Extraction of Ship Product Design Data

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Abstract

Tribon is widely used by ship designers to facilitate product modelling. However, workshop production and on-site construction process could benefit from integrating the use of Tribon design data to achieve effective process planning and production management. Tribon, while providing its own scripting language for data extraction, is not suitable for rapid extraction of data because of its complex internal database structure and of course, it requires licensed access to the Tribon software and hence, its internal database. This paper presents an extraction method to build a relational database of a block's parts and thus enable rapid access to topological data that does not require a Tribon license. Easy and rapid access to a block's topological data, augmented with production data, provides a sound foundation for improvements in productivity and production in a number of areas. Some examples of creating 3D views based on the extracted data are given for illustrative purpose.

Introduction

Tribon is not a single program, but suite of programs that access a common set of databases that contain the design details of ships or semi-submersibles. The databases contain design details, from structural elements to pipe segments to equipment. Tribon is used in 85% of the world's top 20 shipbuilders (AVEVA, 2005b) and clearly plays a significant part in the design and production process or the marine and off-shore industry.

Literature review has revealed very little work on the use of Tribon data outside a Tribon environment. Published work has focused on the weaknesses of Tribon as a CAD system in the design stage (Roh & Lee, 2007), the extraction of equipment model digital data from Tribon (Hwang et al., 2004) and the exporting of Tribon model data in Autodesk's DXF format which is then imported to 3DS Max, a commercial software (Li, 2003). Besides, Kim et al. (2005) introduce a PC-based off-line programming method based Tribon interface. Zhang et al. (2009) also extract the hull structure information from Tribon for the further operational use. Li (2010) develops an open framework to integrate Trion and Spar. The use of commercial software to view a 3D model has its limitation because it is just a viewer/updater and does not provide any reasoning capabilities. Further, DXF does not hold useful engineering information such as the weight of the constituent parts or their centre of gravity.

There seems to be very few commercial applications extracting data from Tribon; one should be noted, namely, Deltatools (Delta, 2010), which extracts Tribon nesting data for cutting.

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The purpose of this work is to design a database, which incorporates Tribon's topological data, to support various enhanced engineering functions in the production of blocks for off-shore rigs. The database design will also incorporate production data. The production data, which is clerical in input, is not held in Tribon.

Specially written software is used to visualize a block's topology, using HOOPS, as its rendering engine. The visualization of a block in 3D helps the engineer to clearly identify the various block components. The specially written software is able to identify different block parts, even though they are classified as a single type in Tribon. Tribon has an object called '*Panel*'; these naturally come in different sizes and, when used in a block construction, different orientations. Generally, panels, and here we are referring to blocks for offshore rigs used in a horizontal plane, are referred to as *panels*, by the engineers, but panels which transverse the block are referred to as *bulkhead.* (Definitions, 2010). Some make a further distinction of panels with flanges along one edge as *T-girders.* To Tribon, these are all 'panels'. Figure 1, illustrates these differences. To any commercial software that reads DXF files, they are just drawn parts. The specially written software is able to determine the difference and show the difference in a 3D view. The engineer benefits from this distinction by being able to identify the different block parts and to make decisions on the construction sequence of the block.

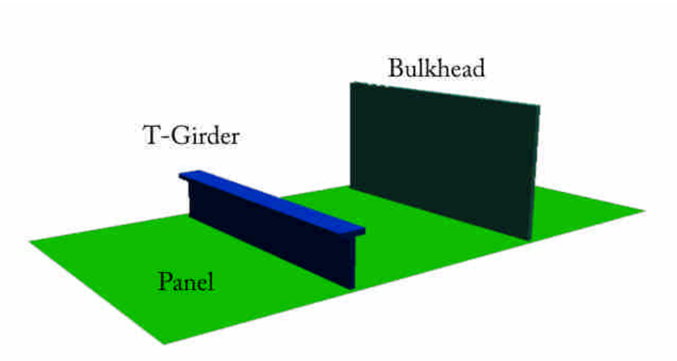

Figure 1. Panel, Bulkhead and T-Girder

This paper describes the extent of the use of Tribon software, the object relationship Tribon exposes for data extraction, how data may be extracted from Tribon and it describes the curved panel used in Tribon. A comparison is made between the number of disk accesses required by Tribon to retrieve data and that required be a relational database to retrieve the same data. The schematic process for extracting Tribon data and creating a relational database together with the database structure is given. Finally, a simple example of the use of the created database is given.

