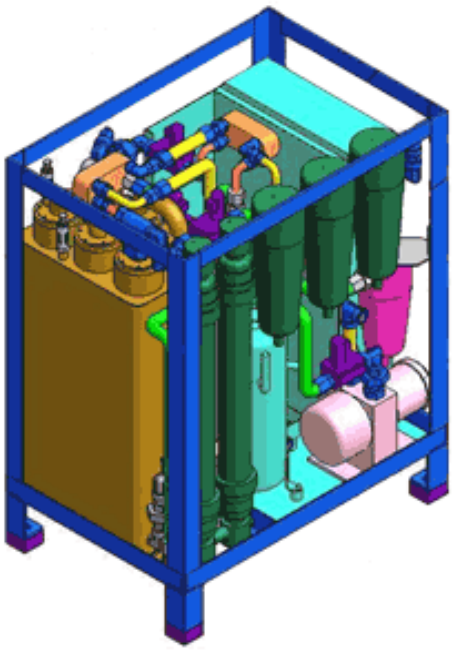
ZEUSNUMERIX



QUARTERLY NEWSLETTER

Q4, 2012-13 | Zeus Numerix

www.zeusnumerix.com

सेना उड़नयोग्यता और प्रमाणीकरण केन्द्र

CENTRE FOR MILITARY AIRWORTHINESS & CERTIFICATION

रक्षा अनुसन्धान तथा विकास संगठन

DEFENCE R&D ORGANISATION

भारत सरकार, रक्षा मंत्रालय

GOVERNMENT OF INDIA
MINISTRY OF DEFENCE

मारतहल्ली कालोनी पोस्ट आफिस बेंगालोर

MARATHAHALLI COLONY P.O.
BENGALURU - 560 037.

DESIGN APPROVAL No – 137

Name of the Firm: M/s. Zeus Numerix Private Limited, Mumbai-400 076

*This is to certify that **M/s. Zeus Numerix Private Limited, M-03, SINE, CSRE Building, IIT Bombay, Powai, Mumbai-400 076**, hereby issued with **Design Approval** to undertake design and development in the following area of activities:*

> *"Design & Analysis of Aerodynamics, Structural Systems and sub-systems, Electromagnetics, Dynamics & Controls of Missiles for Military Airborne applications.*

2 The approval is subject to the following conditions:

i) The design approval implies that M/s. Zeus Numerix Private Limited, Mumbai, is capable of undertaking the above mentioned scope of activities within the firm. However, necessary provisional clearance is to be obtained from the concerned RCMA depending on the aircraft systems or Type Approval from CEMILAC, for each products designed and developed on a case to case basis, for its use.

ii) The scope of approval is applicable only to those activities indicated above in Para-l only.

*iii) The approval is valid for a period of **Two (2) years** from the date of issue of this letter, unless otherwise suspended, revoked or cancelled*

iv) Prior approval of CEMILAC is required to effect any changes in the composition and / or the scope of approval from list of authorized signatories.

*v) **A brief write up** on design activities undertaken & its status under the scope of the approval for Military aircraft and its systems has to be forwarded to **CEMILAC** at **every six months** interval mandatorily for subsequent renewals if any.*

*vi) **Authorized signatories** listed in **Appendix 'A'** will sign the reports on the areas of work defined and those reports with their signatures only will be accepted by CEMILAC/RCMAs.*

vii) The newly developed / fabricated items are Subjected to meeting the Quality Assurance aspects & declared performance requirements, being cleared by DGAQA/ competent inspection authority for ensuring drawing conformance, quality aspects etc.,

Encl : Appendix 'A'
Ref No : CEMILAC/6042/DA-137/TC&S
Dated : 30th Nov 2012

(Dr. R. TAMILMANI)
Distinguished Scientist
Chief Executive (Airworthiness)

Design and Analysis of Composite Landing Gear for UAV

Our customer is engaged with development of Unmanned Aerial Vehicle (UAV) for military reconnaissance and surveillance. As an upgrade of an existing UAV, the customer was aiming for design and integration of Landing gear system. The design process required adherence with FAR 23 guidelines so that landing gear design and analyzed for different load conditions.

