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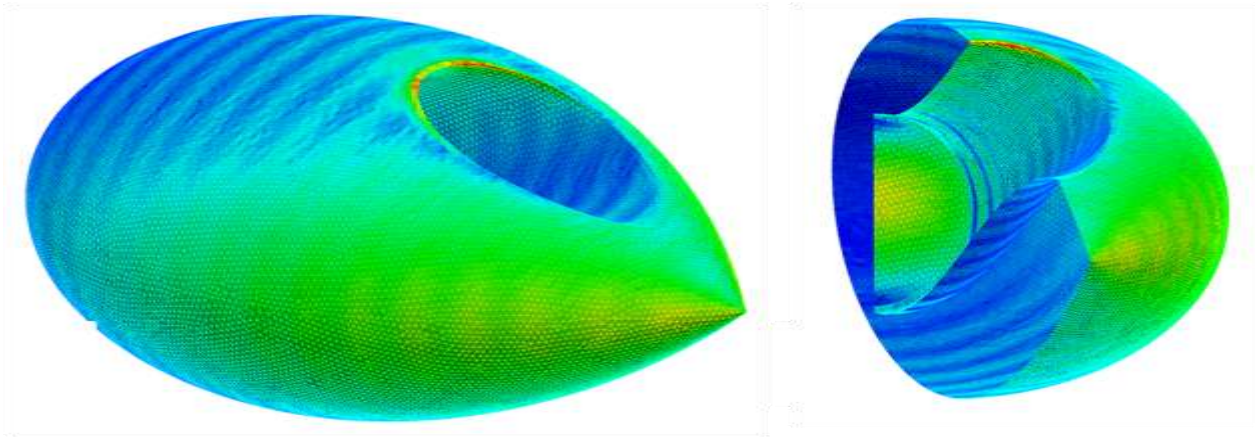

QUARTERLY NEWSLETTER

Q4, 2013-14 | Zeus Numerix

www.zeusnumerix.com

CFD Analysis and Software for Gas Operated Automatic Weapon

VERTICAL:

Aerospace & Defense

SERVICE:

customized CAE Software

TECHNOLOGY:

CFD

Our customer specializes in developing state-of-the-art small arms and light weapons by pursuing extensive research. Gas operated weapon is a rifle where portion of propellant gases is redirected to operate reloading subassemblies. Purpose of this automation is to achieve a high rate of fire and this depends on the amount of gas redirected as well as its pressure characteristics. Thus accurate prediction of gas related parameters is most crucial for design optimization.

Numerical simulation of this problem involved bullet dynamics, gas flow through tapping, pressure built-up ahead of piston & finally, movement of piston subassembly for reloading. Zeus Numerix developed an Octree mesh based CFD solution procedure that couples moving body dynamics of gun-bullet-piston configuration. The simulations were unsteady transient in time domain. The predicted piston velocities were validated against those measured during field trials.

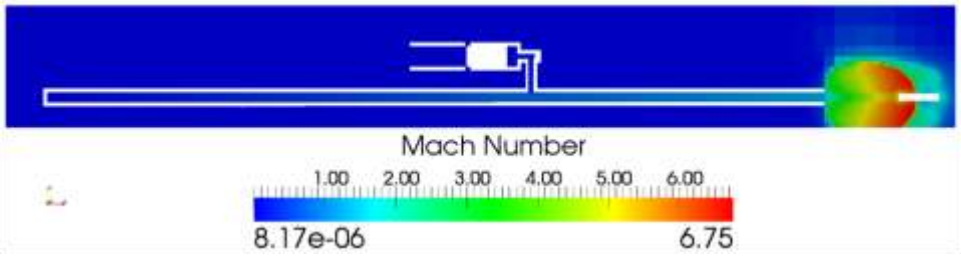

Figure 1: Flow pattern ahead & behind the bullet during firing of gun

Zeus Numerix delivered a customized simulation tool that enabled customer to undertake parametric study to optimize gas reloading design. Later, the simulation tool was upgraded to exploit parallel hardware & reduce turnaround time. Thus, improvements were made to rate of fire by the client using advanced simulation technologies.