Tribon Software

Tribon M3 software is widely used (AVEVA, 2005a) in the shipbuilding and the offshore industry for the complete process of design and construction of ships and semi-submersibles. It is the de facto standard for construction in the offshore industry.

Tribon M3 in the last Tribon version. Tribon M3 is not a single program but a suite of programs that reference a common set of databases that hold the design details of the ship, or semi-submersible. This does not only include the initial design modules, but also outfitting modelling, assembly planning, piping and equipment.

User access to Tribon databases and functionality is via its own scripting language, Tribon Vitesse, which is really the platform independent Python language with some additional features. Python libraries may be used along with Tribon Vitesse.

Tribon Object Relationship

Tribon major identification of work is by project; within a project, there will be blocks. A block is composed of panels. All construction parts are linked to a panel, or curved panel. Objects that are associated with a panel are brackets, flanges, pillars and stiffeners. Objects that are associated with curved panels are curved stiffeners. Because of the size of the panels, they are sub-divided into plates. Figure 2, illustrates the object relationship between these parts.

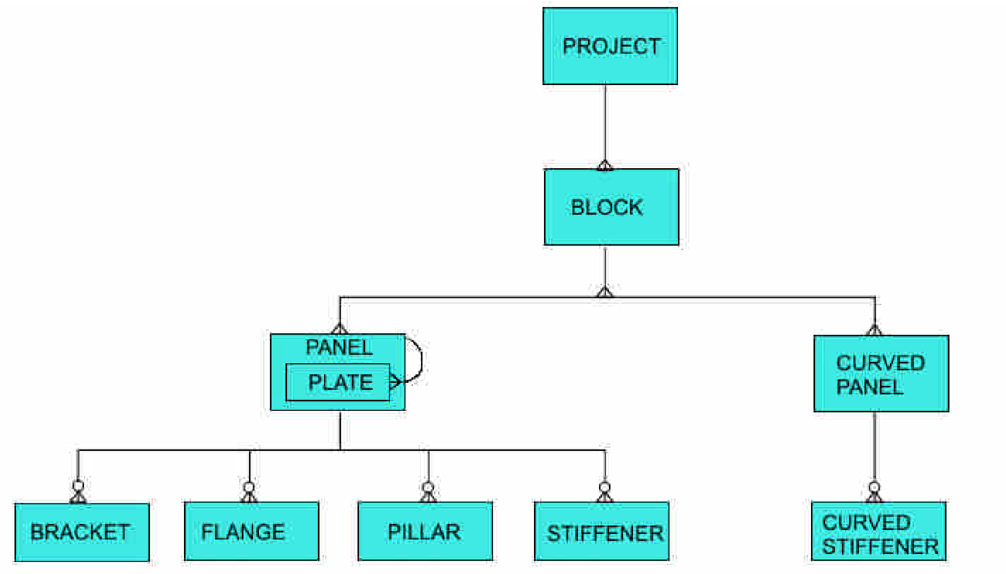

Figure 2. Tribon Object Relationship

Extracting Tribon Modeling Data

Using Tribon Vitesse, modelling data may be extracted from Tribon's databases. The access methodology is basic, and unlike Structured Query Language (SQL), Conference on Data System Languages (CODASYL), compliant databases, or even Object Oriented Database Management System (OODBMS). It would probably be fair to say that Tribon database access is at entity level only. Tribon database access does not support CODASYL's currency, or any SQL functionality. It is unable to access more than one entity at a time. For example, to extract the panel weight for a specific block, one Vitesse statement specifying the specific block and panel, together with the entity 'weight', would be required. For every panel, whose weight property is required, such a statement is required. For every entity of the object Panel, such as dimensions, centre of gravity and thickness, similar statements are needed. Clearly, to be efficient in extracting data, focus needs to be on the same Block/Panel's entities, rather than attempt to extract data from different Block/Panels.

