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VIRTUAL LABORATORY FOR MARINE STRUCTURES

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ABSTRACT

This paper presents the advantages of using a new tool in the development of integrated marine design CAD-CAM in parallel with realistic 3D visualization in virtual systems. The software programs used are Aveva Marine for Ship Structures 3D designs and Navisworks for their visualization.

Keywords: virtual laboratory, marine structures, Aveva Marine, Navisworks, statistical analysis.

1. INTRODUCTION

The curriculum associated to the naval architecture specialization contains some important disciplines during which students become familiar with the various types of marine structures, such as types of stiffeners and assembly technologies for sections and block sections. Just like students at the Faculty of Medicine study the skeletal system, in the same way, the students from the Faculty of Naval Architecture study the “skeletal system” of ships.

2. PROBLEM DESCRIPTION

Due to the large size of ship structures, specialized laboratories are equipped with drawings, models and 3D CAD models. Some laboratory activities are performed by students in shipyards, especially Damen Shipyards Galati.

Since it takes a few years to build a ship, the possibilities for a direct presentation of the types of structures and assembly technologies in shipyard for different types of ships are extremely limited during the four-year undergraduate program.

Because it is very important for students to know and operate with a larger variety of marine structures, setting up a virtual laboratory is associated to this purpose.

3. METHODS USED

The learning resources used before the creation of the virtual laboratory were: classic drawings (see fig. 1), plans, 3D models (Fig. 2) and photography (Fig. 3).

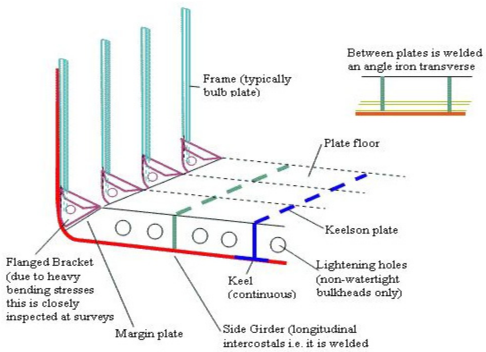

Fig. 2 Hull structure elements
(Classic drawing)

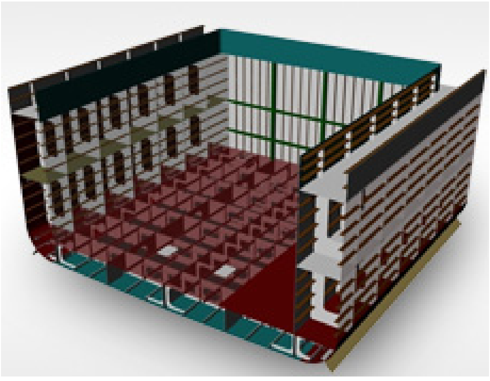

Fig. 2 Hull structure model

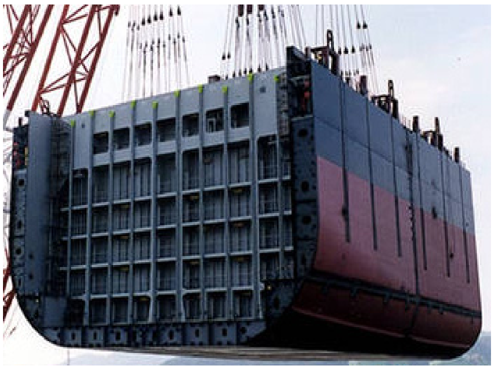

Fig. 3 Hull structure photo

4. IT SOLUTION IN VIRTUAL LAB

The creation of a virtual laboratory is based on a virtual reality software program.

Because naval structures are very complex, the virtual reality software has been combined with an integrated professional CAD – CAM system.

One of the most powerful naval design systems is Aveva Marine. This system has specialized modules for hull design, outfitting and electrical design.

Aveva marine is widely used by naval design companies in the country and in the world. This reality has led to the acquisition of this CAD-CAM system by the Faculty of Naval Architecture of "Dunarea de Jos" University of Galati. The 10-year existence of Aveva Marine system in the faculty has enabled typical projects for different types of ships and various construction systems.

Aveva Marine modules are designed so that each element designed (body structure, Fig. 4 or pipe, Fig. 5) is viewed 3D on its location and in the context of the entire ship. This design system is very useful to designers because they can check possible incidents or intersections of elements.

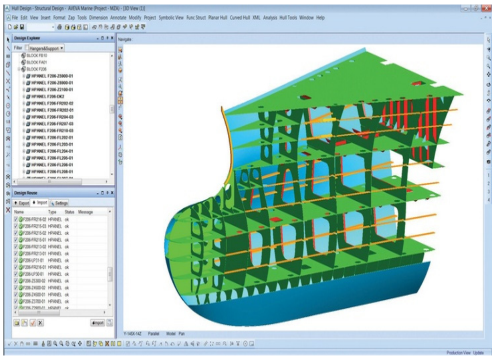

Fig. 4 Hull structure block

When defining each element of the marine structure, a name is associated to it as well as its specific characteristics. Each element is associated with a block section, so that graphic information is managed by the same database unit divided into blocks.

