes, review the log file to see if any 128 entities encountered a problem during the translation process (ignore errors and warnings pertaining to entity 406 form 7 in the log file).

NOTE:

All hull form models must use the hull form seed file. The seed file must contain at a minimum a PDM origin and correct values for basetol, arctol, offset, and chord height. See Table 1 for the current values in use.

Tolerance	**VDS Seedfile Value**	**FastShip VALUES**
Basis (bastol)	.0001 ft	10^{-6} meters
Arc Length (arctol)	.05 ft	N/A
Offset (offtol)	.05 ft	.0005 meters
Chord Height	.01 ft	user defined (mesh div or refine level)

5.3 Clean up in VDS

After the translation process is complete, the I/VDS file will need to be cleaned up and organized for use. The process involved is listed below:

· Fit all views.
· Change element weight.
· Change color of hull and appendages.
· Rename surfaces into directory structure.
· Extract and name curves.
· Check part into PDM.

5.4 Symbology

By default, the I/VDS windows will show only a small portion of the hull form. Fit the windows to view all of the geometry, utilizing the fit button on the menu bar. With all of the geometry displayed in the I/VDS windows, change the line weight of all elements to a weight of 0, with the command "change element weight" using the pocket menu to select all elements in a view.

At this point, mirror all of the surfaces that are symmetric about the ship's centerline. Use the "copy and mirror about plane" command found under the Copy menu bar pull down. Use the base coordinate system as the plane for the mirror image, otherwise there will be a gap in between the hull port and starboard surfaces.

5.4.1 Layer Convention

The hull surface file does not have a rigid layer convention since most software processing the hull surfaces rely on the part naming and directory structure. However the hull composite file require that the hull be placed on layer 30 and appendages be placed on layer 40.

The hull and appendage geometry should be on layer 30 by default. If any of the geometry is not on layer 30, use the "change element layer" command to move the geometry to layer 30. ***Warning*** - Do not leave any geometry on layer 1023, this layer is reserved by PDM.

5.4.2 Rule Line Displays

In general set the rule line display for all surfaces in the u and v directions to 0. This will help by speeding up the graphics display on redraws.