Tribon does provide access to its database via a COM object and supports C#,VB.Net, VBA, C++, using the Vitesse type commands; however, tests proved that such accessing of the Tribon databases was slow when compared with using Vitesse direct. This is because every access of the Tribon database has to go via the COM object before it goes to the Vitesse process.

Topological data is required for each of the objects shown in figure 2. The data consists, inter alia, of the boundary values of the object, which are the high and low values of the x, y, z coordinates of the object, the centre of gravity of the object and the thickness of the steel plate. Pillars and brackets are special cases and are defined by predefined profiles whose parameters, or profile name in the case of brackets are also extracted.

Tribon's panel boundary data is insufficient to enable the drawing of panels. The boundary values retrieved are simply the boundary box of the panel. The panel boundary returned by Tribon includes all objects that are associated with the panel. To draw panels correctly as panels, plate boundary data is required. There will be one set of coordinates for each point on the plate boundary; a triangular plate has 3 points, a rectangular plate has 4 points etc. Plates with curve profiles have tens of points.

The extracted Tribon data is written to comma separated files for later processing.

Curved Panels

Tribon defines two kinds of panels: planar, which have been discussed, and curved panels. Curved panels are an object in their own right. Curved panels are panels that have curves in 3D space. These curves may be simple, following a simple curved profile as in figure 3, left panel, or they can be complex curving in more than one plane at a given point, as in figure 3, right panel. Tribon Vitesse allows the extraction of the curved boundary profile of the panel.

Tribon identifies curve paths by name. Tribon Vitesse exposes the names, the paths (a series of coordinates) and the intersection points of the paths. This is sufficient for panels that curve in two planes, but not sufficient for panels that curve in 3 planes. Tribon holds curve data, in ACIS format, in files that are external to the Tribon database. The data in these files are not accessible via Tribon Vitesse. The details of the extraction of this data and integrating it with other Tribon Vitesse extracted data is the subject of current research. The data that Tribon Vitesse exposes allows only the profile of the panel to be drawn but not the curved surfaces.

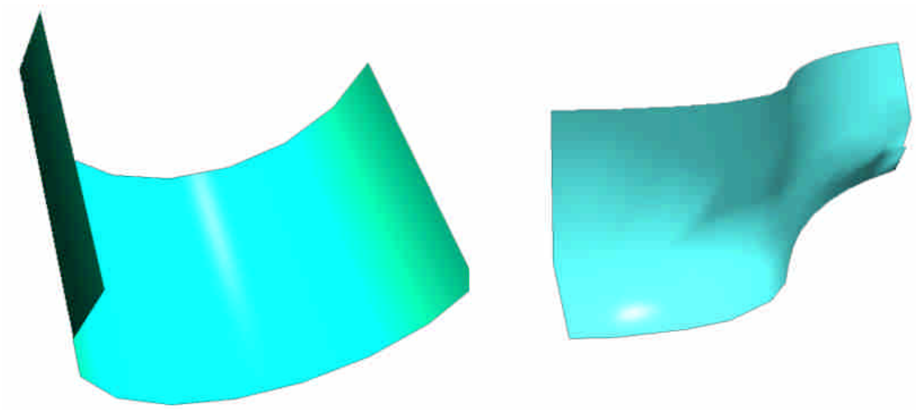

Figure 3. Curve Panel in 2 Planes and 3 Planes

Comparison of Tribon Database Extracts and Relational Database Extract

It was mentioned earlier that Tribon extracts by entity. This clearly is a slow process. To demonstrate the superiority of using a relational database approach, a comparison of database retrievals (accesses) is shown in the following tables. Each object is shown with the number of entities extracted for this research. Following this, 4 projects were chosen for their mixed nature and the number of Tribon database extracts used to retrieve the data is shown.

