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DESIGN AND ANALYSIS OF AIRCRAFT WING

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Abstract **This work presents the development of a parameterized automated generic model for the structural design of an aircraft wing. Furthermore, in order to perform finite element analysis on the aircraft wing geometry, the process of finite element mesh generation is automated. The generic model that is developed in this regard is able to automate the process of creation and modification of the aircraft wing geometry based on a series of parameters which define the geometrical characteristics of wing panels, wing spars and wing ribs. Two different approaches are used for the creation of the generic model of an aircraft wing which are "Knowledge Pattern" and "Power Copy with Visual Basic Scripting" using the CATIA V5 Software. A performance comparison of the generic wing model based on these two approaches is also performed.**

I.INTRODUCTION

Aggressive weight targets and shortened development time-scales in the civil aircraft industry naturally calls for an integration of advanced computer aided optimisation methods into the overall component design process. Airbus has in a number of recent studies used Altair's topology, sizing and shape optimisation tools in an attempt to achieve lighter and more efficient component designs. Considered components include wing leading edge ribs, main wing box ribs, different types of wing trailing edge brackets as well as fuselage doorstops and fuselage door intercostal. The designs for most of these components are to some extent driven by buckling requirements but also by for example stress and stiffness requirements. Dynamic objects are able to combine the benefits of dynamic patterns context dependency and object instantiation of power copies [1].Rules and reactions are higher level of parameterization which can be used to introduce the design knowledge into the geometry [2]. Computer aided design of air craft [4]. The wing spars are subjected to a wide variety of aerodynamic, structural, turbulence and just wind flight and ground loads [5]. To the aerospace industry, the overall weight of an aircraft is a critical design requirement due to the impact just a few kilograms can have on fuel efficiency and co2 emissions. Heavier aircraft use more fuel during flight which leads to increased running costs for the airline carriers. When designing the world's largest passenger aircraft, the airbus wanted to ensure the design was as lightweight as possible while maintaining all performance standards. Altair Product Design was selected to assist in the development of the A380 by helping to define and implement a new optimization process to remove mass from the aircraft's leading edge droop nose wing ribs.

II.AIRCRAFT WING CONFIGURATION:

Based on the type of mission requirements and the different flight regimes the aircraft will encounter be it subsonic, transonic, supersonic or even hypersonic, there are different wing configurations and platform shapes that are available to the aircraft designer for the wings. Some of them are shown in the figure below.

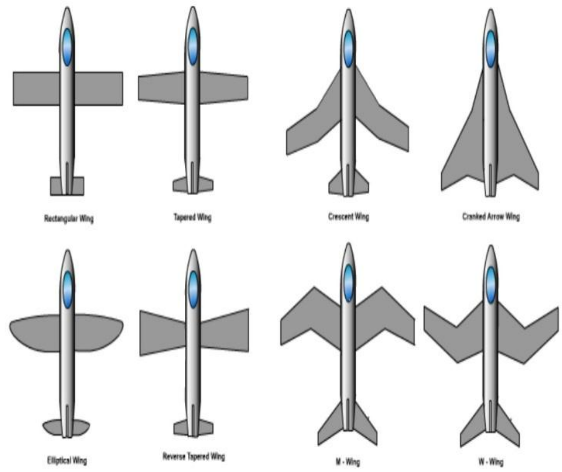

Figure1: Aircraft wing platform and configurations

When the positioning of the wing on the fuselage and the shape of the wing is changed, different types of wing configurations can be achieved, some of which are shown in the figure below,