Through a simple selection of an item, these characteristics are displayed and the position of the element is also marked in the tree, on the left of the display area.

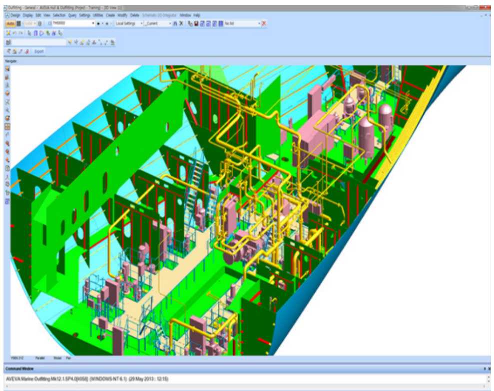

Fig. 5 Hull structure & outfitting

The study of Aveva Marine system is included in the curriculum of the third and fourth years of the undergraduate program.

Students begin the first laboratory activities in marine structures types in the second year of study and it was therefore necessary to combine models created in a professional CAD-CAM system with an easy virtual reality application that does not require skills to work with an integrated design.

Autodesk has created a software application that takes as input a complex 3D model and allows access inside it offering all the facilities of a virtual reality.

Navisworks combines data from different 3D CAD systems and allows the integration into a single digital model of information on the design, process, factory and suppliers. This allows stakeholders to use the 3D model to validate the design, eliminating the need to own or access multiple CAD systems. Navisworks is compatible with all major formats of CAD and laser scan files, so data from multiple sources can be combined to create a digital model for analysis, regardless of the size and complexity of the project.

Navisworks offers a complete set of 3D digital analysis functions that allow:

- detailed analysis functions in different section planes;
- measuring distances, surfaces and angles in detail;
- simulating the movement of materials and equipment;
- running 4D simulation while studying animation project and any phase.

The most compelling 3D visualization project is offered by Autodesk Navisworks.

The images obtained are customized by materials, lights, backgrounds and rendering. This system offers a choice of database of over 1,000 variant materials to generate a realistic aspect of the model. [2]

This software replaces with great success the visualization of real structures in shipyards.

The importance of using Autodesk Navisworks in accomplishing a virtual laboratory facility is based on the creation of animations and analysis interfaces. You can create scripts linking animations to specific events and key reviews. All this gives teachers the opportunity to make descriptions of structural elements in teaching. [2]

Exploring an integrated project model using advanced navigation tools in Navisworks produces a realistic, real-time experience. Real-time navigation capabilities are included in all Autodesk Navisworks products.

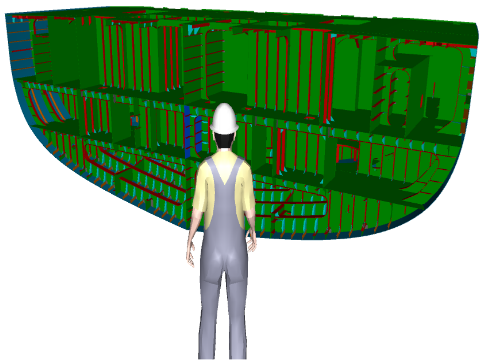

Fig. 6 Hull structure visualization

By using specific Navisworks functions, students visualize the entire block section (see Fig. 6) from outside.

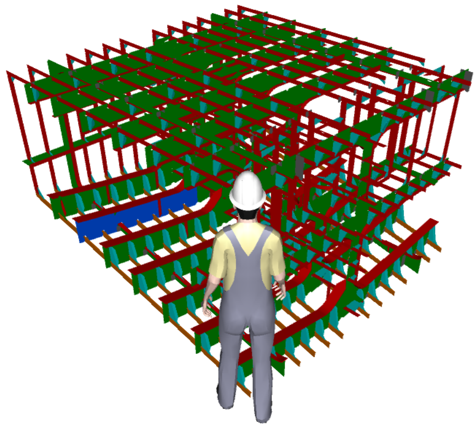

Fig. 7 Hull structures stiffeners

Guided or independently, students can view network stiffeners (Fig. 7). The name and positions of the stiffeners are very easy to set for the students.

This virtual instrument is used both for teaching and also in steps for fixing and knowledge evaluation.

In the evaluation phase of the knowledge, the students are "inside" a structure and they must correctly describe all its stiffeners (Fig. 8).

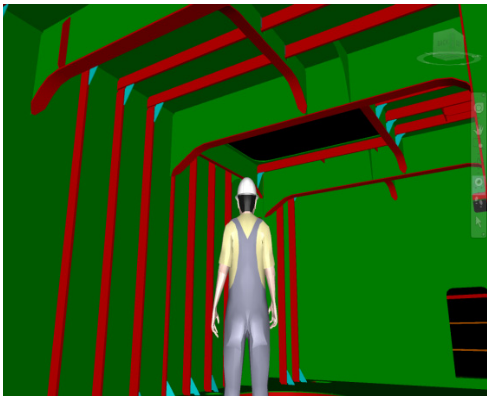

Fig. 8 Inner compartment analysis

For a summative evaluation of the skills acquired by students they must analyze a complex type of naval structure (Fig. 9).