Table 1. Number of Extracted Entities For Each Object Type

Block	Panel	Plate	Plate Boundar y	Stiffener	Flange	Pillar	Plate Name	Curve Panel	Curve Panel Limits	Curve Stiffener
1	12	9	1	14	15	11	1	7	3	14

Table 2. Sample Database Retrievals

	Block	Panel	Plate	Plate Boundary	Stiffener	Flange	Pillar	Plate Name	Curve Panel	Curve Panel Limits	Curve Stiffener	Total Accesses
Project A												
Entities	1	12	9	1	14	15	11	1	7	3	14	
Objects	74	4137	5783	97234	8608	1830	294	5783	0	0	0	
Tribon Accesses	74	49644	42047	97234	120512	27450	3234	5783	0	0	0	355978
Relational Accesses	74	4137	5783	5738	8608	1830	294	0	0	0	0	26417
Project B												
Entities	1	12	9	1	14	15	11	1	7	3	14	
Objects	101	5759	8188	113819	13757	3132	119	8188	1928	3465	1095	
Tribon Accesses	101	69108	73692	113189	192598	46980	1309	8188	13496	10935	15330	545556
Relational Accesses	101	5759	8188	8188	13757	3132	119	0	1928	3645	1095	45812
Project C												
Entities	1	12	9	1	14	15	11	1	7	3	14	
Objects	64	2236	3033	75193	8543	1964	23	3033	5707	7578	15053	
Tribon Accesses	64	26832	27297	75193	119602	29460	253	3033	39949	22734	210742	555159
Relational Accesses	64	2236	3033	3033	8543	1964	23	0	5707	7578	15053	47234
Project D												
Entities	1	12	9	1	14	15	11	1	7	3	14	
Objects	32	1316	1637	33546	4229	980	4	1637	1227	2058	3445	
Tribon Accesses	32	15792	14733	33546	59206	14700	44	1637	8589	6174	48230	202683
Relational Accesses	32	1316	1637	1637	4229	980	4	0	1227	2058	3445	16565

Table 3. Summary of Database Accesses

Project→	Sample A	Sample B	Sample C	Sample D
Tribon Accesses/Block	4810.5	5401.5	8674.3	6333.8
Relational Accesses/Block	357.6	454.6	738.0	517.7
% Reduction in Accesses	92.6%	91.6%	91.5%	91.8%

Clearly, using a tailor-made relational database reduces the number of database accesses between 91.5% and 92.6%. This is important for the engineer to have a rapid response to his enquiry experience. Tests showed that retrieving block information using Tribon and writing the data to a comma separated file, averaged 1 minute a block. Times varied depending on the network load and the speed of the CPU being used.

Creating an External Database

Once data has been extracted from Tribon, it is loaded into a Microsoft Access Database, which is a relational database, see figure 4 for schematic. MS Access has been used for this research, but the system will work on any SQL compliant database.