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DEVELOPMENT OF FVTD BASED RCS PREDICTION CODE ON UNSTRUCTURED MESH

VERTICAL:

Aerospace & Defense

SERVICE:

Customized CAE Software

TECHNOLOGY:

Computational Electromagnetics

Zeus Numerix has initiated the efforts towards incorporating capability of handling unstructured meshes to its proprietary FVTD based RCS prediction solver. This will eliminate the large manual work involved in generating structured meshes. Structured meshing for complex aerospace configuration becomes too complicated & current software will enable users to solve full aircrafts with their minute details.

Work involved implementation of the numerical schemes, previously implemented for structured meshes. The code has been validated for RCS prediction over canonical shapes. It was found that usage of unstructured mesh increases the number of grid point requirement compared to those required with structured mesh. Therefore, solver data structure was designed to be massively parallelizable. So far, it has been tested for scalability upto 128 cores. Other features such that polyhedral grids, storage of large grids in linked files, partitioning of mesh are also present in the current version of code.

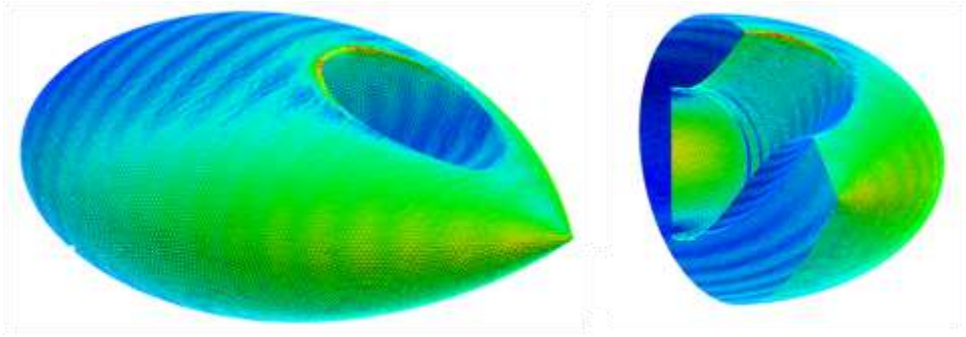

Figure 2: Surface current on almond with cavity configuration solved (fine unstructured mesh seen for 2GHz)

Current activities include validation of ABC (Absorbing Boundary Condition) & PML (Perfectly Matched Layer) boundary conditions. Scalability of the solver is being established for meshes up to 200 million tetrahedrons. Next release of solver will incorporate handling of dielectric materials.

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Assessment of Nose Shape & Taper on Aerodynamic Stability of Missiles

VERTICAL:

Aerospace & Defense

SERVICE:

Engineering Services

TECHNOLOGY:

CFD

Our customer is engaged in development of strategic guided missile systems. These missiles will travel at hypersonic speeds with interception range up to 5000 Km. Such missiles do not feature control surfaces such as tail fins as they are ineffective in high altitude rarified atmosphere. Stability is ensured by correct selection of nose shape and appropriate taper at rear. During its preliminary design stage, it was decided to employ CFD method to find suitable configuration.

Zeus Numerix employed its proprietary CFD simulation tools for generation of stability coefficients. Structured multi-block mesh was generated using GridZ, whereas, in-house Navier Stokes compressible solver, FlowZ, calculated aerodynamic forces & moment at hypersonic speeds. The results were analyzed for stability margin & aerodynamic heating rates at nose region. The study considered multiple nose types as well as taper angles during design iterations.