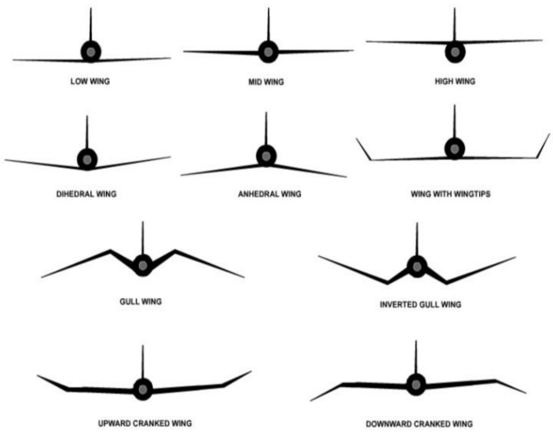

Figure 2: Positioning and Shape of the Wing

III.MODELLING OF WING RIB:

The generic aircraft wing model is composed of both the surface and the solid model for wing panels, wing spars and wing ribs. Each wing panel, wing spar and wing ribs also have individual parameters that define the geometry and shape of each element, furthermore, there are also global parameters which control the number of wing panels, spars and ribs as well as the mesh characteristics. Whenever, a new wing panel, a wing spar or a wing rib is added into the model, a join which already exists in the model is updated with the new geometry. These joins are connected to each individual surface mesh for wing panels, wing spars and wing ribs..

A.Modeling steps using catia v5 r19 software

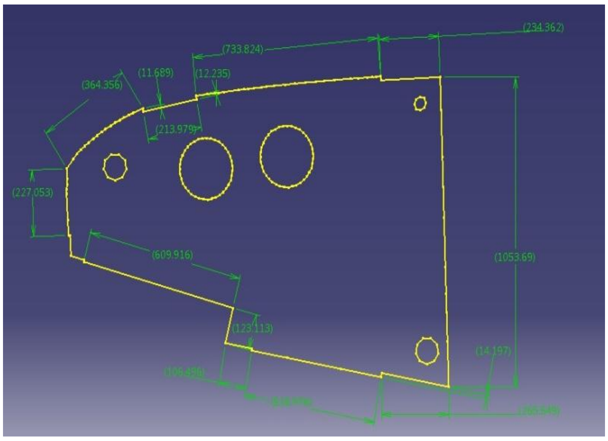

Figure 3: 2D drawing Using CATIA V5R19 Software

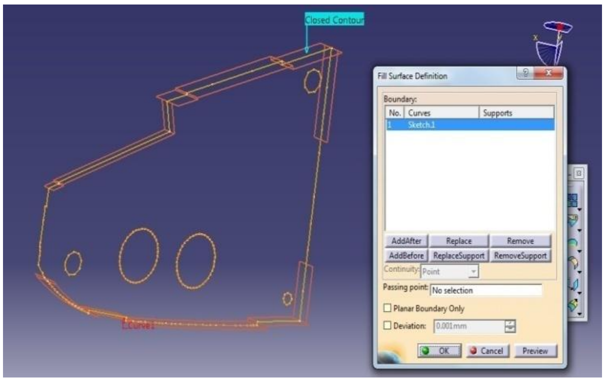

Figure 4: Filling Surface option to Wing Rib Model using Fill surface option

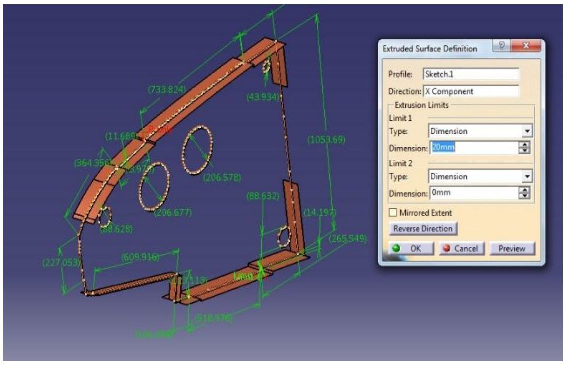

Figure5: Extrude Option To create flange for wing rib

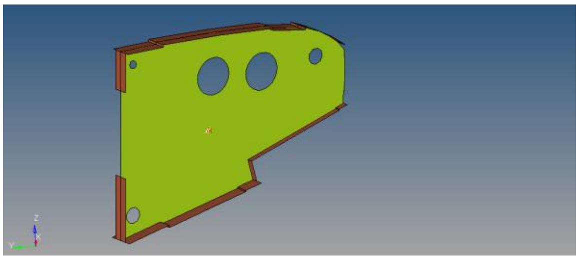

Figure6: After doing above steps 3d model is developed in catia v5r19 software model