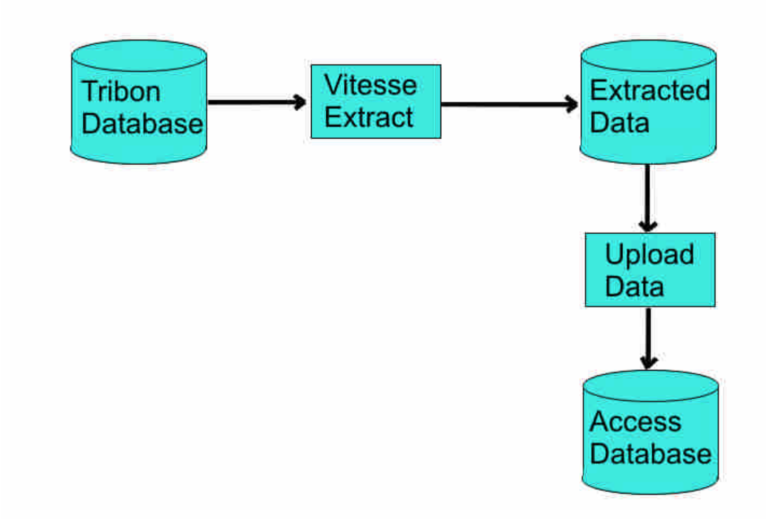

Figure 4. Tribon Data Extraction and External Database Creation

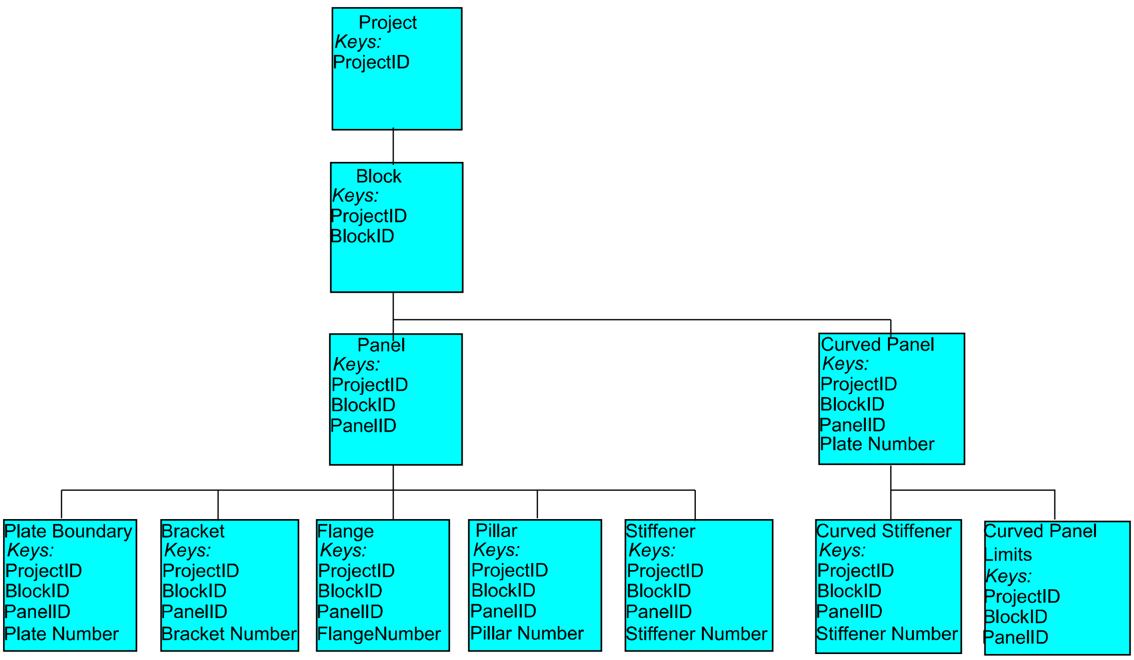

Figure 5. Key Structure of External Database

Figure 5 gives the relational database structure with the keys. The relationship is very similar to Tribon's object relationship, but it differs in that the data is organized in tables and retrieved by rows. This is the reason why a relational database significantly reduces the number of disk accesses when compared with Tribon to retrieve the same data. Unlike Tribon, different tables may be accessed simultaneously without loss of the position in a table. For example, reading the Bracket table is independent of reading the Pillar table. In Tribon, there is only one read mechanism through which all data reading is carried out. This clearly makes the relational database more flexible and easier and provides a firmer foundation for building other requirements.

A few examples of research, whose details are beyond the scope of this paper, will demonstrate the usefulness of an external relational database. First, relationships between various components, such as T-girders, bulkheads, panels and stiffeners can be inferred quickly. This is useful when locating crossover points of some parts, which is required for the sighting of lifting lugs. Second, the data can be used to produce 3D views of ship's blocks, which, in itself, can has been used to show what parts are used in a block's construction in a workshop. Using the relational database gives a quick response to an engineer's enquiry. Third, it is possible to see the effects of removing sections from a construction on the block's weight and centre of gravity. Fourth, it would be possible with the addition of production data to view the status of a block construction progress.

Having a relational database which is external to Tribon frees the engineer from needing a Tribon license to view block information. If, the viewing of block data was by directly using Tribon data via its COM object, that would require a license and would further put an unnecessary loading on the Tribon database. Having the external database allows unlimited access to the Tribon extracted data without any impact on Tribon's performance.

An Example of Creating and Using 3D Drawings

By way of example, figure 6 shows a block with all parts being displayed while figure 7 shows the same block without the pillars being displayed. These 3D images were produced after reading the data from the external database, intelligently identifying the various types of parts and using the HOOPS (Techsoft, 2010) rendering package, to render the result.

Sometimes, for operational reasons, some parts, as in case of this example, pillars, will not be constructed with the block in the workshop. In such cases, the non-construction of some parts will have an effect on the centre of gravity and weight; it will no longer be the same as the full block. Engineers will need to calculate the new weight and centre of gravity. This may prove cumbersome as they may not always have to hand the required details, which are held in the Tribon databases.

