EDA Engineering
Design and Analysis

Company Overview

(PRODUCTS and CAPABILITIES)

January 2024

Contents

COMPANY OVERVIEW

Foundation :

EDA was founded in 2003 by Dr. Erdal Oktay in METU Technopolis, Ankara/TURKEY.

Area of Interest :

- Mechanical and Aeronautical Engineering

Target Sector :

- Defense and Aerospace Industry

Our Team

Field	Degree	Number	Avg. Years of Experience
Aeronautical & Mechanical Engineer	PhD.	1	42
Civil & Mechanical Engineer	Prof.	1	57
Mechanical Engineer	PhD.	1	37
Computer Engineer	PhD.	1	32
Chemical Engineer	Bs.	1	20
Aeronautical Engineer	Ms.	2	8
Computer Engineer	Bs.	1	5
	TOTAL	8	28.7

Services*

MKE (*Mechanical and Chemical Industry Corporation*)

- Development of Ballistic Design & Analysis Software
- Engineering Services concerning Ammunition and Weapon System Design
- Development of Firing Control Inputs (FCI) for Firing Control Computers and Tabular Firing Tables (TFT) for Howitzers and Battle Tanks

TUBITAK-SAGE (*Defense Industries Research And Development Institute*)

- Development of Hybrid Mesh Generation Software
- Development of Grain Burnback Analysis Software for Solid Propellants of Rocket Motors
- Flutter Analysis of A Transonic Aircraft Wing

TEI (*TUSAS Engine Industries Inc.*)

- Development of Hybrid Mesh Generation Software

ROKETSAN (*Missile Industries Inc.*)

- Aerodynamic Heating Analysis of A High Supersonic Missile

(*) All these services have been performed by using EDA's Software

R&D Projects

- Development of A Parallel Fluid-Structure Interaction Software *
- Development of A Pre-Processor Software for CFD Applications *
- Development of Solid Model & Unstructured Mesh Generation Software for Parametric Complex Surface Geometries *
- Adding Structural & Thermal Design Capabilities to CAEeda Software Package *
- A Software Development for Aerodynamics and Structural Design Optimization & Automation *
- A Software Development for Computer Aided Design and Physical Simulation of Guided Projectiles and Missiles *
- Development of Structural Analysis and Design Automation Software for Composite Structures
- Software Development for Ballistic Design & Analysis
- Development of a CAD and Grain Burnback Analysis Software for Solid Propellant Rocket Motors

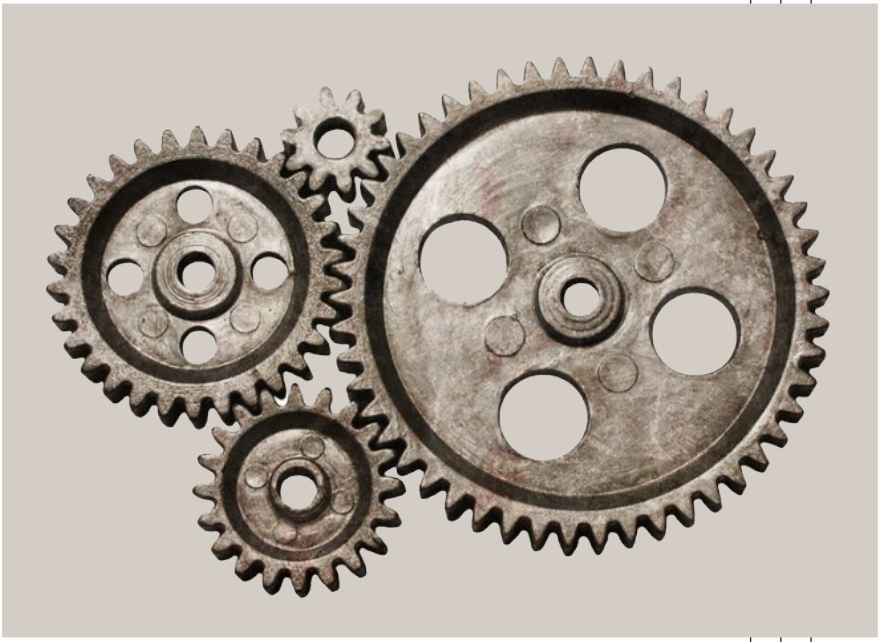
(*) Partially Supported by TÜBİTAK-TEYDEB

Capabilities*

Topic	Capability	Service
Ballistic design, design optimization and analysis	✓	✓
Development of Fire Control Input (FCI) and Tabular Firing Tables for direct and indirect firings with respect to NATO standards	✓	✓
Gun barrel design and design optimization	✓	
Projectile, missile design and design optimization	✓	
Warhead design	✓	
Basebleed design and analysis	✓	
Design and analysis of Mine Clearing Line Charge (MICLIC)	✓	
Grain Burnback Analysis for Solid Propellant Rocket Motors	✓	✓
Development of fire control software	✓	
Design of guided ammunitions	✓	

(*) The weapon and ammunition related studies, carried out and completed for serving to clients or acquiring new company talents.

THE FIELDS OF ACTIVITY



Engineering Design Development & Improvement

- Used Computational Methods for Engineering

Low Order Engineering Methods	→	High Order Advanced Computational Methods

Engineering Analysis

- Software Tools
  - CAEeda - Computer Aided Engineering Design & Analysis Software
  - BALLISTICeda - Ballistic Design & Analysis Software

Software Development, Customization & Automation

- Objectives
  - Improving capabilities that are not available on the market yet
  - Using EDA's software for Design & Analysis independently
  - Gathering all Design & Analysis tools under a single software
  - Increasing cost efficiency of projects using customized software

FCI & TFT Creation, Fire Control Software

- Development of FCI (Fire Control Input) and TFT (Tabular Firing Table)
- Fire Control Software Development

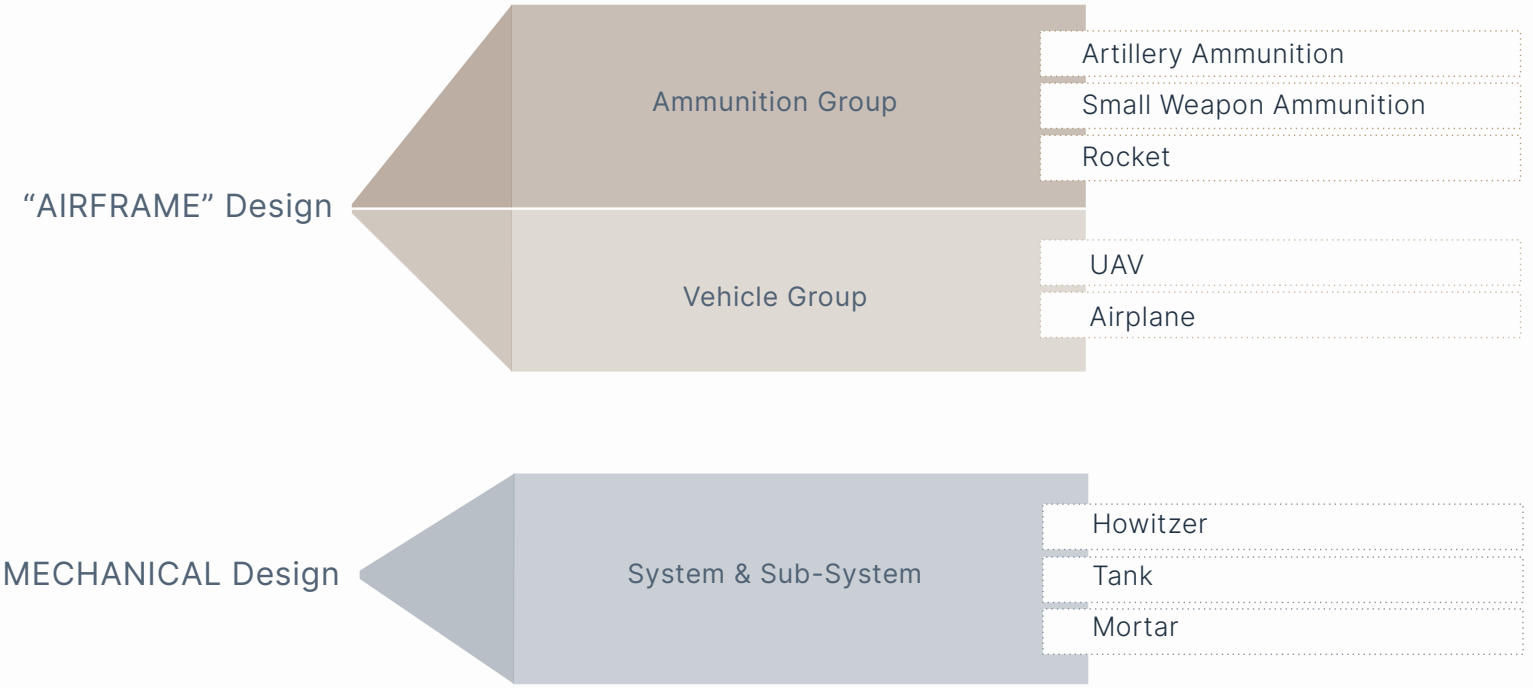
Firing Test

- Firing Test Planning
- Firing Test Consultancy

Engineering Design & Design Improvement

- Design of original, high-tech systems or sub-systems from the idea to the prototype
- Design modification and improvement of the existing design
- Design optimization based on specified design parameters and constraints to improve the performance of the existing product or the new product to be designed
- We use the company property software CAEeda™ for all these studies

Design Topics



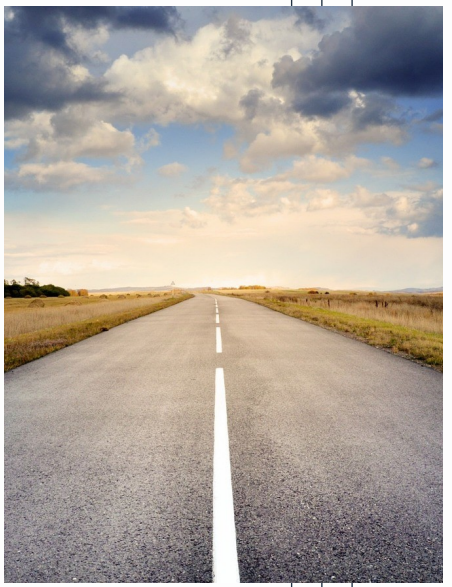
Design Methodology : Computational Approach

Development of a design software considering design objective and constraints

- Define inputs
- Decide on design parameters
- Decide on interactive disciplines (fluid, solid, thermal, dynamic, etc.)
- Develop parametric design software
- Use previous design experience
- Automate the design software
- Link existing CAD, MATHEMATICS and COMPUTATIONAL GEOMETRY libraries
- Integrate the developed parametric design software into the design manager software (heuristic or gradient based designer)
- Parallelize the design software
- Run the design software on a parallel cluster
- Identify the desired number of candidate design alternatives from the run results
- Make a decision on one of the design candidates after detailed computational studies

If necessary

- *Topology optimization*
- *Shape optimization*
- *Size optimization*

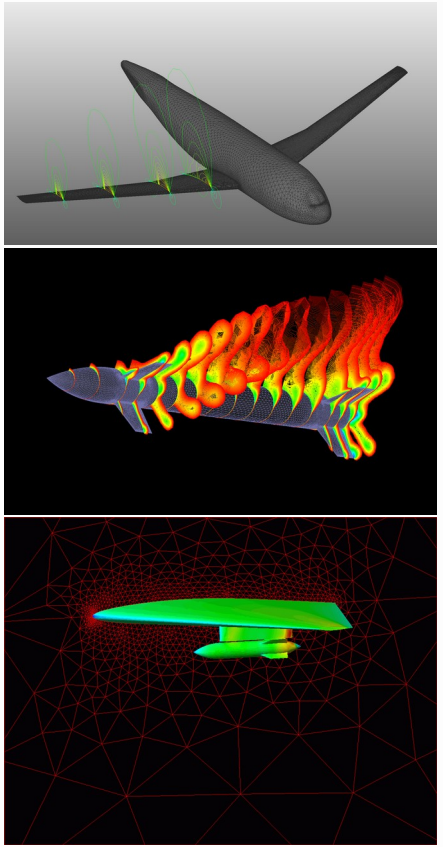


Engineering Analysis

- Analysis is performed during design projects carried out or independently from projects
- CAEeda™ is used during engineering analysis with its modules, which include computational tools ranging from basic engineering to high precision advanced methods.

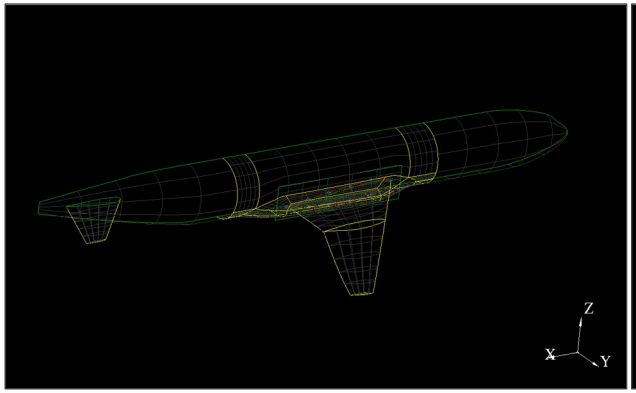
Analysis Topics

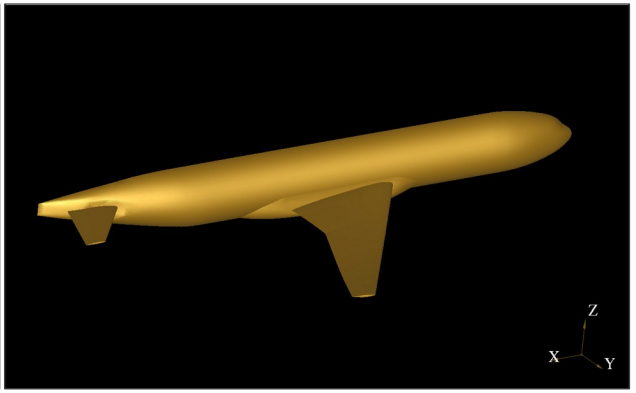
- Fluid Dynamics (compressible, incompressible)
- Heat Transfer (conduction, convection, radiation)
- Solid Mechanics (linear, nonlinear)
- Flight Mechanics
- Multidisciplinary Interaction Problems
  - Fluid - Structure Interaction (static, dynamic)
  - Flow - Heat Transfer Interaction
  - Flow - Flight Mechanics Interaction
  - Fluid-Structure-Heat Transfer Interaction
- Aircraft and Helicopter External Weapon Integration
- High Performance Computing (HPC)
  - Parallel computer cluster design and installation
  - Software parallelization

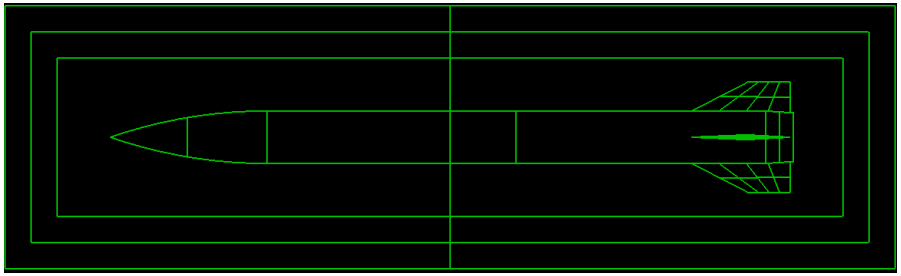


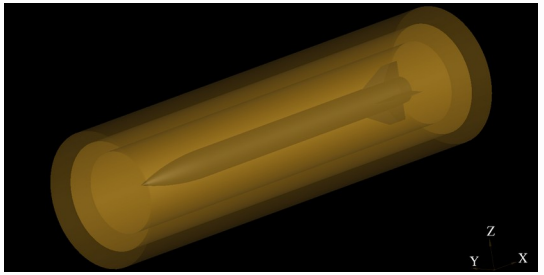
Some Studies on Engineering Design and Analysis