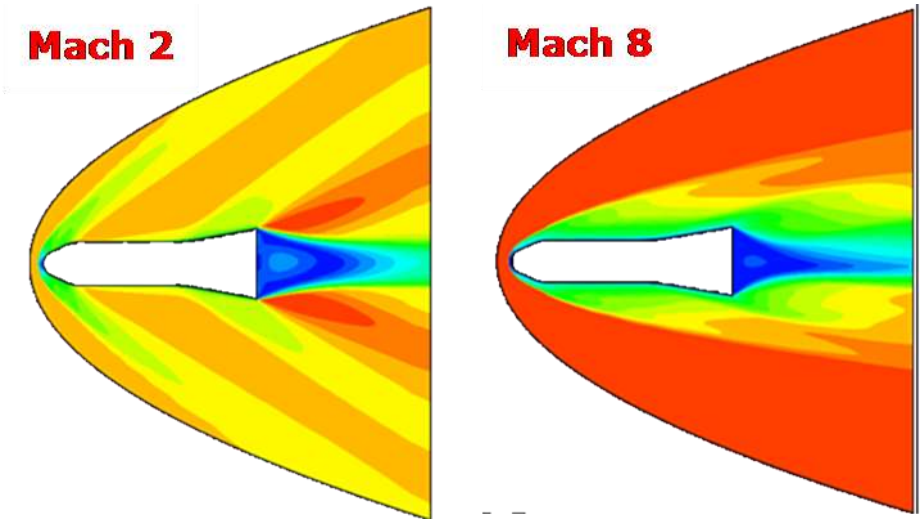

Figure 3: Validation results on a NASA benchmark configuration

Customer was delivered with a detailed aerodynamic study report. The report concluded with recommendation on nose shape & taper angle that provides stability margin during the glide phase of missile. The customer proceeded with design of other stage of the missile and detailed engineering.

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PREDICTION OF PRESSURE TRANSIENTS DURING THE LAUNCH OF PLUG FROM TUBE

VERTICAL:

Aerospace & Defense

SERVICE:

Engineering Services

TECHNOLOGY:

CFD

Our customer is a reputed Shipbuilder engaged in construction of commercial vessels and warships for the navy. They were carrying out design and manufacturing of launcher tube system of submerged vessel. A common issue with tube launch is initiation of cavitation, which will retard the "plug" being launched. Before prototype testing, client sought CFD simulation to understand extent of cavitation and ways to mitigate it.

Zeus Numerix used its proprietary software CFDExpert™ to simulate tube launch hydrodynamics. CFD was conducted at different time instances with corresponding "plug" location, velocity & acceleration. Flow parameters ahead & behind the plug were noted. As expected, cavitation was predicted near the tail end of "plug". Initiation of cavitation was found to be a function of submerged depth as well as internal bore profile of tube.

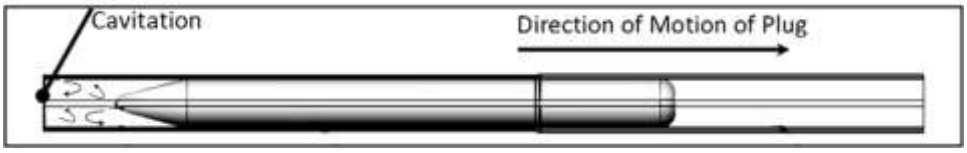

Figure 4: Schematic of Tube Launch

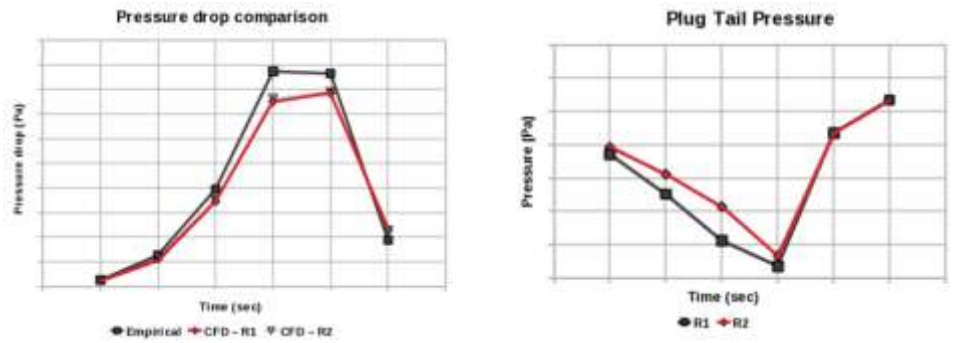

Figure 5: Time History of Pressure inside Tube

For each design of tube internal profile, client was supplied with a detailed analysis report covering the onset and duration of the cavitation. Accordingly, customer selected the most optimum tube profile. The study report was used to get sufficient confidence level of tube design and hence move ahead with prototype building.