In figure 5, the centre of gravity is shown as X=1543mm, Y=1705mm, Z=1702mm; this is relative to the origin of the block. The block's local origin is determined by the lowest corner coordinates of the block. The weight of the block is shown to be 5.76 tonnes. Figure 6 shows the same block with the 2 pillars removed. As the details of weight and centre of gravity of all parts are known, a new centre of gravity and weight can be calculated. The updated centre of gravity is X=1301mm, Y=1705mm, Z=1634mm and the weight is 4.74 tonnes.

The calculation of the updated centre gravity is calculated from all the shown component parts and their respective weight. $R = \frac{\sum m_i r_i}{\sum m_i}$, where R is the centre of gravity, m_i is mass of a component part and r_i is its position

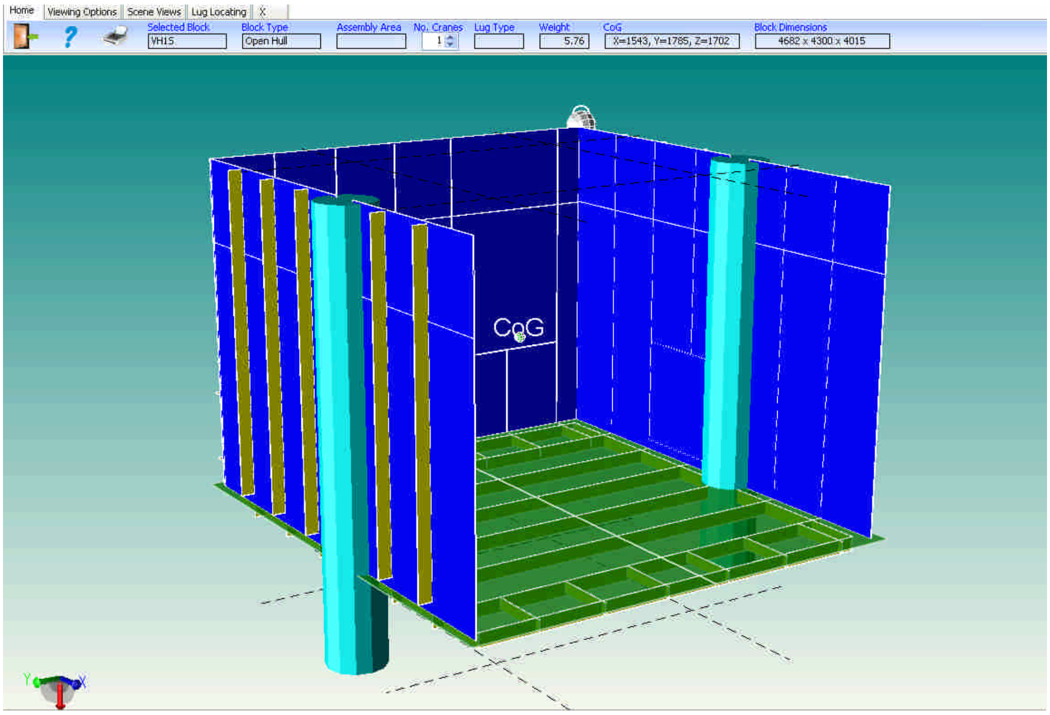

Figure 6. Block Showing All Objects

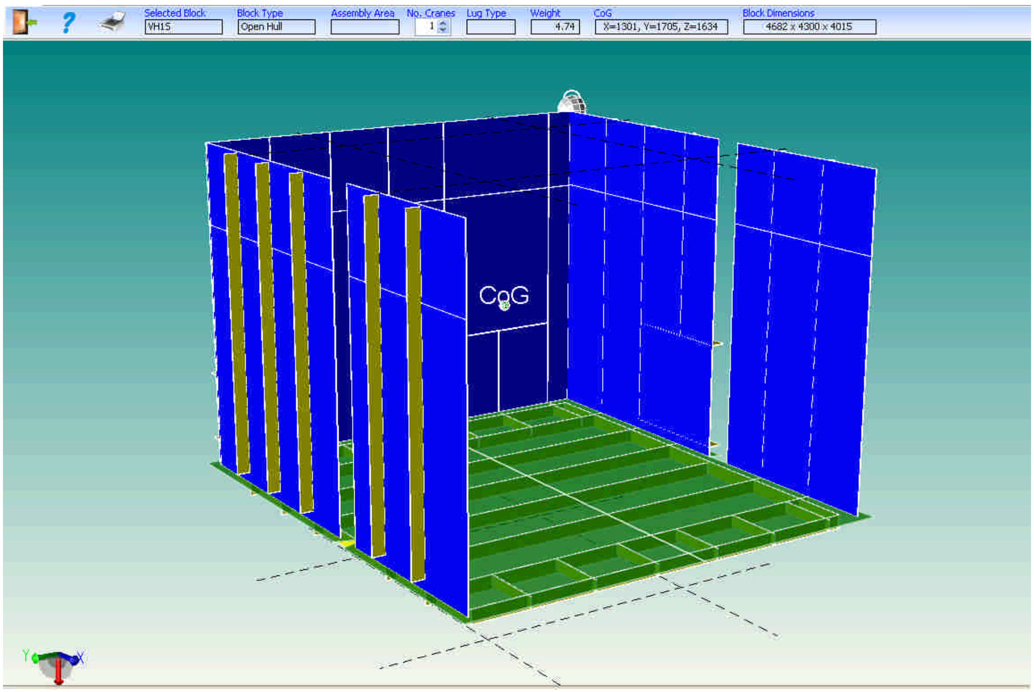

Figure 7. Block Showing Pillars Removed

Conclusion

Tribon for all its wide use as a design package for the shipping and off-shore industry does not provide reasoning capabilities per se. In order to extend the capabilities of Tribon, it is necessary to either interface with Tribon directly, but this proves to be cumbersome, too slow in terms of response time, uses additional Tribon database resources and requires a license. Two options remain, either to export data directly from Tribon in a format that is usable by other packages, e.g. export in a DXF format for use in commercial software that supports reading of files in DXF format, or to extract data and create an external database for use on tailor-made software. The option chosen here, as it supports the production of blocks and enhances the engineer's productivity, is to extract the data by directly interacting with Tribon using Vitesse and finally creating a relational database. The database becomes the foundation for intelligent use of the topological data and thus, enables suitable software support to be created that supports the engineer in his decision making.