Creation of solid model by using CAEeda



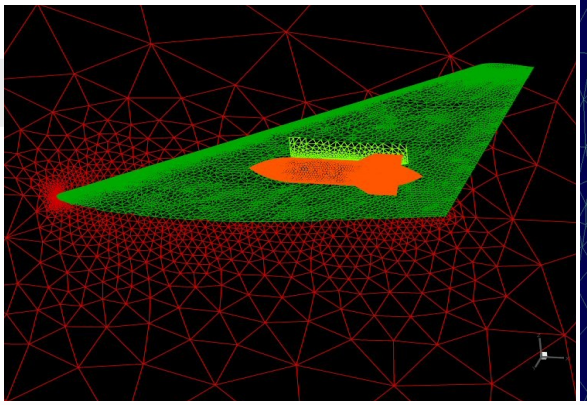


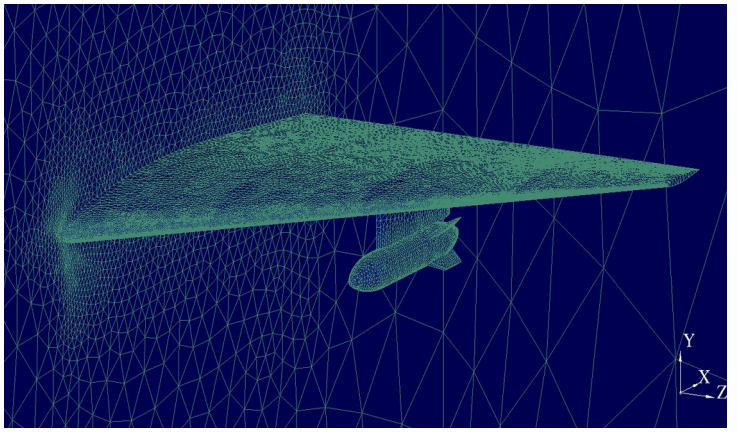




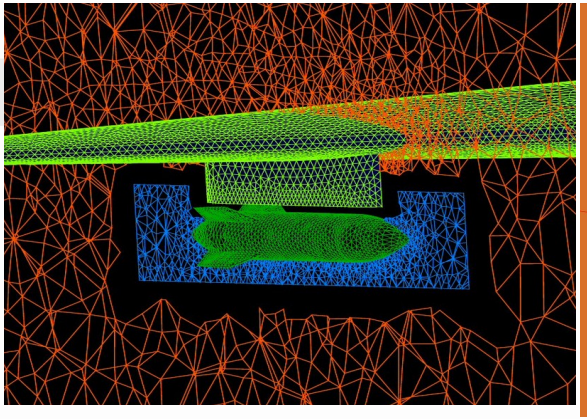
Store Separation

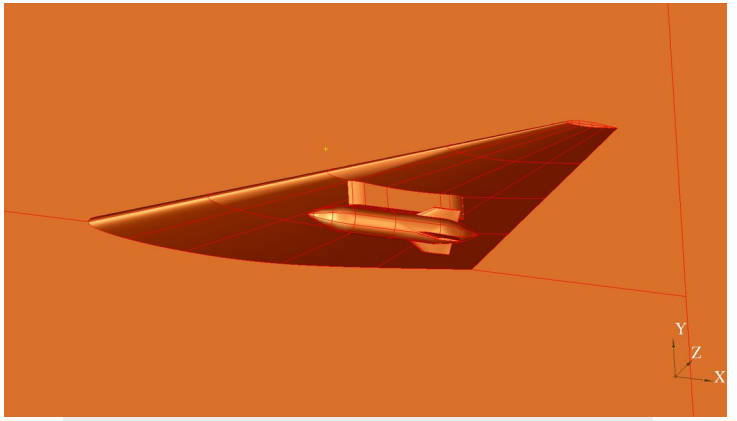
Unstructured surface mesh





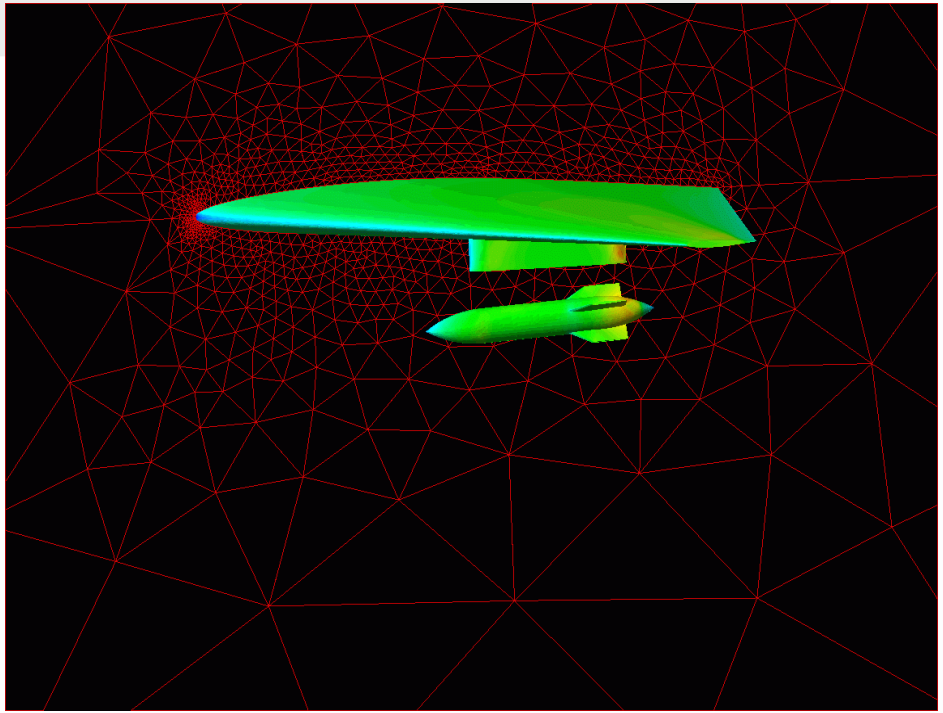
Mesh blanking and stitching



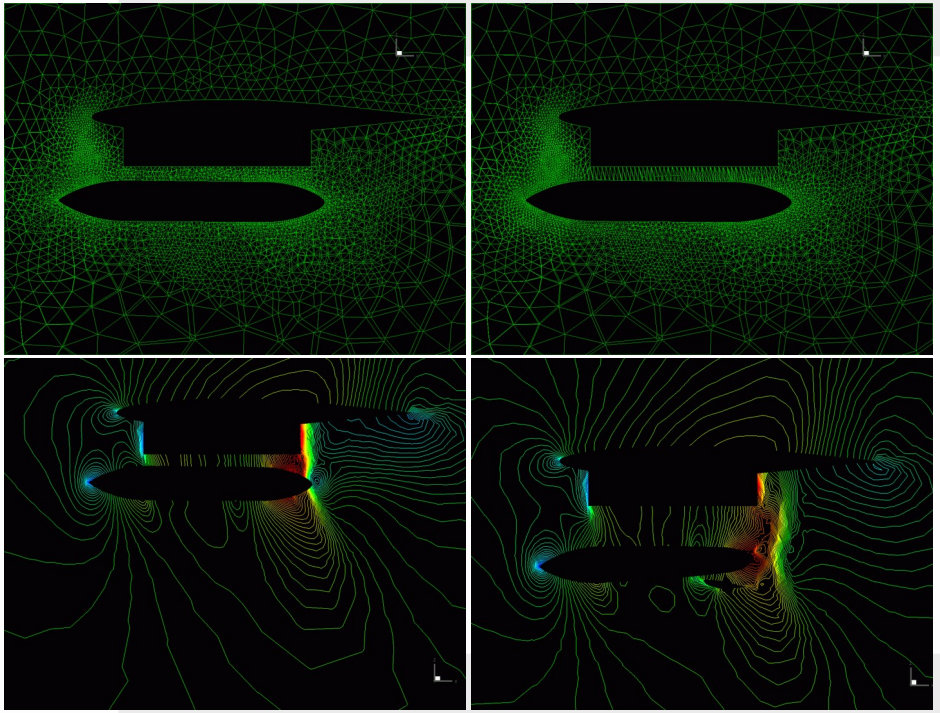


Solid model

Computed store positions and pressure distribution on surfaces



Deforming mesh

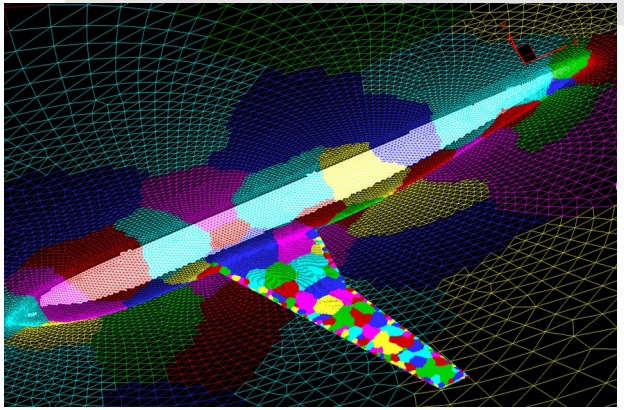


Shock positions during separation

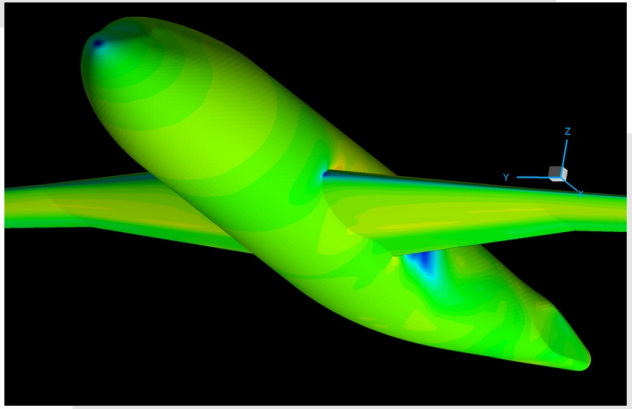
Parallel Computing

Test case: DLR-F6

Mesh partitioning for parallel computing



Mach number distribution on the surface



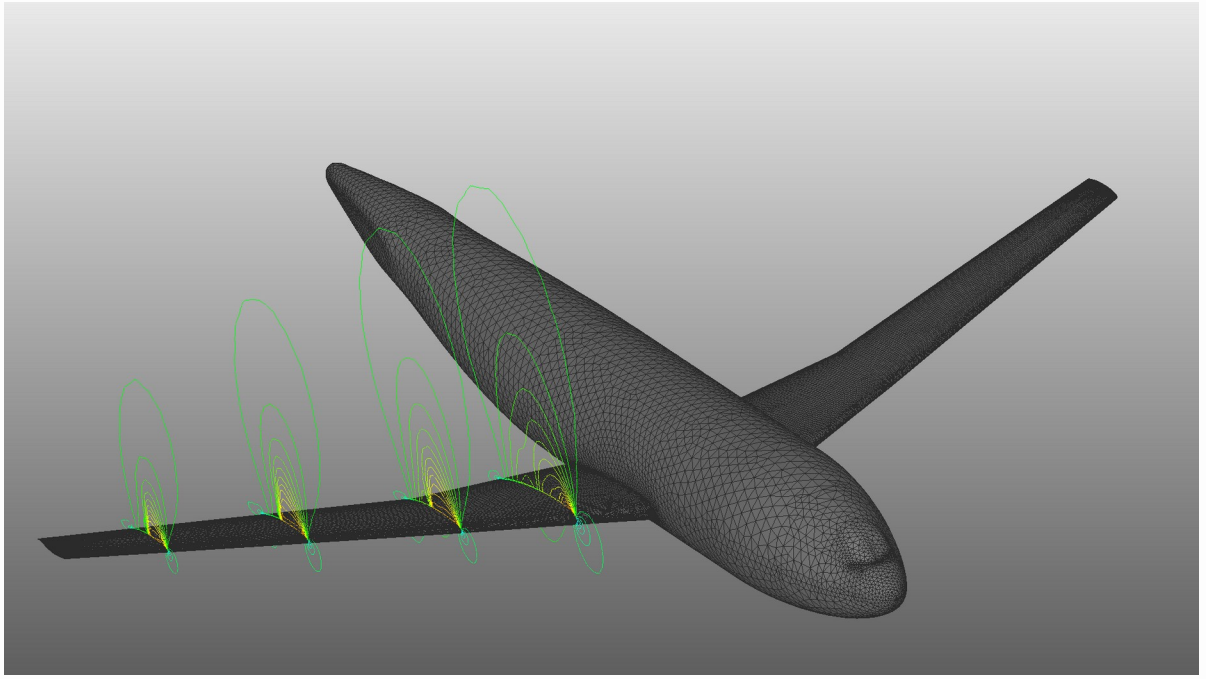
18 M cells	
Time steps	: 20,000
Elapsed time	: 36.4 min
Average CPU time	: 32.1 min (per processor)
Efficiency	: 88.1% (estimated)
Estimated Single Processor Time	: 273 hours (11.4 days)