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STRUCTURAL ANALYSIS OF SOLLECTOR SOLAR TRACKING SYSTEM

VERTICAL:

Power, Energy & Nuclear

SERVICE:

Engineering Services

TECHNOLOGY:

Structural Analysis

Our client is innovating an efficient way to collect solar energy for the production of industrial process heat and electrical power. A new solar tracking system is developed, wherein the parabolic dish moves and tracks the sun through the day and through the seasons. The client had named the system "Sollector". As a result dish reaches extreme orientations with respect to its baseline support. The client desired to conduct FEA based structural analysis to identify the sections where the stresses and displacements are maximum and accordingly undertake modifications to make the design more robust and reliable.

Structural integrity of the system needs to be evaluated for its survival against load of 150 KMPH wind speed. 6 combinations of different positions and orientation of the dish were analyzed. Wind load was generated using CFD simulation and its distribution was mapped for structured analysis; Proprietary CFD to FEA load mapping tool was utilized. A static structural analysis of system revealed regions of high stresses that were prone to failure.

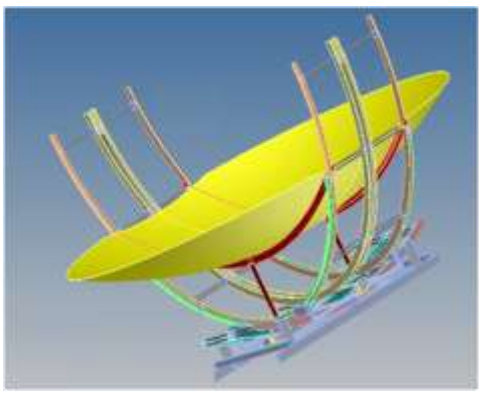

Figure 6: Representative image of Sollector

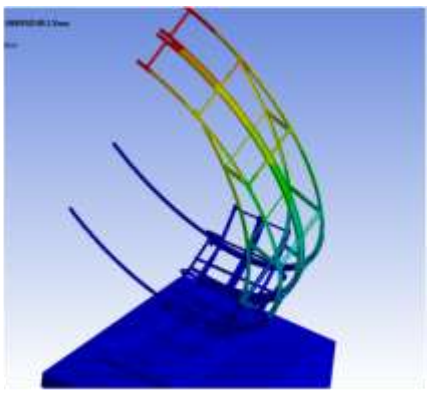

Figure 7: Stress variation at extreme orientation

Customer was delivered with an analysis report. To strengthen the system, some changes in section design and additional stiffeners were recommended. The recommendations were supported by another set of structural analysis. The study allowed the customer to proceed with fabrication of solar collector system with a decent level of confidence.

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ASSESSMENT OF HEAT TRANSFER USING JET IMPINGEMENT

VERTICAL:

Industrial & Fluid Machinery

SERVICE:

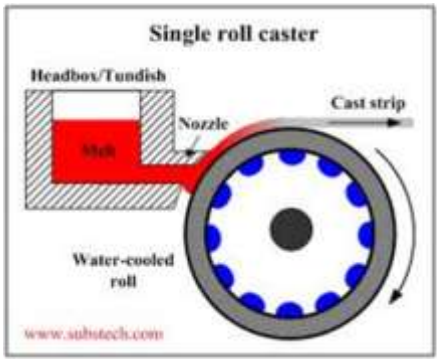
Engineering Services

TECHNOLOGY:

CFD

Our customer is the leading manufacturer – exporters of amorphous alloy ribbons. The production of ribbons is through a process which involves rapid cooling of a 5mm thick moving copper plate. Cooling arrangement comprises of an elaborate jet nozzle arrangement through which coolant is made to impinge on the plate. Customer desired to improve the cooling rate by optimizing the nozzle arrangement. Since, manufacturing & physical testing of multiple arrangements was costly; CFD simulations were employed to assessment.