IV.ANALYSIS:

Aerodynamic pressure is applied on the wing profile and checking the displacement, stresses for the wing rib. After this aim and challenge is to reduce the weight of the component Altair Optistruct is used for topology optimization. Above procedure is shows complete steps to solve the aerodynamic analysis using Radioss software. After seeing base run analysis results, optistruct is used for seeing weight reduction model. Using analysis page constraints, forces and moments are applied to the component. For topology optimization we need to do organizing the elements like shown in above figure.

We need to move the mesh to non design area for which model should not change at that location. For that purpose design and non design area is created and solved the Optistruct software. Tool page-Count-select FE entities- and click on displayed, It shows nodes and elements.

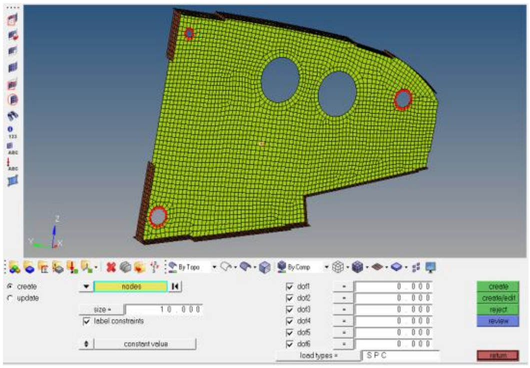

Fig7: Nodes=4091 and elements=3924

V.RESULTS AND DISCUSSIONS:

A. Displacement:

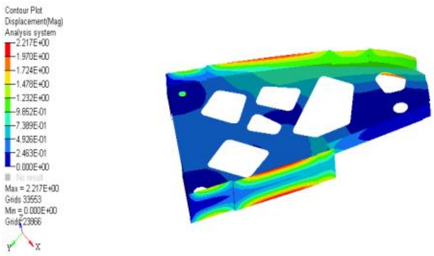

Figure8: Displacement for optimized model is 2.217 mm

B.Stress:

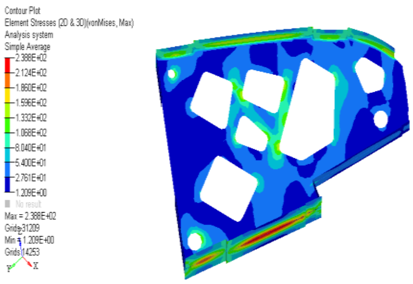

Figure.9: Stress for optimized model is $2.355*10^{2}$ tones]

Comparison of results

TABLE-I

STRESS COMPARISON FOR TWO MODELS:

CONTENTS	BASE MODEL	OPTIMIZED MODEL
STRESS(Mpa)	237	238
DISPLACEMENT(mm)	1.93	2.21
MASS(kg)	28	24

The above table shows the comparison of stress, displacements and mass of two models, which is below the yield point value of Aluminium 2024-T3 material The value of stress in optimized model is $2.355*10^2$ is 238 Mpa

VI.CONCLUSION

The present work illustrates how topology, sizing and shape optimisation tools may be used in the design of aircraft components. The technology has been successfully used in an industrial environment with short industrial time scales and has on a single application proved to be able to provide efficient stress and stability component designs.

Initial studies have shown that care should be taken in the modelling of the load and boundary conditions of the components. For aircraft component design it is also important to be aware of the impact of changing loading situations. The truss type designs obtained using the topology optimisation are highly specialised designs optimised for certain loading situations. Load definitions generally change as the design of an aircraft mature, and this could seriously affect the optimality of the structure. It could therefore prove important to carefully select applications for topology optimisation and only use the technology on structures with well defined loading conditions

VII.REFERENCES

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