Zeus Numerix designed a GFRP / EPOXY based landing gear that is non-retracting type, tricycle with steerable nose wheel and two main wheels. Longitudinal location of main and nose landing gear was determined based on CG location, static loads & tip back angle. The lateral location was governed by turnover angle, turning radii & ground clearances. The design was analyzed by FEM simulation using non-linear layered shell element for handling orthotropic properties. Simulations corresponding to 2.7g drop test & one wheel landing conditions fine-tuned the thickness and geometrical parameters of landing gear. Finally, tires were recommended based on maximum speed and load.

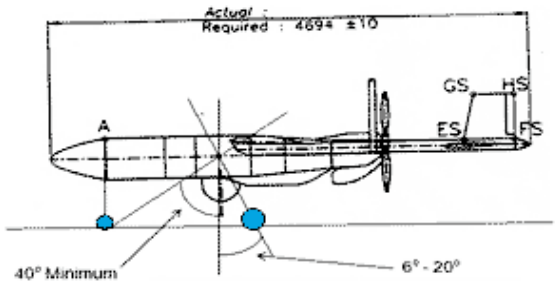


Illustration 1: Schematic for positioning of landing gear

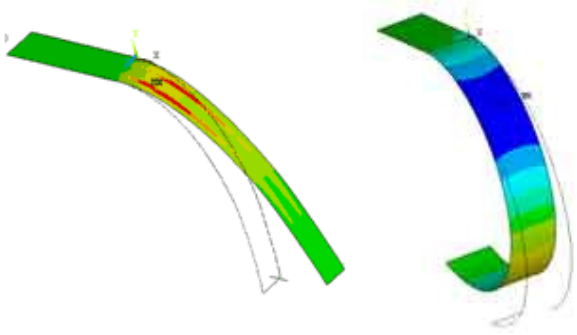


Illustration 2: Shear stress on main & nose landing gear

The customer was delivered with a comprehensive design & analysis report along with detailed manufacturing drawings. The delivery from this project was used by the customer to obtain an approval from certification agency for activities related to integration and flight testing.

Conceptual Design & Performance Analysis of Naval Arrester System

Our customer is a reputed manufacturer of custom designed and engineered systems to the needs of core & defense sector. They were engaged with design of a system to decelerate an underwater moving body by dissipating its kinetic energy into hydraulic twisters. The sizing of the twister i.e. rotor / stator dimensions were to be determined based on the loads arising out of this unique application. There were no off-the-shelf solutions available for this requirement.

Zeus Numerix started with a system level modeling of the arrester system that included design parameters like net stiffness (primary & safety), tape elasticity, inertia of moving mass. This time transient code generated important data such as impact load on the body, deceleration distance, tension on net / tape etc. Accordingly, hydraulic twister was designed; efficacy of which was verified based on CFD simulation.

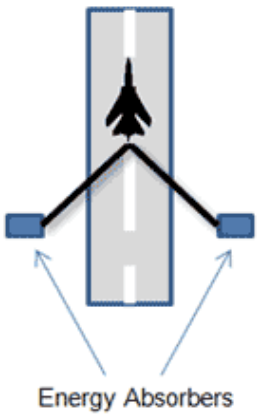


Illustration 1: Concept of Underwater Arrester

Illustration 2: A typical hydraulic twister construction

The customer was delivered with the design of hydraulic twister which met all the severe constraints posed by its unique application. The customer fabricated twister & other components of arrester systems and successfully tested to their satisfaction of their end clients. Using an innovative simulation approach, Zeus Numerix delivered a solution that could not have been obtained from anywhere else.

Design Verification of Naval Subassembly for Shock Load

Our customer is a large private company that delivers custom-built solutions in high technology engineering and manufacturing domain. They were engaged with design & fabrication of CO_2 adsorption unit for a naval platform. The major concern was to verify the structural integrity of proposed assembly which had to withstand continuous vibration & high shock load. Design verification through FEA was a mandatory requirement before fabrication of adsorption units can be undertaken.

Zeus Numerix adopted an approach where the skid was modeled as shell elements and bulk components were modeled as point masses with rigid connection to the skid. The model was analyzed for shock loads (equivalent static & transient dynamic) and vibration loads. Skid design was strengthened by introducing stiffeners in the regions of failure. The selection of stiffeners was such that they add very little weight to the adsorption unit.