Zeus Numerix employed, CFDExpert-Lite™, its proprietary CFD software for simulations. The domain that comprised of flow channel around plate and jet nozzles was meshed using structured multi-block. Mesh was refined up to viscous sub-layer so that high gradients and recirculation zones are captured. Wall functions that are not valid for such flow features were not employed as they could have affected the heat transfer estimates.



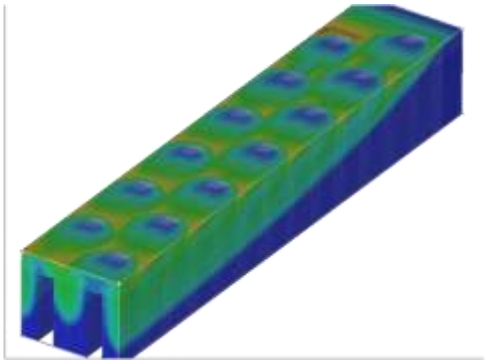


Figure 8: Typical process for strip casting Figure 9: Temperature on upper wall of channel

Customer was delivered with a detailed scientific analysis report that described the dependence of heat transfer coefficient on parameters of jet cooling arrangement. During the study, the distance between nozzles, distance between nozzle-plate, diameter of nozzles and option of staggered / inline arrangement of jets were varied to obtain optimum design. The improved performance of cooling systems was confirmed by undertaking actual trials of ribbon production.

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Structural and Vibration Analysis of Control Valves

VERTICAL:
Industrial & Fluid Machinery

SERVICE:
Engineering Services

TECHNOLOGY:
Structural Analysis

Our customer is a global provider of integrated flow control solutions in oil and gas industries, specializing in highly engineering control valves. Due to a critical nature of installations, a high degree of structural robustness is desired. Not only do the valves need to withstand high internal pressure, but it also need to function reliably under vibration. The most cost effective & quick way to establish design robustness is through Finite Element Analysis.

Zeus Numerix was engaged by customer for all their valve designs ranging from 2'' to 12'' nominal diameters. Considering valve as a pressure vessel, FEM was carried out as per ASME Section VIII, Division 2, Appendix 4 - "Design based on Stress Analysis". Valve was simulated under vibratory environment by predicting its natural frequency. A high value above forced excitation frequency confirmed robustness.

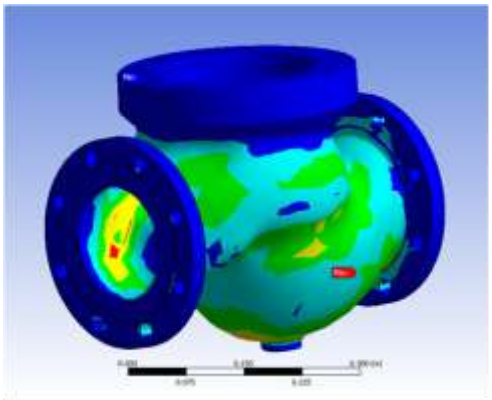

Figure 10: Stress Distribution on Valve Body

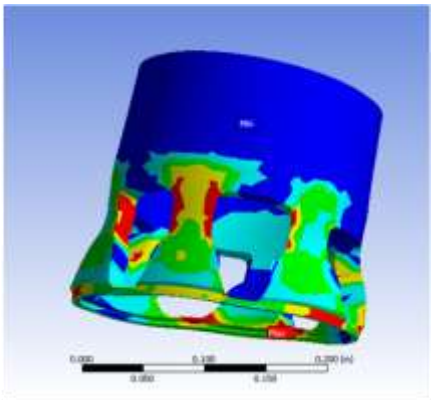

Figure 11: Deformation of Cage under Extreme Load

During the design phase of valves, Zeus Numerix acted as an extended team to the customer. A process guaranteeing delivery of desired analysis in minimum turnaround time was setup. This association meant that customer was able to obtain specialized design support without needing to increase its fixed cost.