FAPeda Verification for Transonic Flow

AIAA Drag Prediction Workshop

Test case: DLR-F6, WB, Mach=0.75, AOA=0.93

Mesh : unstructured, nelem=2.7milyon, nnode=470427

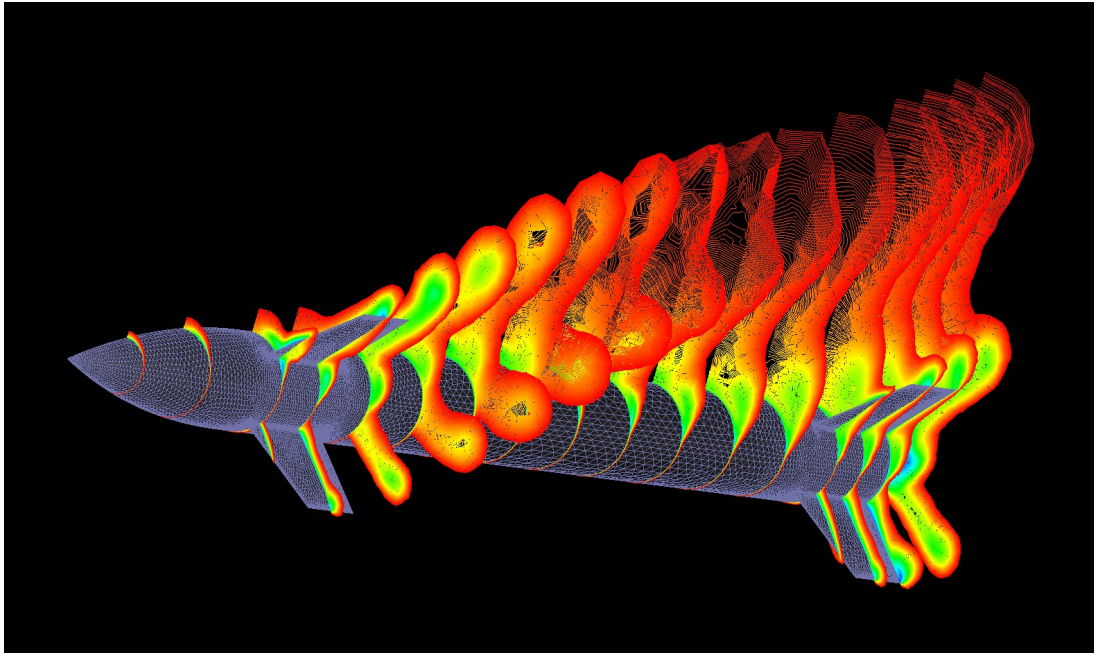


FAPeda Verification for Supersonic Flow

RTO-AVT-082 : Assessments of Turbulent Modeling for High Speed Vehicles

Benchmarking *: NASA Tandem-Control Missile at Mach=1.75, AOA= 6 deg, 24 deg.*

Mesh *: Unstructured, nelem= 4milyon, nnode=719702*



Results with CAEeda

6Deg CA : 0.5974

CN : 2.0869

Case No.	Appendix	Angle of Attack	CN	Cm	CA(p)	CA(f)	CA	Cm/CN	Authors
1		5.946	1.9856	0.8521			0.5594	0.429	Experiment
2	A	6	1.99	0.973	0.239	0.254	0.493	0.489	Khalid and McIlwain
3	B	5.9	2.102	0.819	0.478	0.253	0.731	0.390	Henig
4	C	6	2.032	0.8379	0.2804	0.1902	0.4706	0.412	Prince and Moule
5	C	6	2.0668	0.7708	0.2733	0.1565	0.4298	0.373	Prince and Moule
6	C	6	2.0451	0.8833	0.2736	0.1760	0.4496	0.432	Prince and Moule
7	D	6	2.0706	0.8560	0.4753	0.2127	0.6881	0.413	Leavitt and Pirzadeh
8	D	6	2.0703	0.8206	0.5109	0.2256	0.7365	0.396	Leavitt and Pirzadeh
9	D	6	2.0600	0.8352	0.4910	0.2289	0.7199	0.405	Leavitt and Pirzadeh
10	E	6	1.975	0.909	0.4833	0.1105	0.5938	0.460	Dujardin
11	E	6	2.006	0.864	0.4799	0.1068	0.5875	0.431	Dujardin
12	E	6	2.007	0.894	0.5092	0.2038	0.7121	0.445	Dujardin
13	E	6	2.031	0.923	0.4988	0.1866	0.6845	0.455	Dujardin
14	E	6	1.986	0.908	0.4620	0.1581	0.6198	0.457	Dujardin
15	E	6	2.009	0.847	0.4592	0.1513	0.6104	0.422	Dujardin

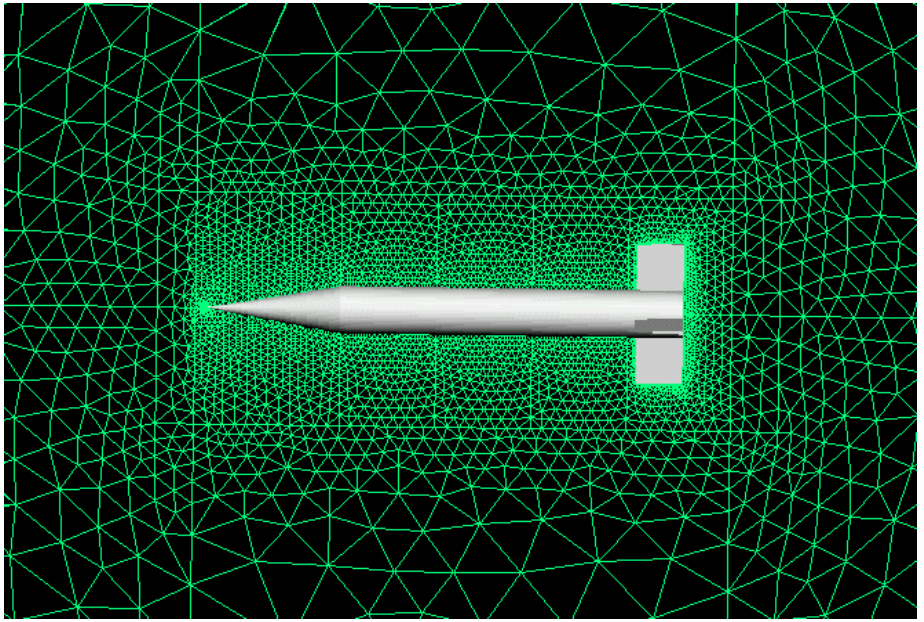
Results with CAEeda

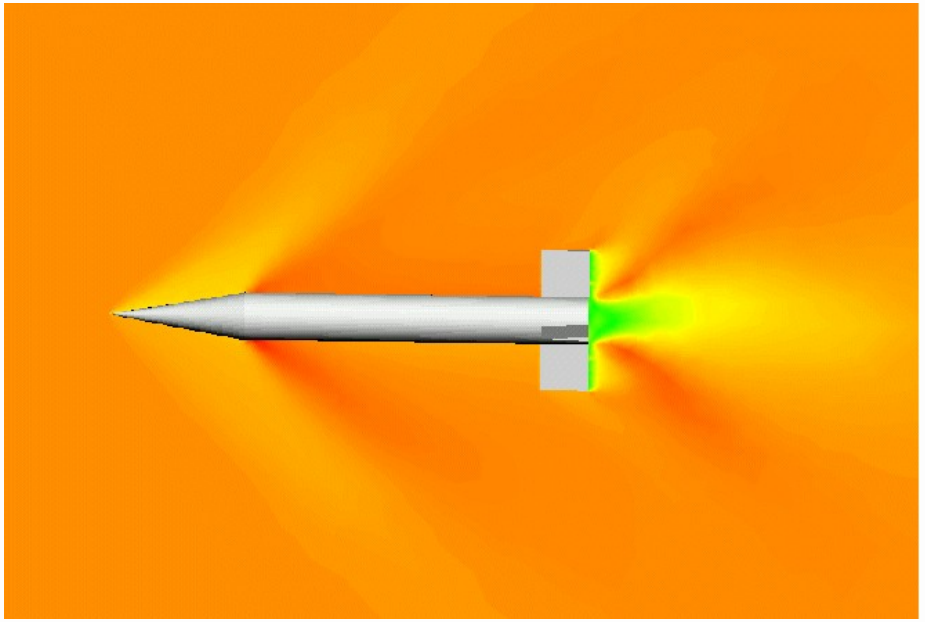
24Deg CA : 0.6001

CN : 10.6177

Case No.	Appendix	Angle of Attack	CN	Cm	CA(p)	CA(f)	CA	Cm/CN	Authors
21		23.978	10.4720	-3.9151			0.5097	-0.374	Experiment
22	A	24	9.89	-3.02	0.250	0.223	0.473	-0.305	Khalid and McIlwain
23	B	24	10.609	-3.87	0.537	0.243	0.708	-0.365	Henig
24	C	24	10.506	-3.8897	0.2482	0.2028	0.4510	-0.370	Prince and Moule
25	C	24	10.5393	-3.5669	0.2406	0.1791	0.4197	-0.338	Prince and Moule
26	C	24	10.5364	-3.615	0.2428	0.1897	0.4325	-0.343	Prince and Moule
28	D	24	10.563	-3.9742	0.5244	0.2142	0.7387	-0.376	Leavitt and Pirzadeh
31	E	24	10.363	-3.680	0.5195	0.1251	0.6447	-0.355	Dujardin
32	E	24	10.202	-3.544	0.5195	0.2049	0.7243	-0.347	Dujardin
33	E	24	10.369	-3.770	0.5343	0.1750	0.7089	-0.364	Dujardin
34	E	24	10.239	-3.853	0.5424	0.2035	0.7403	-0.376	Dujardin
35	E	24	10.364	-3.844	0.5155	0.1890	0.7047	-0.371	Dujardin

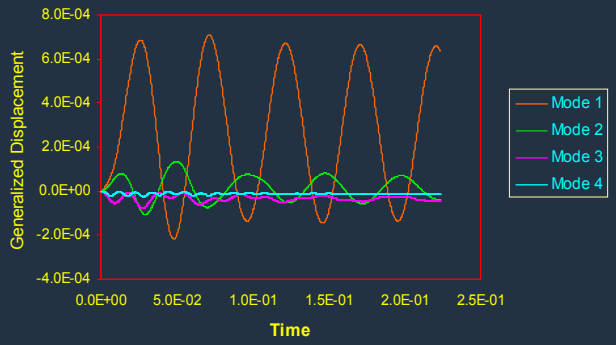
Moving Boundary Calculations for Damping Derivatives

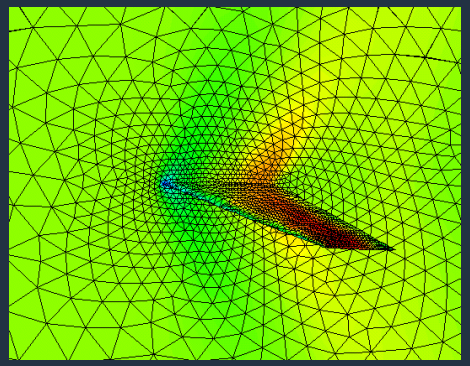


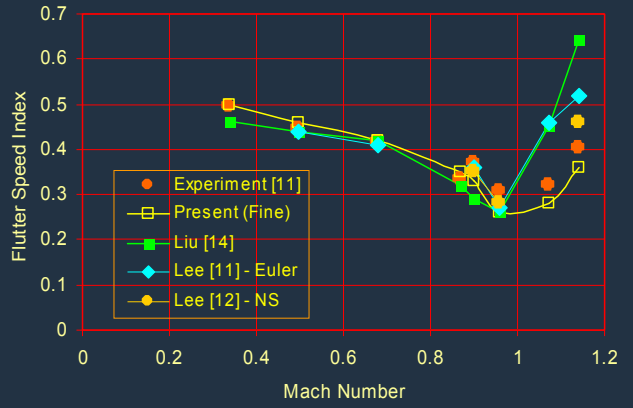


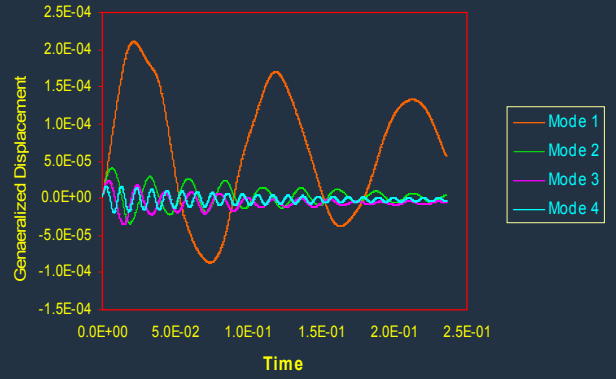
Aeroelastic Analysis - Flutter Analysis

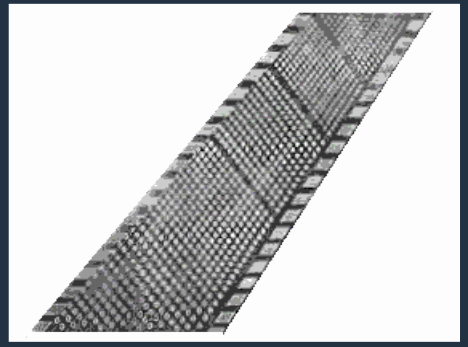
NASA-AGARD 445.6 Wing Aeroelastic Flutter Analysis

