PARAMETRIC DESIGN OF SHIP HULL USING NURBS IN CATIA ENVIRONMENT

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Abstract

The design of the hull, which is the main part and structural unit of the ship system, is a research and development project of shipbuilding science. With the advancement of computers, its design process has been more efficient and reliable. The discovery of Bezier parametric curves, B-Splines and NURBS curves gave even greater flexibility to designers to formulate their designs and to be able to give the desired shape to hull points with complex geometries and topologies. Using empirical tables, analytical expressions and shape factors as well as making verified assumptions about specific sizes we were able to create a mathematical framework that describes the geometry of the hull. The design was done in the design program Catiav5R20. This program uses the above parametric curves and surfaces enabling us to create complex and demanding surfaces such as that of a ship's hull. We placed the geometric sizes in the software spreadsheet and attached them to their corresponding variables in the design program. This action gave us full control over the design as by simply changing a value in the spreadsheet we have the ability to modify our 3D model. The result of the process is a fully configurable and modifiable model which is a template for the creation of other types of ships.

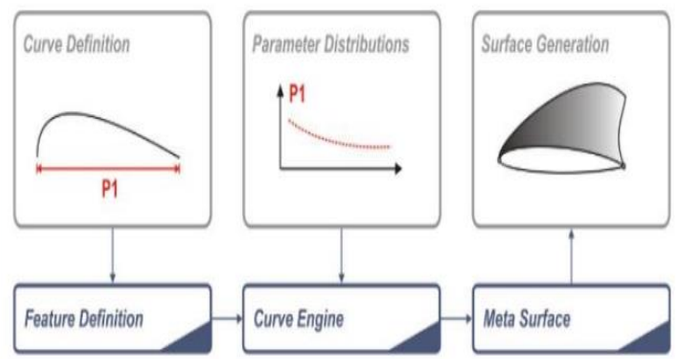

Figure 1. Process of Generating Parametric Surfaces

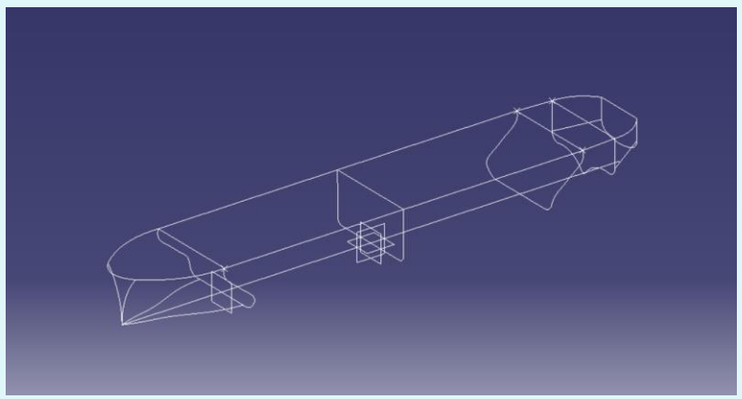

Figure 2. Ship Sketch Using Parametric Curves

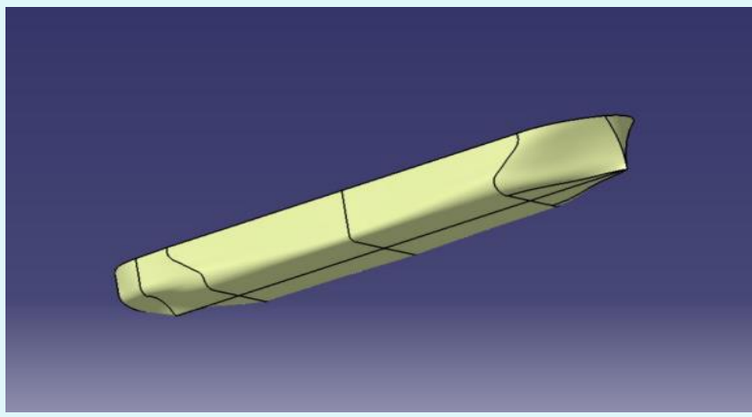

Figure 3. Isometric Depiction of Ship Hull

Conclusions

The use of CAD software played a key role in the design of the hull of the ship, with the result that the design process is more efficient. By the end of this project, a step-by-step design was developed for the hull of an Aframax tanker, using parametric curves and surfaces. The steps followed are interconnected and it is worth mentioning that a parametric model of the ship was created which has the potential to be modified to any type of ship by altering only the dimensions and the basic shape coefficients.

Equations of Surfaces

Bézier : $P(u,v)=\sum_{i=0}^{n}\sum_{j=0}^{m} P_{ij}\, B_{i,n}(u)B_{j,m}(v)$

B-Splines : $P(u,v)=\sum_{i=0}^{n}\sum_{j=0}^{m} P_{ij}\, N_{i,k}(u)N_{j,l}(v)$

NURBS : $P(u,v)=\sum_{i=0}^{n}\sum_{j=0}^{m} R_{i,j}(u,v)\, P_{ij}$