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Structural Analysis of Sugar Dryer Assembly

VERTICAL:
Industrial & Fluid Machinery

SERVICE:
Engineering Services

TECHNOLOGY:
Structural Analysis

Our customer is design, engineering & manufacturing company of critically customized industrial equipment. One of their leading products is sugar dryer that works on the principle of flow of hot air over sugar particles. Sugar particles are oscillated as they move on a vibrating perforated plate. Frequent failures were observed, mainly, sharing of bolts that hold leaf spring & flattening of bracket. The client resorted to finite element analysis to eliminate failures in the dryer.

Finite element analysis was carried out in ANSYS for the leaf spring, bottom plate & flange. Higher order 3D elements SOLID87 & SOLID186 were utilized. Load pertaining to eccentric displacement was applied to leaf spring. Similarly, self weight & centrifugal load was applied to base plate. It was found that spring leaf is failing as stresses were higher than the endurance limit. Analytical calculations were also done to compare against FE results.

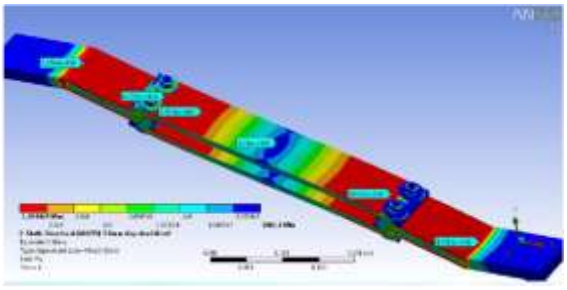

Figure 12: Sugar dryer assembly Figure 13: Stress distribution on leaf spring during breaking

Customer was given recommendation of increasing the width of leaf spring and introducing a fillet in bracket to reduce stress. Simulations to confirm the benefit of these modifications were also delivered. The study allowed the customer to identify the problematic areas in the design. These were incorporated to obtain robust operation of sugar dryer.

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VALUE ENGINEERING FOR WEIGHT REDUCTION OF PORTABLE COMPRESSOR CANOPY

VERTICAL:

Industrial & Fluid Machinery

SERVICE:

Design Optimization

TECHNOLOGY:

Structural Analysis

Our customer is an industrial group with world leading position in construction and mining equipment. For their product line comprising of portable air compressor, they were engaged in activities leading to reduction in material weight & fabrication cost. These were to be done without sacrificing design robustness and performance. The customer wanted a third party to independently review and thoroughly analyze the design to make recommendation.

Zeus Numerix initiated the process of value engineering by making a list of components, their functionality, fabrication process & associated cost. Thereafter, major load bearing components like lifting beam, bottom frame and cover were identified. These were subjected to finite element analysis. Size, shapes & sections were varied and analysis was carried out iteratively till design with least material requirement was obtained.

Figure 14: Typical portable air compressor

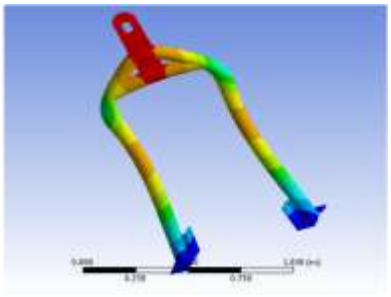

Figure 15: Stress patterns on main lifting beam

The customer was delivered with detailed fabrication drawings of the optimized canopy design. This design had 27% less weight and 14% less fabrication cost. Physical load tests were further conducted by the client to confirm the design robustness. Similar modifications were done by client on other compressor sizes.

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