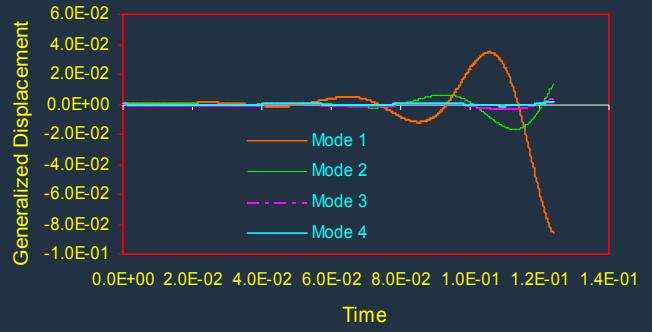








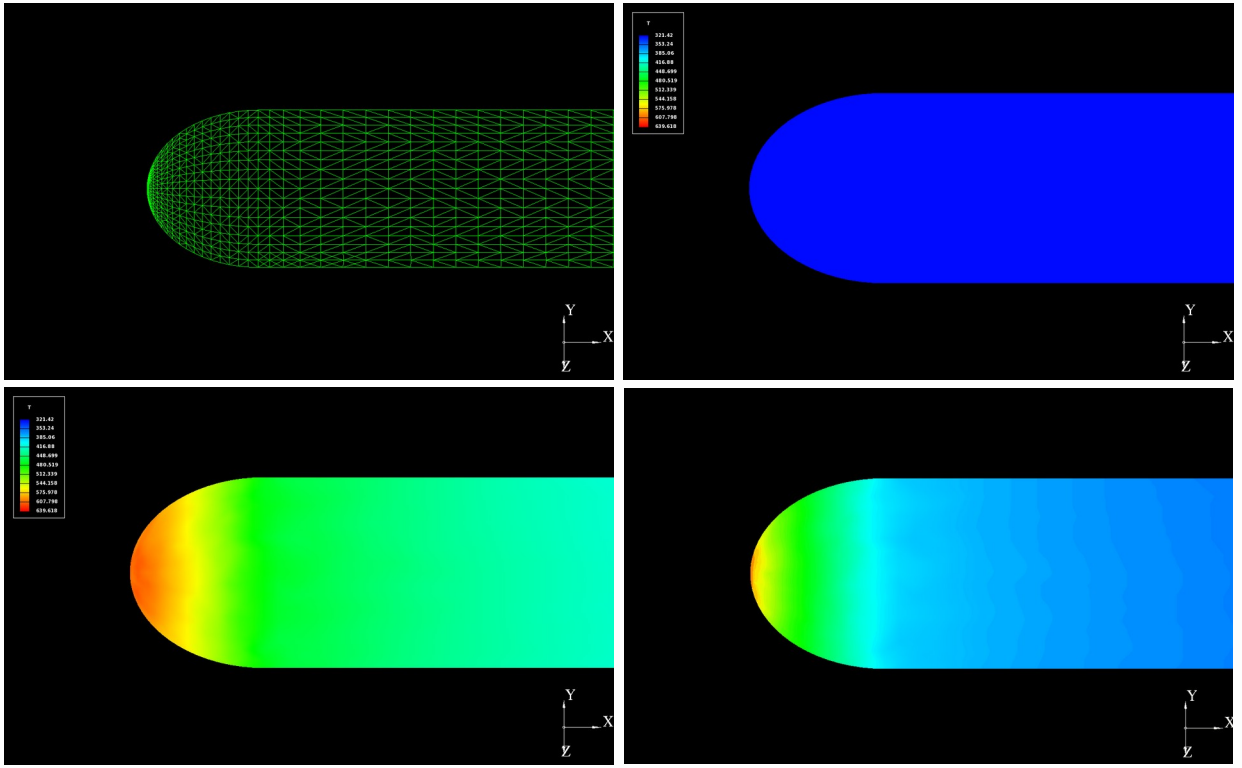




Aerodynamic Heating

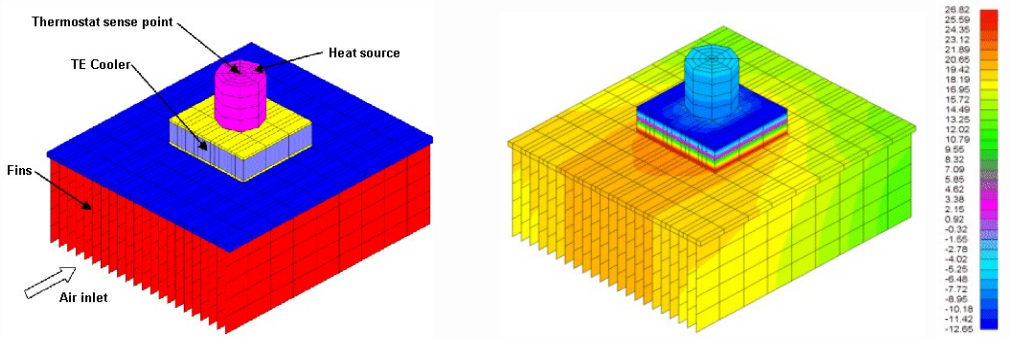
Test : Sphere + Cylinder

Mach : 6.88

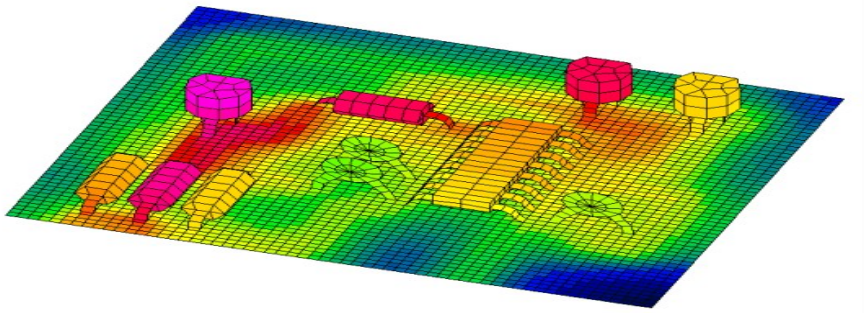


Thermal Analysis

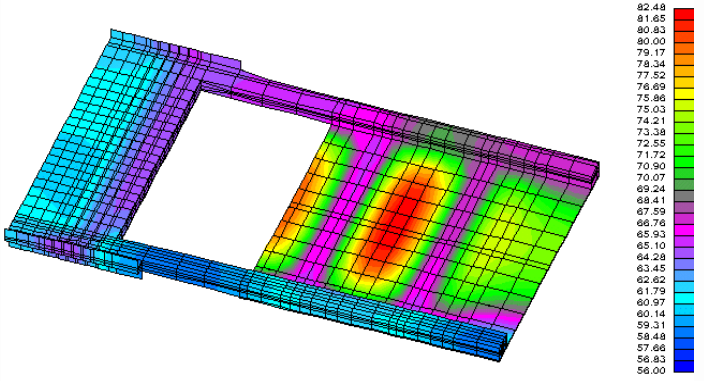
Thermoelectric cooler analysis



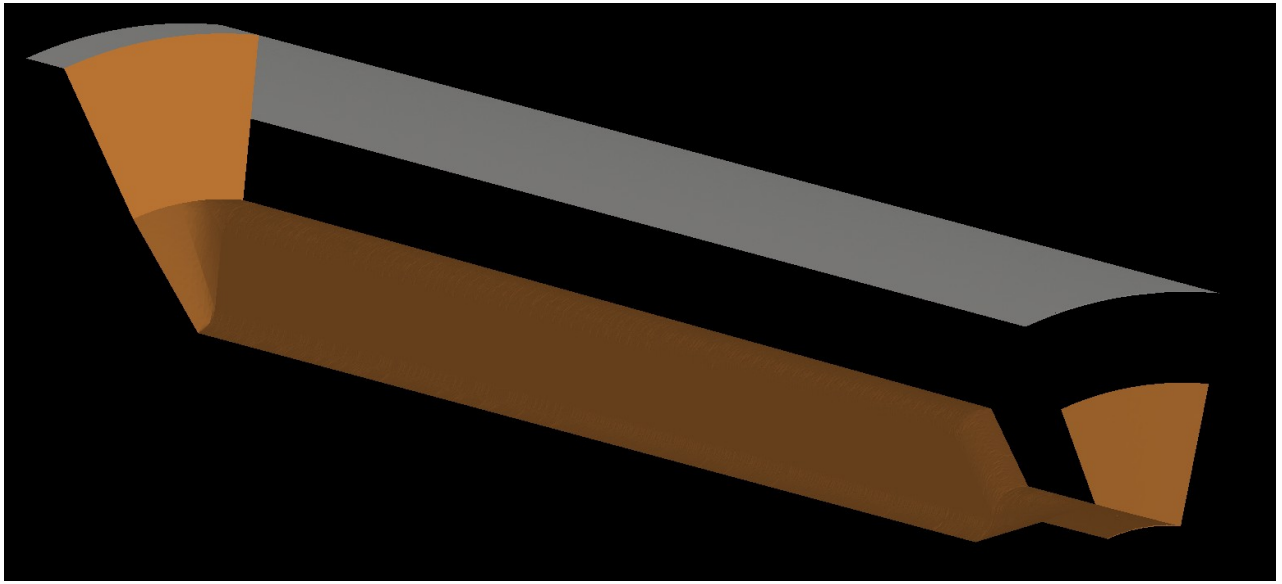
Electronic card heat transfer analysis

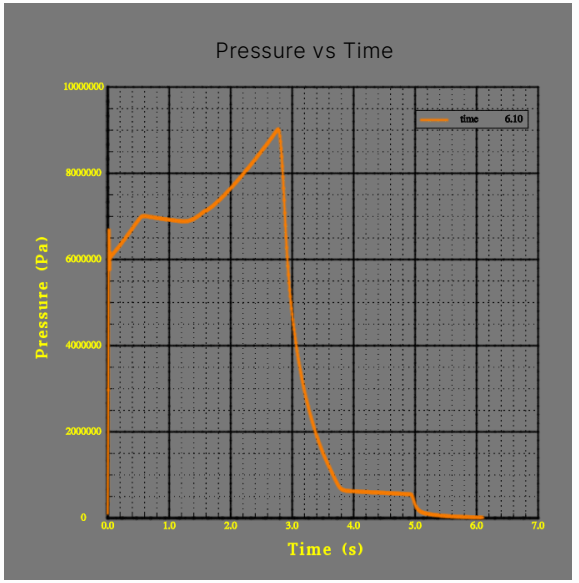


Heat transfer analysis of liquid-cooled plate



Burn-back Analysis of A Solid Rocket Motor





Software Development, Customization & Automation

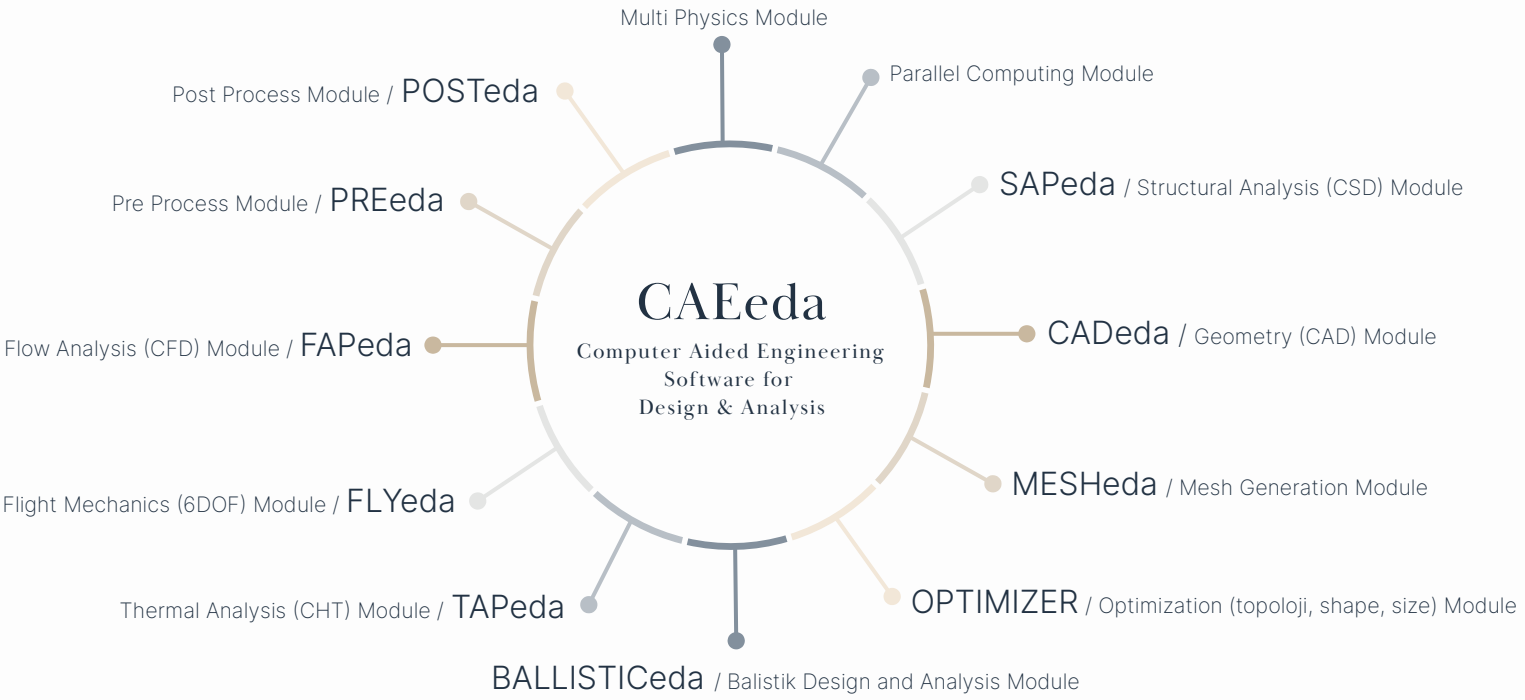
Objective

- To be **independent** in design work and not be bound by any capability limitation
- **To Increase time and cost-effectiveness** of design and analysis studies
- To be able to develop **original advanced technology** products as completely independent

Activities

- Development and **automation** of engineering design and analysis software
- **Customization** of existing engineering software with respect to user requests and needs
- Software **parallelization** for solving large-scale complex problems

Software Products



Software To Be Developed

Our software products to be in service by the end of 2024

FCIpro / Fire Control Input (FCI) Creation Software

TFTpro / Tabular Firing Table (TFT) Creation Software

FCMpro / Fire Control Software

- Calculates the elevation angle and azimuth angle of the barrel to hit the target
- Gives coordinates of the impact point (distance to the weapon and side deviation from the line of sight) and trajectory
- Offers an easy-to-use graphical interface (GUI)
- Provides transformations of weapon and target location according to geographic and grid coordinate systems used in artillery
- Uses a selectable and reliable database that can be sorted with respect to compatible bullets, fuzes and projectiles to be used in the weapon system for any country

Desktop and Mobile Applications of Fire Control Software

- Used to specify a safe firing zone and operation
- Used for preparation of FCI and TFT

FCI & TFT Creation, Fire Control Software

Fire Control Input (FCI) Creation

Preparation of input files (FCI) used by the fire control computer (AKB) during computer-aided firing with a weapon system for all kinds of heavy weapons and ammunition duos

- Howitzer
- Mortar
- Tank

Tabular Firing Table (TFT) Creation

Preparation of Tabular Firing Tables (TFT) for all kinds of heavy weapons and ammunition duos