References

AVEVA, 2005(a), http://www.aveva.com/news_content.php?_id=55 [Accessed 3 June 2010]

AVEVA, 2005(b), http://www.aveva.com/news_content.php?_id=80 [Accessed 3 June 2010]

Definitions. http://www.marineterms.com/cgi-bin/insearchdictionary.pl [Accessed 3 June 2010]

Delta. http://www.kolumbus.fi/granbrott/luukku/index.html. [Accessed 3 June 2010]

Hwang, H.J., and Lee, H.M., 2004. Digital exchange of design models between marine equipment libraries using hybrid neutral formats. *Journal of Marine Science Technology* 9, 182–189.

Kim, C., Hong, K and Han, Y., 2005. PC-based off-line programming in the shipbuilding industry: open architecture. *Advanced Robotics*, 19(4), 435-458.

Li, J., 2010. Framework and realization of ship product data exchange. *Proceedings of the 2010 IEEE International Conference on information and Automation*, Harbin, China.

Li, Q., 2003. Transferring the Hull Model between TRIBON and 3DS MAX. *Journal of East China Shipbuilding Institute(Natural Science Edition)* 1(17), 1-4.

Roh, M.I., and Lee, K.Y,, 2007. Generation of production material information for building block and simulation of block erection for process planning and scheduling in shipbuilding. *International Journal of Production Research*, 45(20), 4653–4683

TechSoft. 2010 http://www.techsoft3d.com/ [Accessed 3 June 2010].

Zhang, H.Q., Yang, S.L., An, Y.C., Zhao, J.J. and He, W.X., 2009. Information processing of the hull structure oriented to ship structure knowledge-type military specification. *The 2nd International Conference on Interaction Sciences: Information Technology, Culture and Human*, Korean.