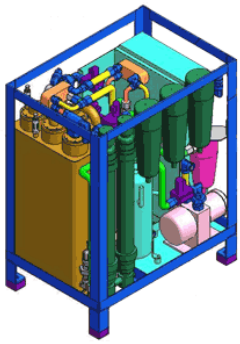


Illustration 1: Schematic of CO_2 Adsorber Skid

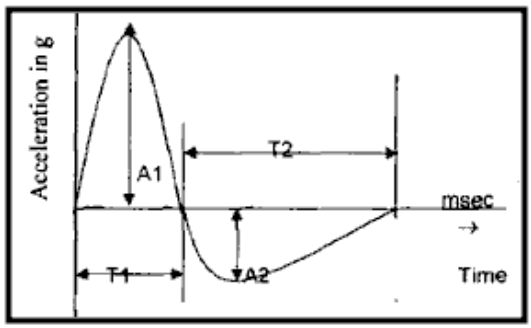


Illustration 2: Shock load profile on Skid

Zeus Numerix supplied a final consolidated design verification document to the customer. It accompanied the customer to end-client's site and presented the simulation approach & supplied analysis files for their approval. The project was completed within stipulated time & cost and to the fullest satisfaction of the end-client.

Aerospace & Defense	Design Optimization	CFD, Structural Analysis

Aero-Structural Optimization of Winglet for Regional Transport Aircraft

Our customer is a high technology oriented institution with a mandate to develop aerospace technologies as well as design and build small / medium sized civil aircrafts. For regional transport aircraft, winglets were considered an essential design feature as they reduce the induced drag. However, winglets also produce additional bending moment for which main wing needs to be strengthened. Therefore, an optimized winglet design was desired that gives maximum drag reduction with minimum weight increase.

Zeus Numerix adopted a Genetic Algorithm based optimization technique for winglet design. Winglets were aerodynamically evaluated using 3D Navier Stokes CFD simulations, whereas, their impact on structural weight of composite wing was determined using FEA analysis. In an automated manner, approx. 1000 candidate designs were evaluated. Due to massive computing requirement, Zeus Numerix implemented & executed the optimization framework on grid computing architecture.

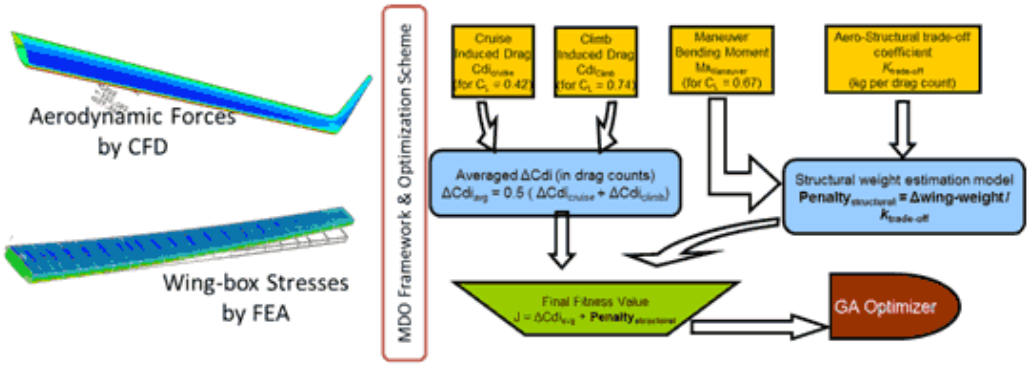


Illustration1: Versatility of CFDExpert-Missile in Analyzing Various Missile Configurations

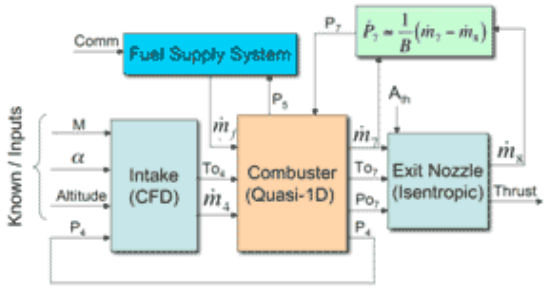
The customer was delivered with the parametric design of winglet that demonstrated 14% reduction in drag. The customer was also shown the feasibility of carrying out complex design optimization using GA, which is now possible due to availability of the computing resources. This exercise helped customer to prove the readiness-level of using frontier simulation technologies for aircraft design.