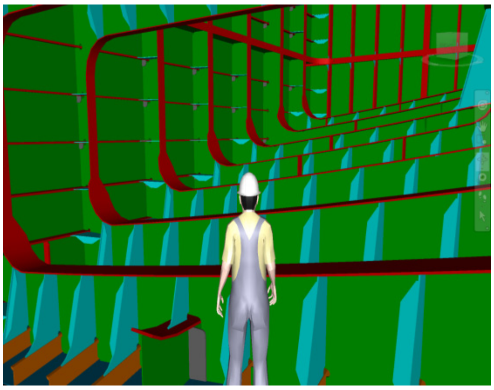

Fig. 9 Aft bottom structure analysis

Besides software applications, the development of a virtual laboratory and of the hardware is needed so that every student can operate, manoeuvre and benefit from his/her own virtual reality.

The existence of a panoramic projection of the naval structure is also useful in the teaching process. This is possible with two or more synchronized video projectors.

5. STATISTICAL ANALISYS OF THE IMPACT OF USING A VIRTUAL LAB BY STUDENTS

During shipbuilding, partial evaluation results of students in the second year were analyzed comparatively, considering that two laboratory activities were performed with classical teaching materials and in two other laboratory activities the virtual reality system was used [3]. The study sample included twenty-five students.

The four topics of the laboratory activities had the same complexity, with a nearly identical number of stiffeners.

The partial evaluation consisted of grading students' responses to a test grid with twenty items at the end of each laboratory activity.

The conventional laboratories are:

- Conventional laboratory 1- CL1
- Conventional laboratory 2- CL2
- Virtual laboratory -VL1
- Virtual laboratory – VL2

The scoring of the tests was with grades from 2 to 10.

Table 1. Mean & Standard Deviation

		Mean	N	Std. Deviatio n
Pair 1	Conv. LAB 1	6.04	25	1.541
	Conv. LAB 2	6.20	25	1.472
Pair 2	Virtual LAB 1	7.12	25	1.364
	Virtual LAB 2	7.96	25	1.207
Pair 3	Conv. LAB 1	6.04	25	1.541
	Virtual LAB 1	7.12	25	1.364
Pair 4	Conv. LAB 2	6.20	25	1.472
	Virtual LAB 2	7.96	25	1.207
Pair 5	Conv. LAB 1	6.04	25	1.541
	Virtual LAB 2	7.96	25	1.207

In the statistical analysis, results were compared by one CL1-CL2, VL1-VL2, CL1-VL1, CL2-VL2 and CL1-VL2

In Table 1 we observe an increasing sample average for all pairs of cases analyzed.

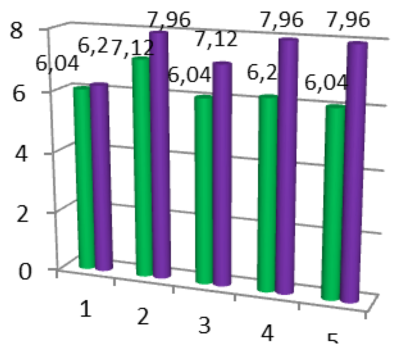

Fig. 10 Mean evolution of analyzed pairs

Table 2. Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	Conv. LAB 1 - Conv. LAB 2	-.350	24	.729
Pair 2	Virtual LAB 1 - Virtual LAB 2	-2.871	24	.008
Pair 3	Conv. LAB 1 - Virtual LAB 1	-2.855	24	.009
Pair 4	Conv. LAB 2 - Virtual LAB 2	-5.284	24	.000
Pair 5	Conv. LAB 1 - Virtual LAB 2	-4.908	24	.000

In Table 2 are analyzed the parameter values Sig. 2, for a 95% confidence interval of the difference for paired samples test [4].

We find that between:

- Conv. LAB 1 & Conv. LAB 2 - there are no significant differences in scores (0.729> 0.05);
- Virtual LAB 1 & Virtual LAB 2 - there are significant differences in scores (0.008< 0.05);
- Conv. LAB 1 & Virtual LAB 1 - there are significant differences in scores (0.009< 0.05);
- Conv. LAB 2 & Virtual LAB 2 - there are significant differences in scores (0.000< 0.05);
- Conv. LAB 1 & Virtual LAB 2 - there are significant differences in scores (0.000< 0.05).

6. CONCLUSION

It is found that the average increase in partial evaluations of students is not significant when using conventional teaching materials. If students benefit from virtual lab, their grades evolution is significant.

These results were predictable due to the facilities offered by the virtual laboratory and due to the interest young students have in the use of software applications (Fig. 11).

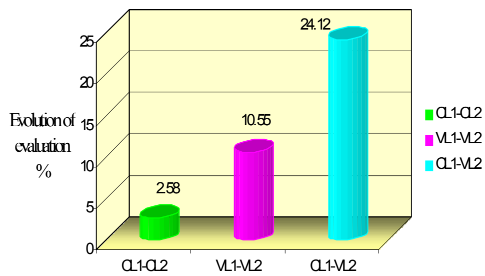

Fig. 11 Percentage evolution of means

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