- Howitzer
- Mortar
- Tank

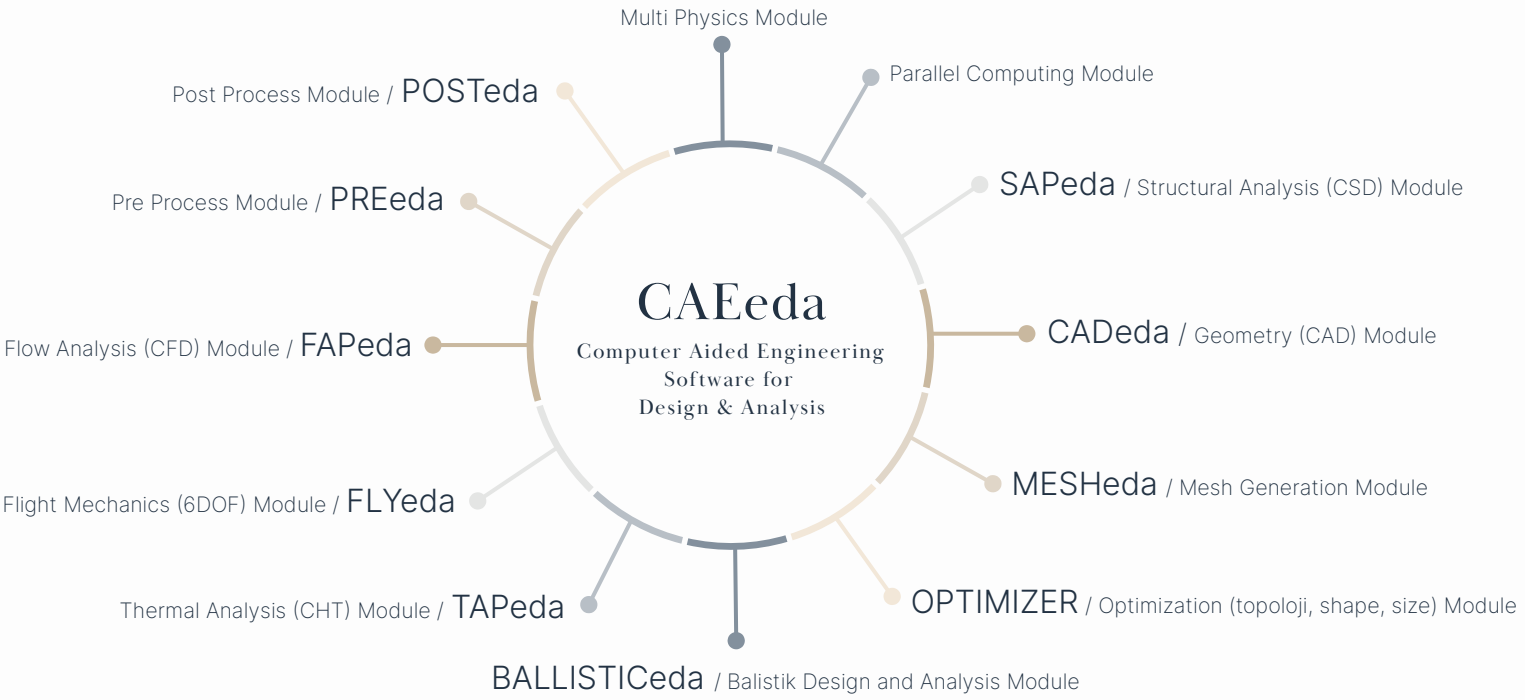
Ability to use Fire Control Software

- NABK-based fire control software
- EDABK-based fire control software

Firing Test Capabilities

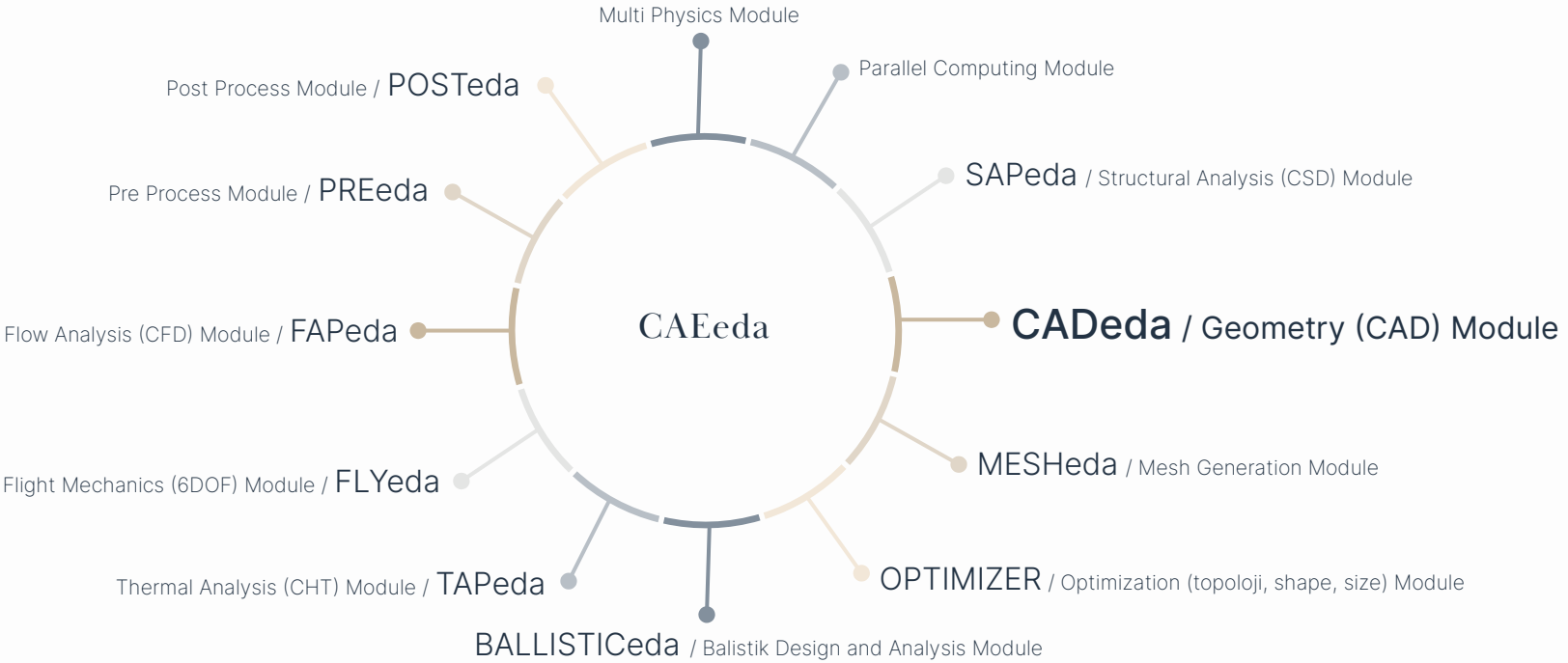
- Planning
  - Defining necessary data to be gathered during firing tests
  - Defining necessary instruments and their use
  - Defining the number of rounds and the number of projectiles
  - Defining quadrant elevation, azimuth angle, and propellant temperature ranges
- Support & Consultancy
  - Participating in firing tests as an observer and adviser

SOFTWARE PRODUCTS


Multi Physics Module
Parallel Computing Module
SAPeda / Structural Analysis (CSD) Module
CADeda / Geometry (CAD) Module
MESHeda / Mesh Generation Module
OPTIMIZER / Optimization (topoloji, shape, size) Module
BALLISTICeda / Balistik Design and Analysis Module
Thermal Analysis (CHT) Module / TAPeda
Flight Mechanics (6DOF) Module / FLYeda
Flow Analysis (CFD) Module / FAPeda
Pre Process Module / PREeda
Post Process Module / POSTeda
CAEeda
Computer Aided Engineering Software for Design & Analysis

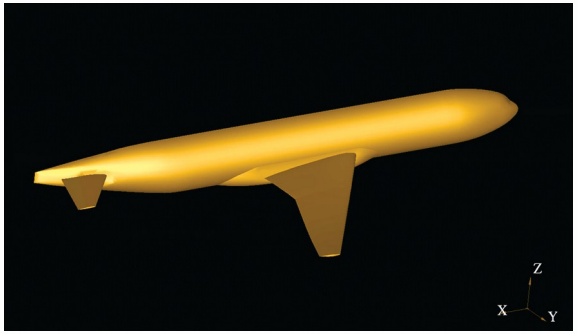
CAEeda™ Capabilities

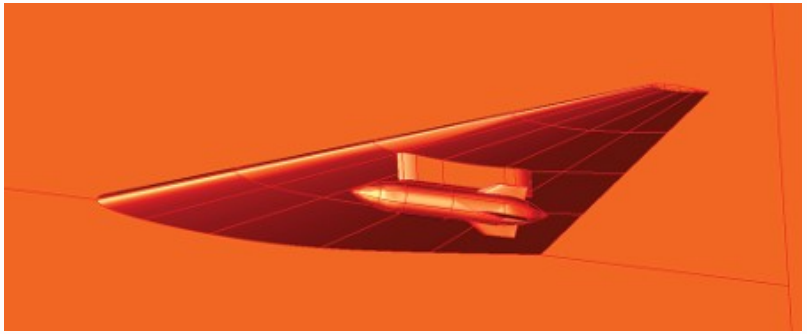
- All engineering design & analysis studies in one
- Interactive engineering design automation and optimization
- Parametric 3D (CAD) geometry creation
- Structural topology, shape and size optimization
- Aerodynamic shape optimization and automation with CST-NURB method
- To be interactively run with other commercial software
- Suitable for use in parallel computers
- Customizable according to user needs
- Verified with internationally recognized test cases
- User-friendly interface with multilingual support

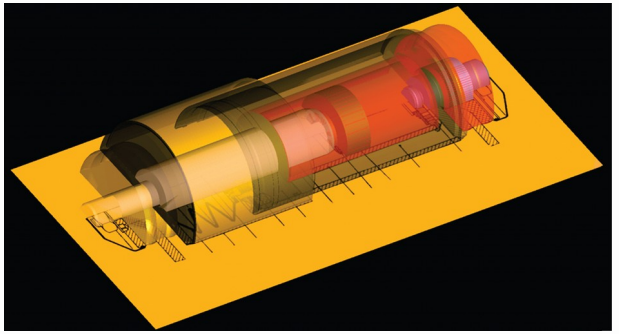

Multi Physics Module
Parallel Computing Module
SAPeda / Structural Analysis (CSD) Module
CADeda / Geometry (CAD) Module
MESHeda / Mesh Generation Module
OPTIMIZER / Optimization (topoloji, shape, size) Module
BALLISTICeda / Balistik Design and Analysis Module
Thermal Analysis (CHT) Module / TAPeda
Flight Mechanics (6DOF) Module / FLYeda
Flow Analysis (CFD) Module / FAPeda
Pre Process Module / PREeda
Post Process Module / POSTeda
CAEeda

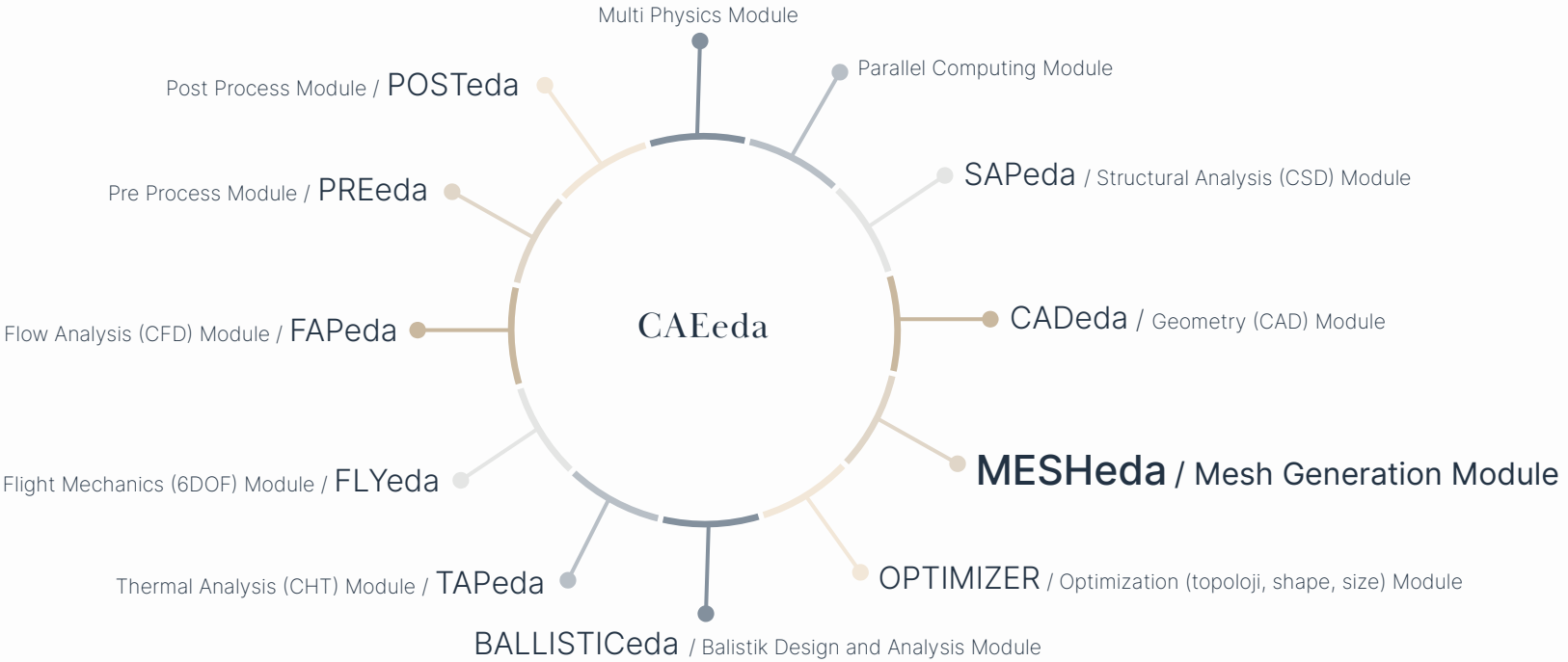
CADeda (Geometry CAD Module)

- A geometric modeling software that allows **2D or 3D complex geometries** to be modeled easily and **parametrically** in a very short time using different methods and functions at **the desired level of precision**
- Thanks to its **catalog** of frequently used geometries such as aircraft wings, rocket outer geometry, etc.
  - **Parametric** and **automatic** generation of these geometries
  - Interactive **improvement** with aerodynamic and structural optimization algorithms
- **Customizable** depending on user requests and needs