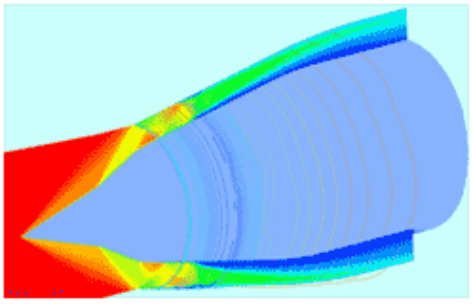
Aerospace & Defense	Engg. Software Development	Control & Dynamics, CFD

Performance Characterization of Air Breathing Engine

Our customer in S. Korea is engaged with conceptual design & development of supersonic air breathing engine. The engine is based on mixed-compression air intake, subsonic combustor, fuel injection system & a nozzle. A mathematical model was desired to be developed for estimating & understanding its working over its flight envelope. The development of such multi-component mathematical model required a multi-disciplinary group with deep expertise in development of numerical simulation tools.

Zeus Numerix selected the most appropriate techniques for component wise simulation and then integrated them all into a common framework for system level performance prediction. It included 3-D CFD simulations for air intake, 1-D detailed chemical kinetics of JP-10 for subsonic combustor and empirical modules for fuel injection & nozzle functioning. A novel system level dynamics framework to integrate the component modules was designed & implemented.





Customer was provided with a well documented integrated framework, its validation studies & analysis report. The framework was further used by customer to devise control strategies for this engine. Through this engagement with Zeus Numerix, customer overcame the critical constraint on availability of R&D resources with expertise in development & usage of numerical methods.

Design & Fabrication of Deployable Boom

Our customer is the leading institute of the country, engaged in basic & applied research in Atmospheric & Space Physics. They were aiming to conduct high altitude balloon experiment for measurements of electric & magnetic field. The probes, in this case three pairs of 200 mm sphere, were to be deployed 4m away from the gondola of balloon after the initial take-off. Thus, the experiment required design & development of reliable light-weight booms with minimum tip deflection.

Zeus Numerix explored various different concepts of boom opening mechanisms. A collapsible type opening was selected for detailed design and prototyping. The entire system was made with lighter weight material and with mechanical joints. Initially the arm remains in folded condition with solenoid holding it. On actuation of solenoid, the arms open up with the help of spring force. All the design calculations for various components are verified using FEA analysis.

Illustration: Prototype of deployable boom assembly

The customer was delivered with six sets of deployable booms that were readily integrated with gondola. These booms are being used by the customer for atmosphere experiments. The process of boom development did not encounter any need for costly concept revision since the design was derived from first principles of structural mechanics.

Prediction of Liner Erosion from Rocket Plume Impingement

Our customer is engaged with development of naval platform based air defense systems. One of the critical issues relates to management of rocket plume as it lifts off from the platform. The plume is diverted back to open atmosphere by way of curved deflector plates. The plates are protected from extreme thermal effects of plume impingement by applying a coating of suitable liner material. Selection of liner materials & their thickness at various regions of deflector plates requires precise estimation of their erosion during each rocket launch. It is not practical to experimentally evaluate liner performances in such a setup for obvious reasons.

Zeus Numerix developed a mathematical model to simulate melting and erosion of liner due to thermal effects during rocket launch. The model was based on Landau transformation of transient heat transfer equation with moving boundary. The methodology was validated against the experimental erosion data generated during SPREE studies by NASA. Finally, the model was applied for customer's rocket launch scenario and three different liner materials were evaluated.

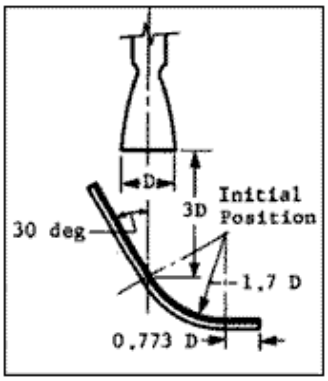


Illustration 1: Schematic of deflector - SPREE studies

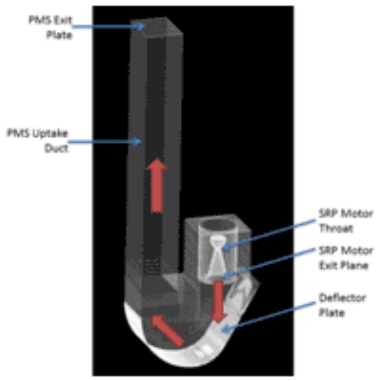


Illustration 2: Schematic of plume management system

The customer was provided with the prediction on erosion depths and temperature variations in different type of liners at different regions of plume deflector plates. Accordingly, recommendations were made on thickness of the liners to be used such that weight penalty from liners is minimum. The customer used this study to obtain approval for rocket plume management system from a safety review panel.

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