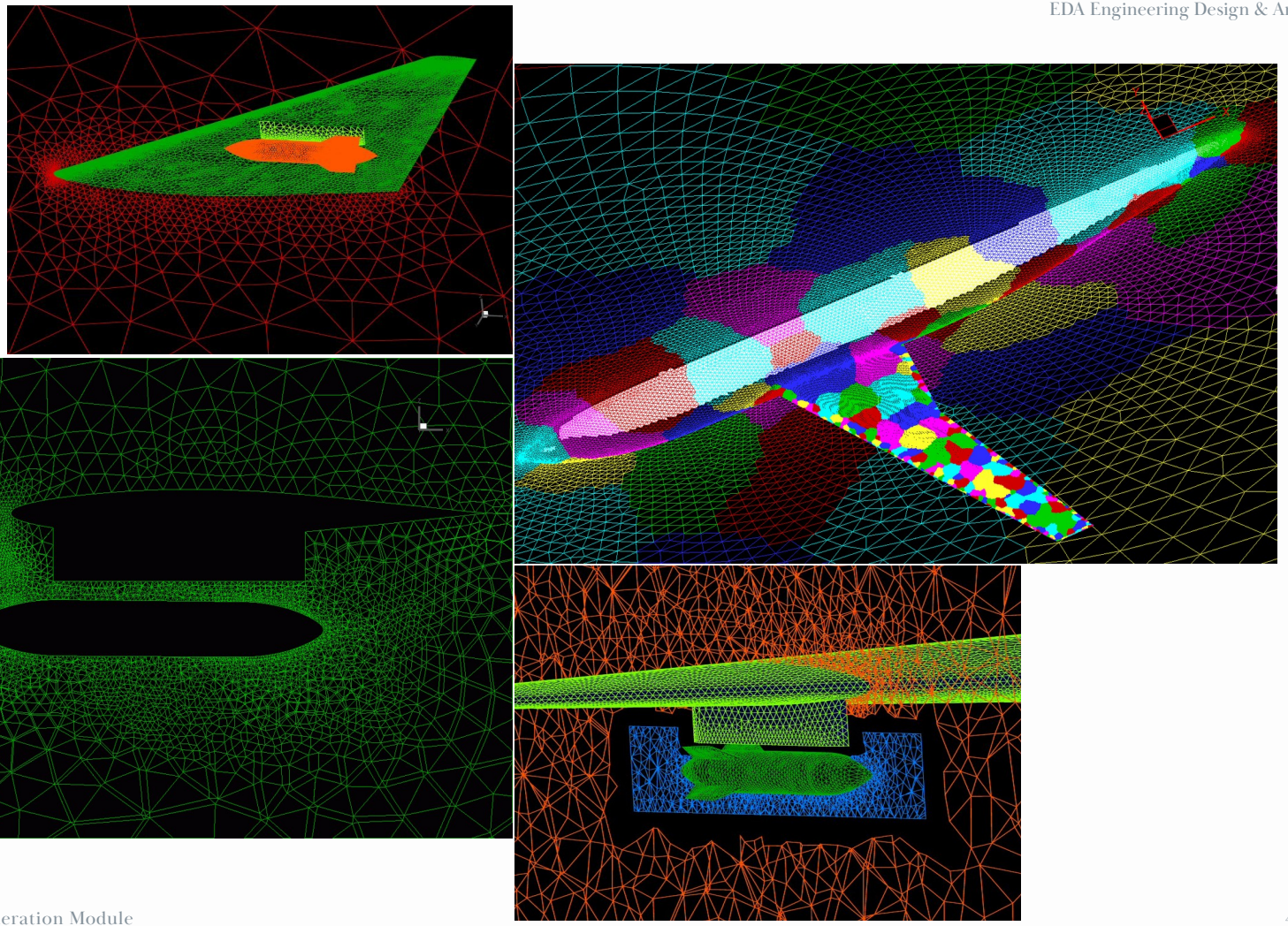


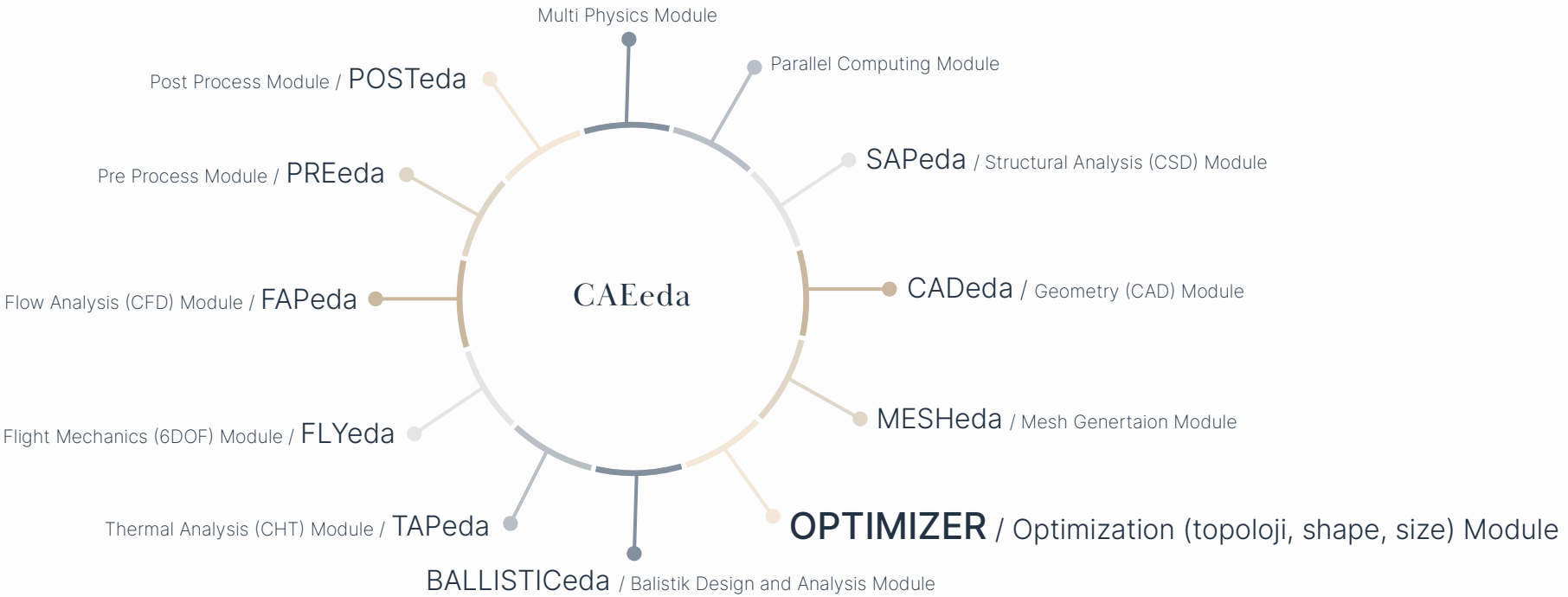



Multi Physics Module
Parallel Computing Module
SAPeda / Structural Analysis (CSD) Module
CADeda / Geometry (CAD) Module
MESHeda / Mesh Generation Module
OPTIMIZER / Optimization (topoloji, shape, size) Module
BALLISTICeda / Balistik Design and Analysis Module
Thermal Analysis (CHT) Module / TAPeda
Flight Mechanics (6DOF) Module / FLYeda
Flow Analysis (CFD) Module / FAPeda
Pre Process Module / PREeda
Post Process Module / POSTeda
CAEeda

MESHeda (Mesh Generation Module)

- Generation of 2D and 3D structured and unstructured surfaces and volume mesh based on parametric surfaces or triangulated surfaces
- Improvement of existing mesh by making relevant parametric definitions
- Can be used for finite element structural and thermal analysis and finite volume flow analysis
  - Interact with PREeda (pre-processor module of CAEeda™) to define boundary conditions and material properties
  - Decompose the unstructured mesh for parallel computing
- Automatic geometry creation and mesh generation with respect to parameters defined by design manager software during design automation and optimization runs
- Customizable depending on user requests and needs




Multi Physics Module
Parallel Computing Module
SAPeda / Structural Analysis (CSD) Module
CADeda / Geometry (CAD) Module
MESHeda / Mesh Genertaion Module
OPTIMIZER / Optimization (topoloji, shape, size) Module
BALLISTICeda / Balistik Design and Analysis Module
Thermal Analysis (CHT) Module / TAPeda
Flight Mechanics (6DOF) Module / FLYeda
Flow Analysis (CFD) Module / FAPeda
Pre Process Module / PREeda
Post Process Module / POSTeda
CAEeda

OPTIMIZER (Optimization Module)

- Reduction of building weight, determination of material usage, shaping and dimensioning processes to achieve the best design to meet the target design criteria

 Topology Optimization

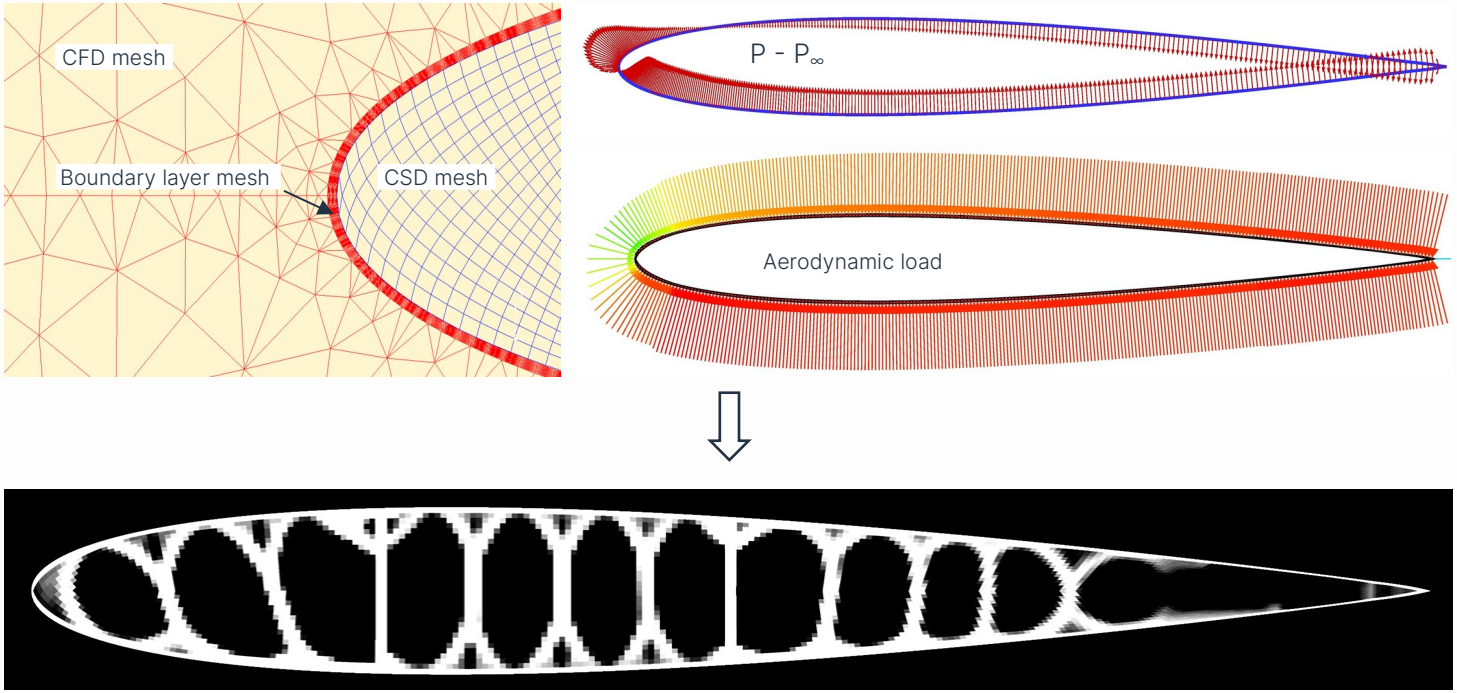
 Shape Optimization

 Size Optimization

- Method :
  - Deciding on the physical model and the geometric parameters to be changed as well as the constraints for change
  - Interactive running of physical model software and geometric model software under the management of optimization software based on an evolutionary model ("Genetic Algorithm")
  - Directing the change of geometry according to the objective and penalty functions determined by the designer
  - Stopping the runs when the targeted objective value is reached and obtaining the optimum design shape with the desired properties
  - Ability to utilize parallel computer clusters and grid infrastructure consisting of parallel clusters since it requires a large number of physics solutions

Topology Optimization using Parallel CFD - CSD Interaction for Aircraft Wing Structural Design*

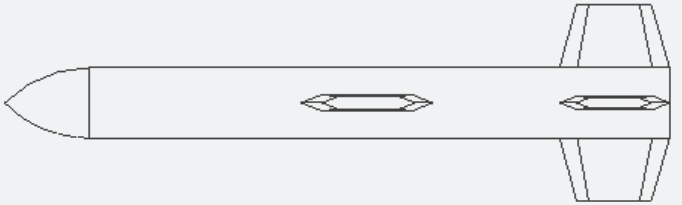
* *Oktay, E., Akay, H., Merttopcuoglu, O., "Parallelized Structural Topology Optimization and CFD Coupling For Design of Aircraft Wing Structures ", Computers & Fluids, Vol. 49, October 2011, pp.141-145.*



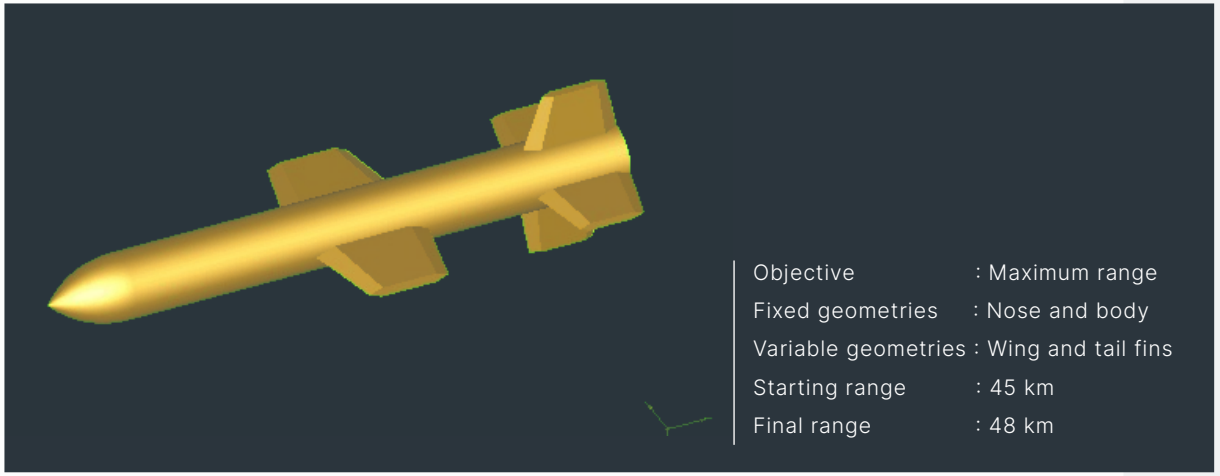
CAD, MESH, CFD Coupling for Design Automation and Optimization

Sample Application :

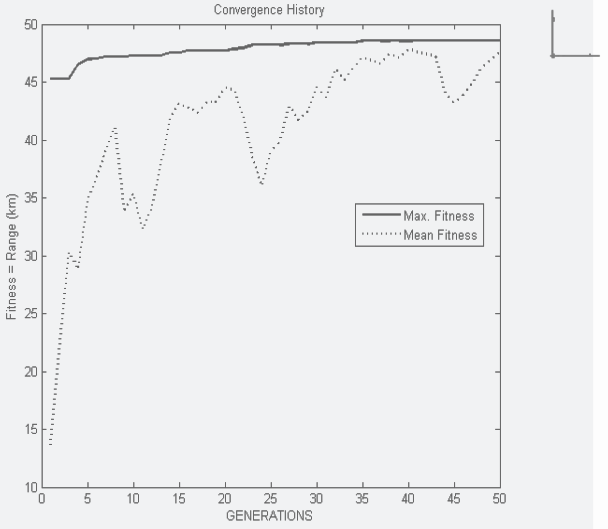
Wing and Tail Shape Optimization to Extend the Range of a Missile



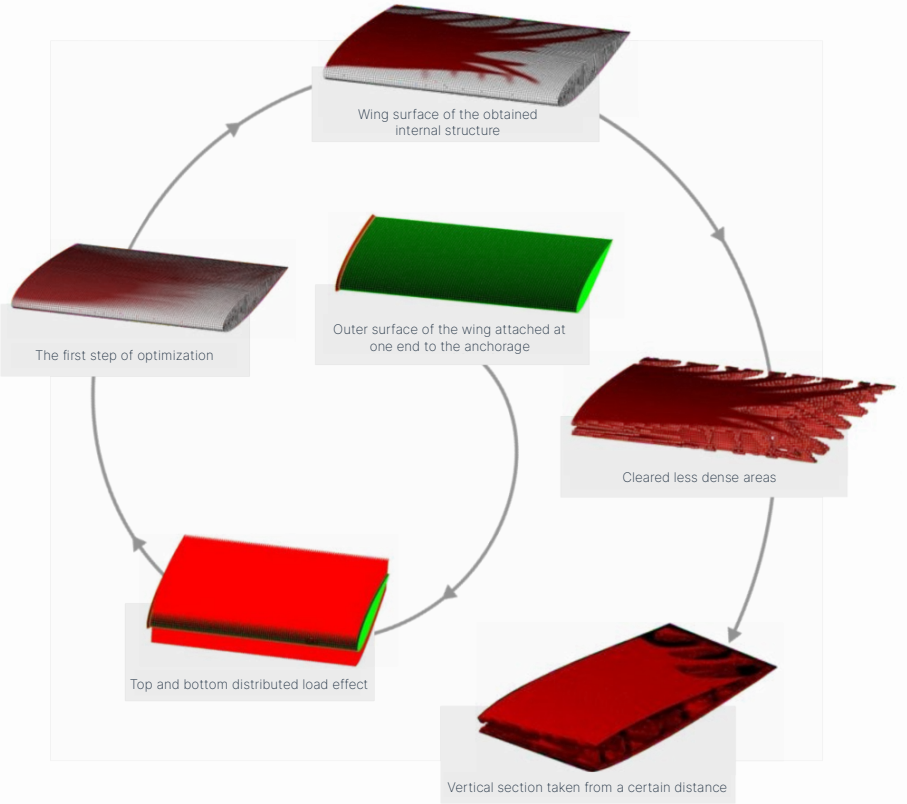
Design Parametrization



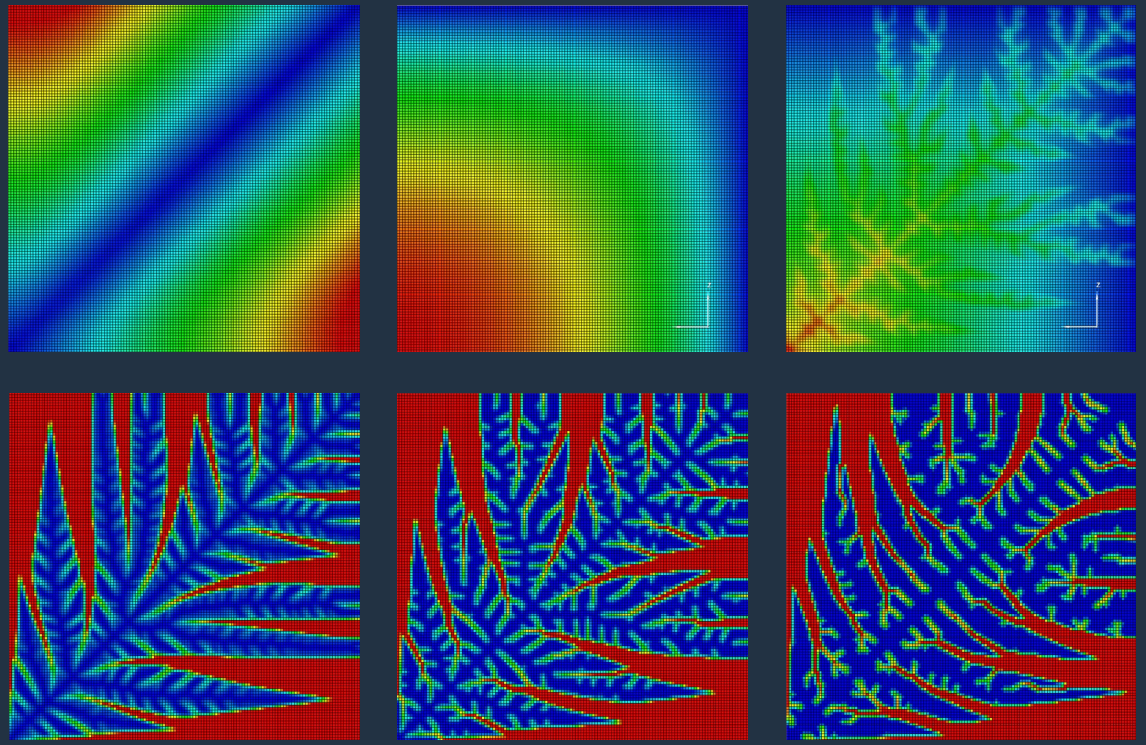
Objective	: Maximum range
Fixed geometries	: Nose and body
Variable geometries	: Wing and tail fins
Starting range	: 45 km
Final range	: 48 km



Interior structure of a mono-block mini UAV wing under aerodynamic loads

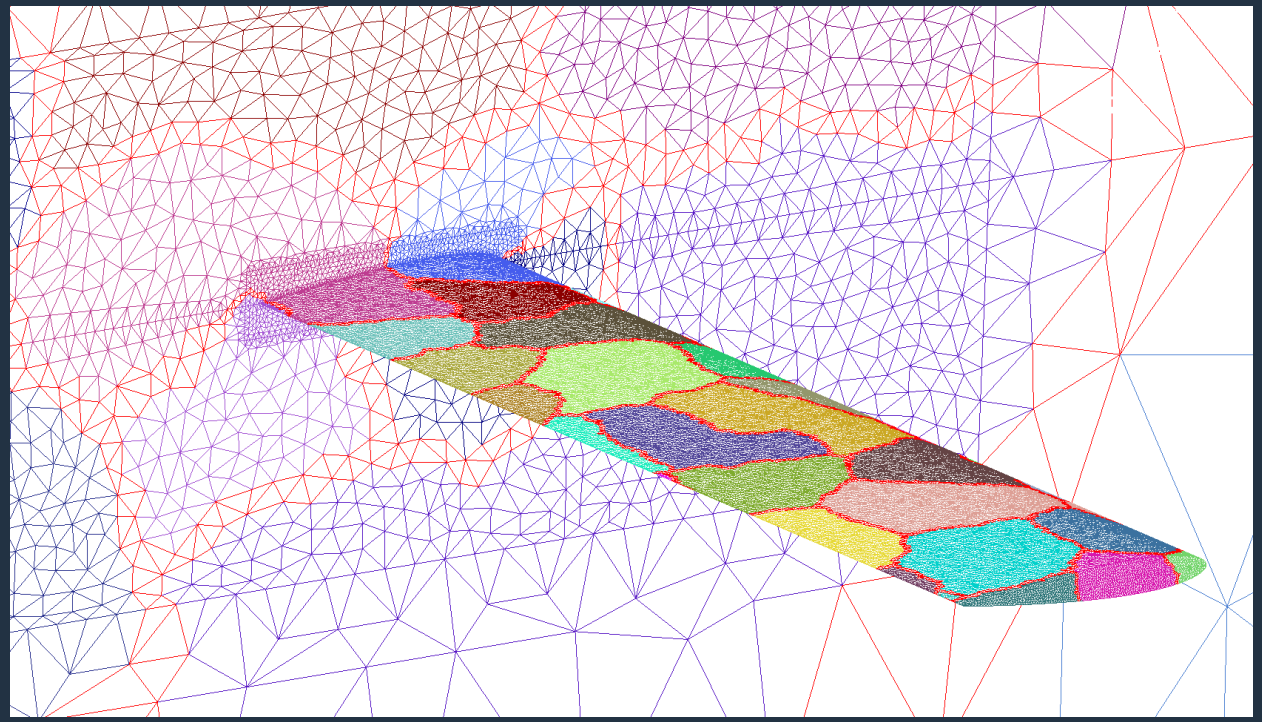


Topology Optimization for Thermal Cooling

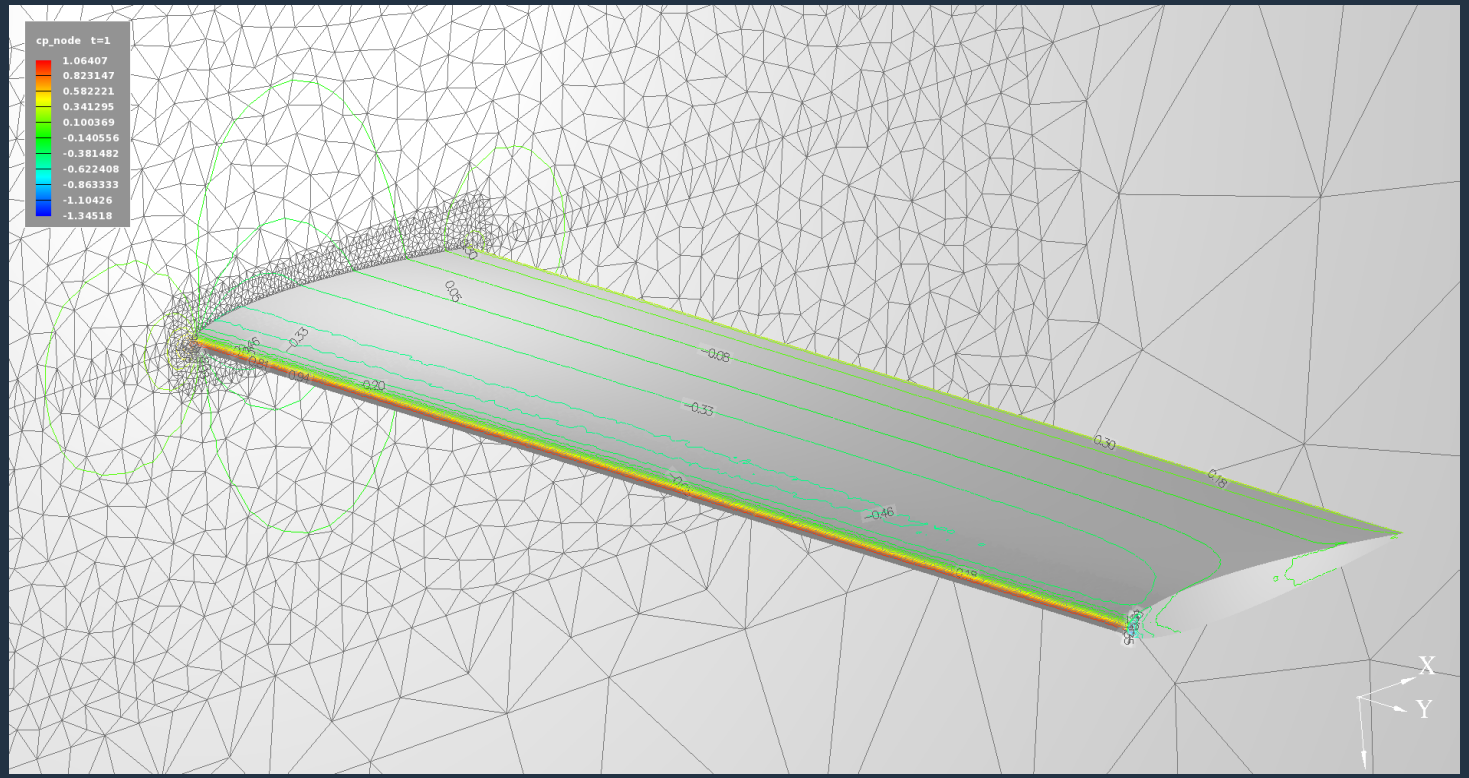


Structural Topology Optimization and Design of UAV Wing

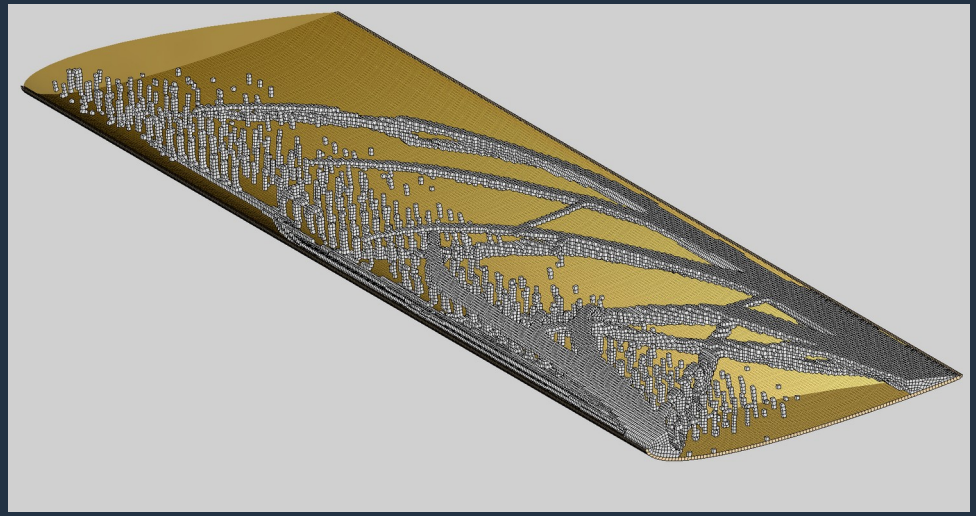
Unstructed mesh for parallel computing

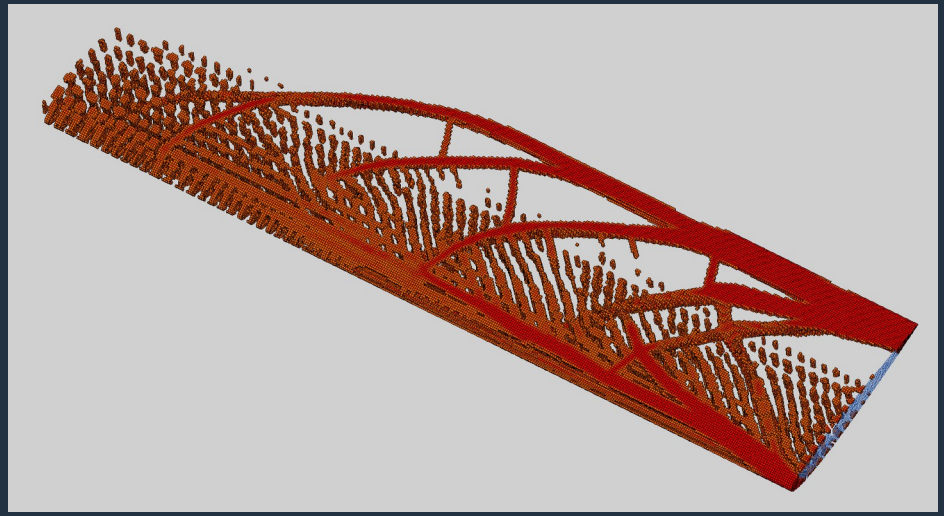


Aerodynamic Solution

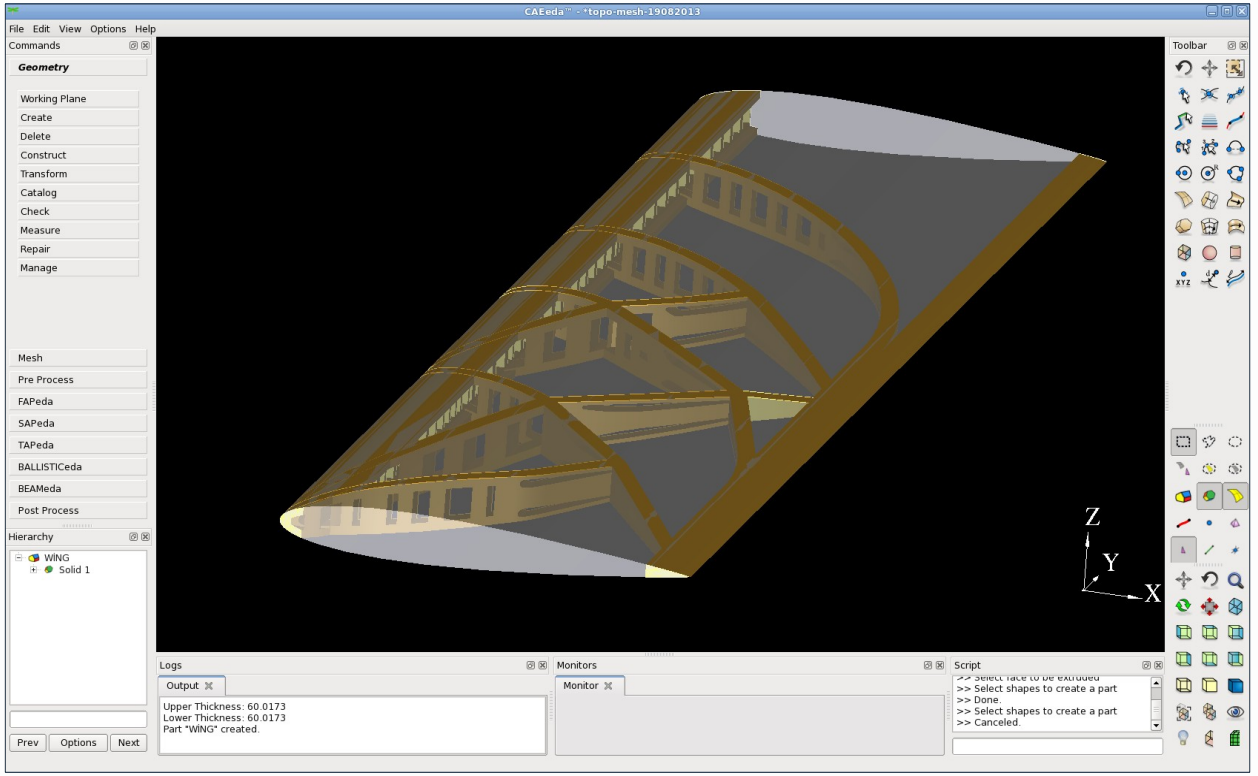


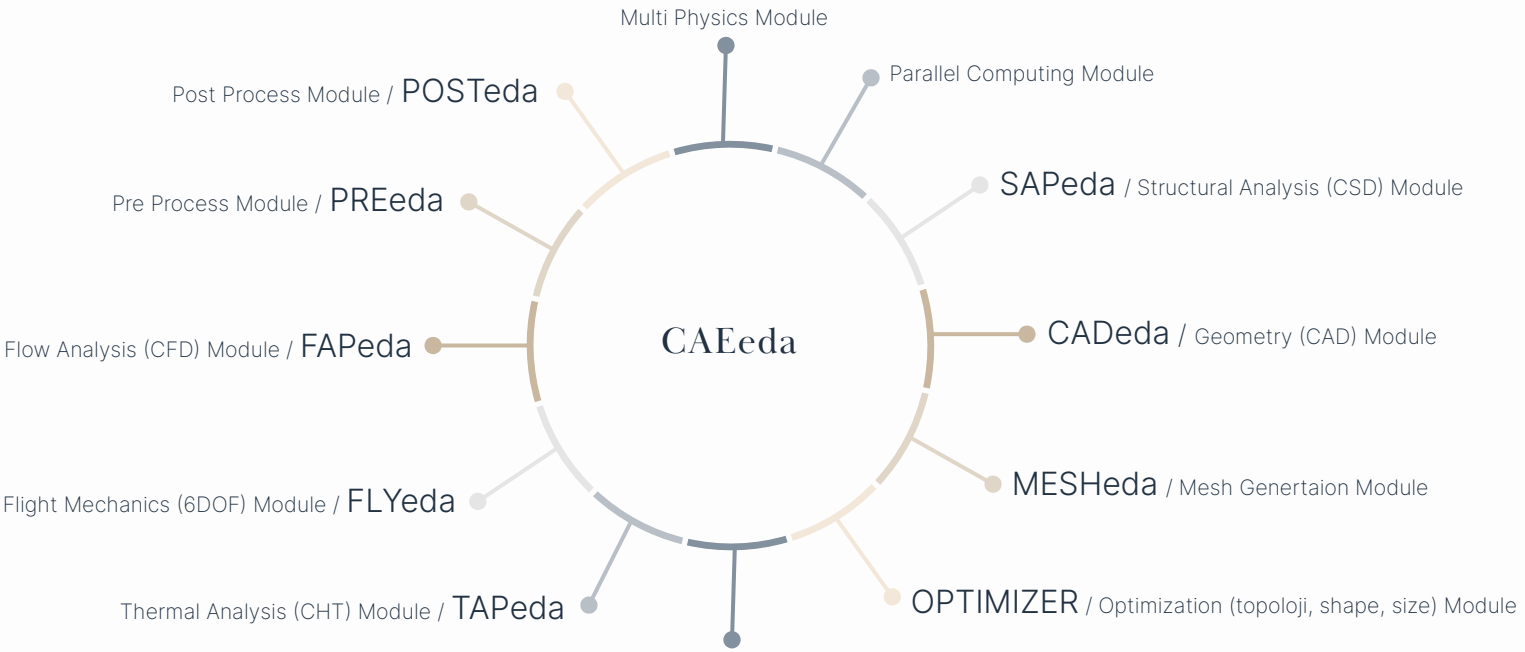
Topology Obtained As A Result Of The Solution





New Design Of Lightened Wing Obtained By Topology Optimization

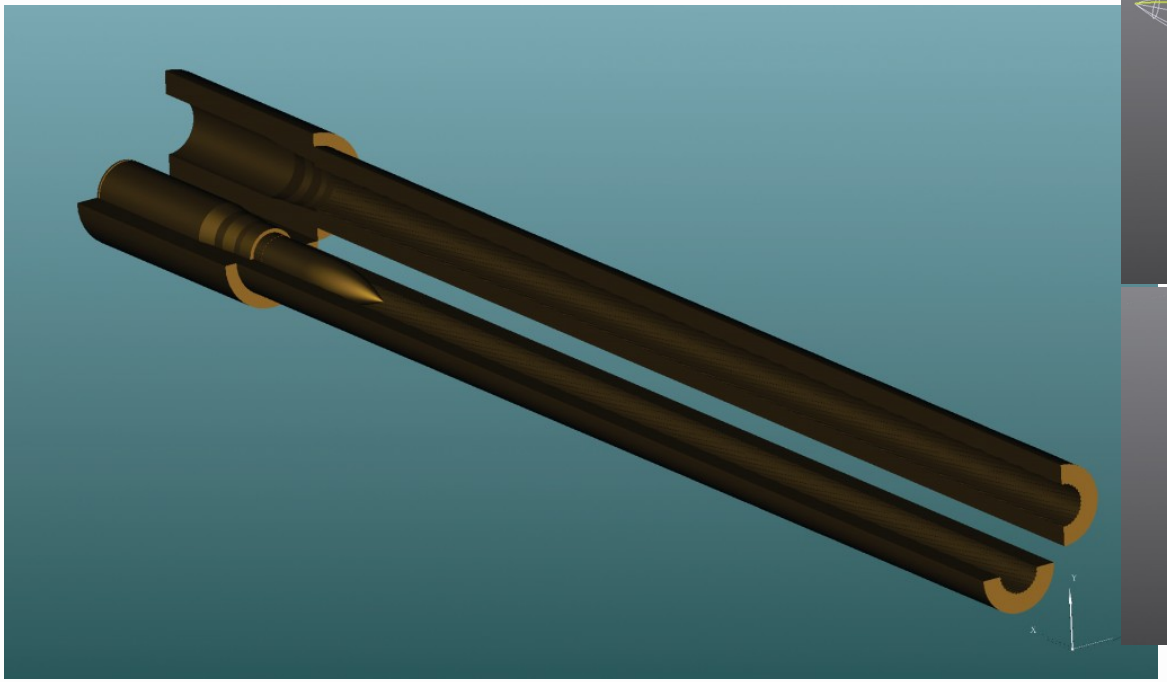


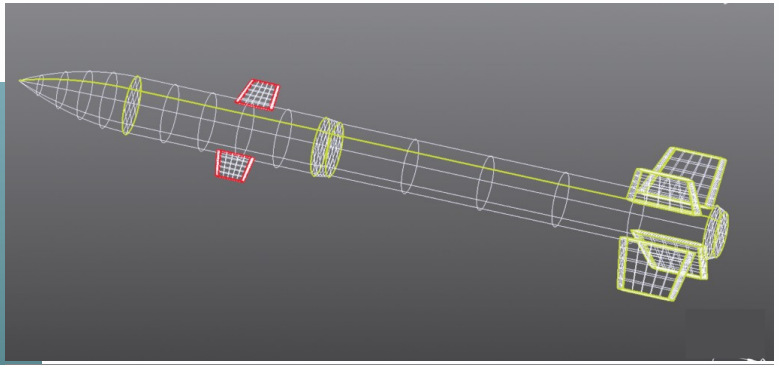

Multi Physics Module
Parallel Computing Module
SAPeda / Structural Analysis (CSD) Module
CADeda / Geometry (CAD) Module
MESHeda / Mesh Genertaion Module
OPTIMIZER / Optimization (topoloji, shape, size) Module
BALLISTICeda / Balistik Design and Analysis Module
Thermal Analysis (CHT) Module / TAPeda
Flight Mechanics (6DOF) Module / FLYeda
Flow Analysis (CFD) Module / FAPeda
Pre Process Module / PREeda
Post Process Module / POSTeda
CAEeda

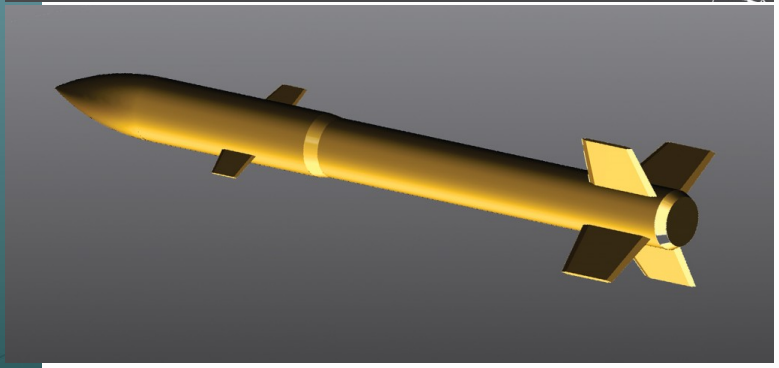
BALLISTICeda (Ballistic Design and Analysis Module)

- Ballistic design and analysis of missiles and projectiles
- Automatic and parametric creation of solid models of 3D projectile and missile geometries and transfer of these models to analysis modules under the management of CAEeda™'s design automation and optimization module
- Customizable depending on user requests and needs
- Modules
  - GEOMETRY MODELING AND DESIGN
  - AERODYNAMIC CALCULATIONS
  - FLIGHT MECHANICS CALCULATIONS
  - INTERNAL BALLISTICS
  - POST PROCESSOR

Geometry Module

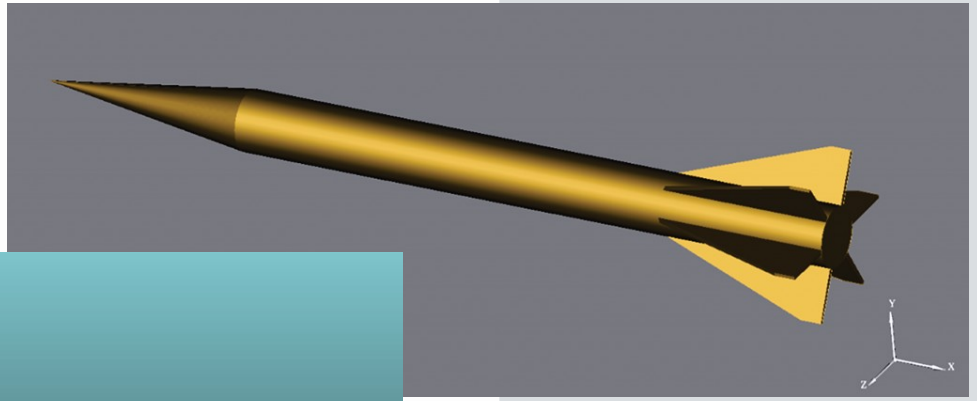


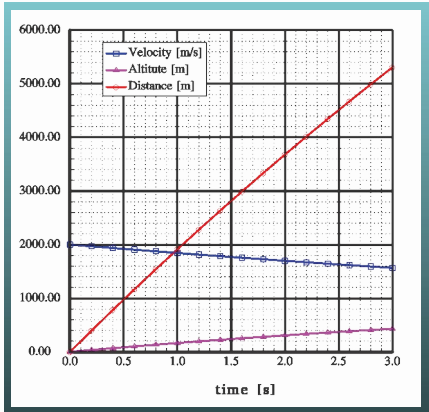


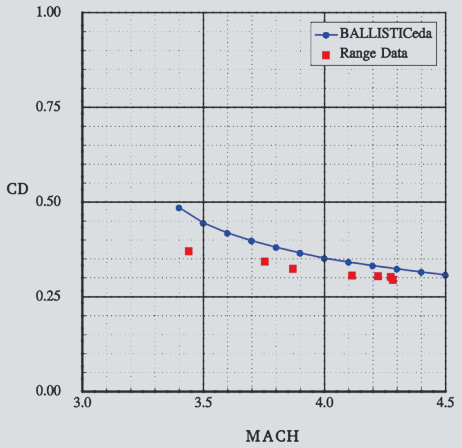


Flight Mechanics Module

- Trajectory Analysis
- Sensitivity Analysis
- Dispersion Analysis
- Hit Target Analysis
- Cross Plane Analysis
- Stability Analysis
- Drag Extraction Analysis

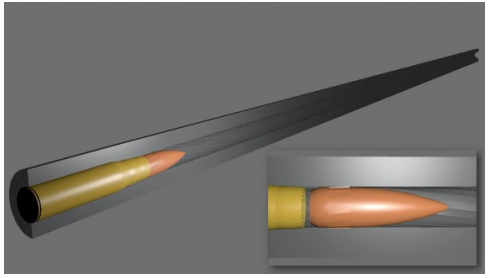
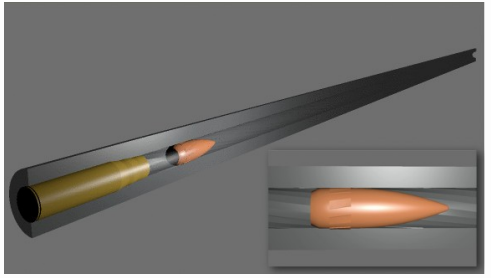
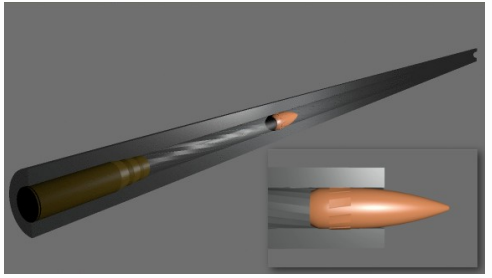




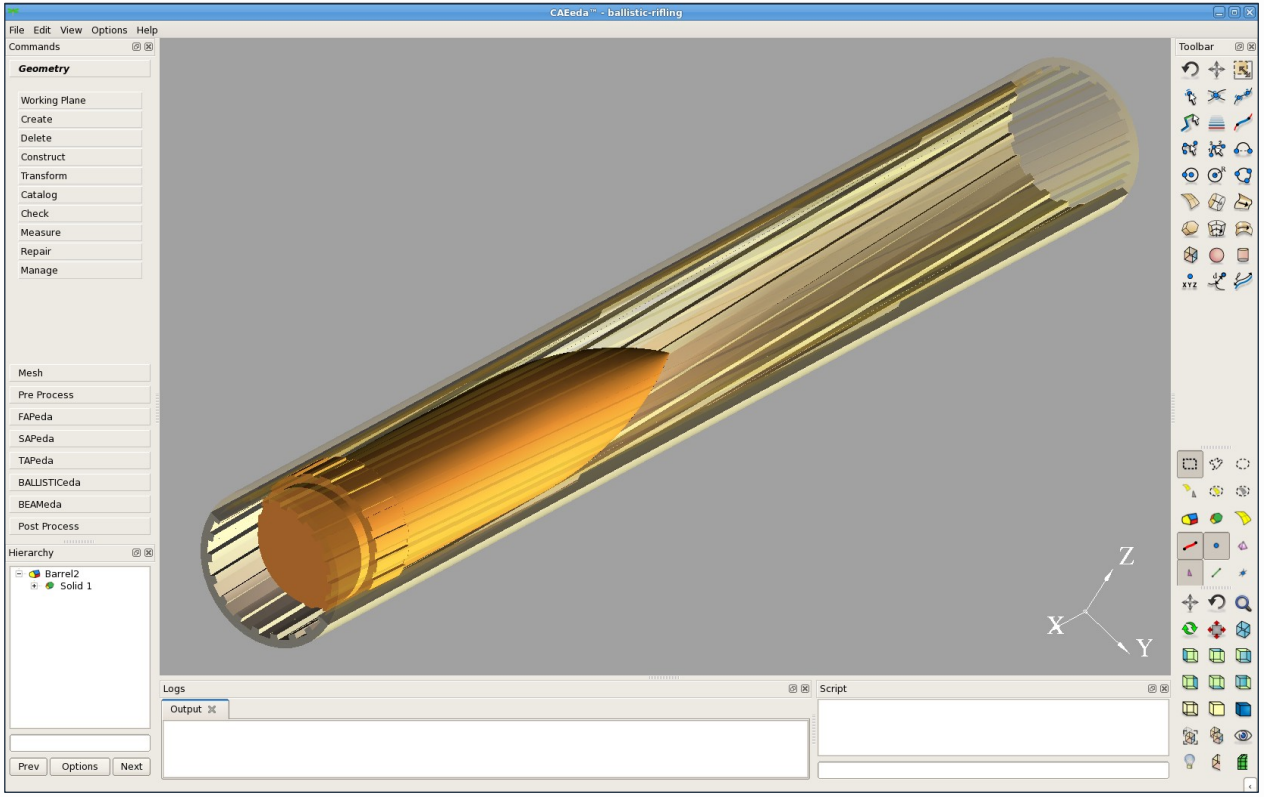


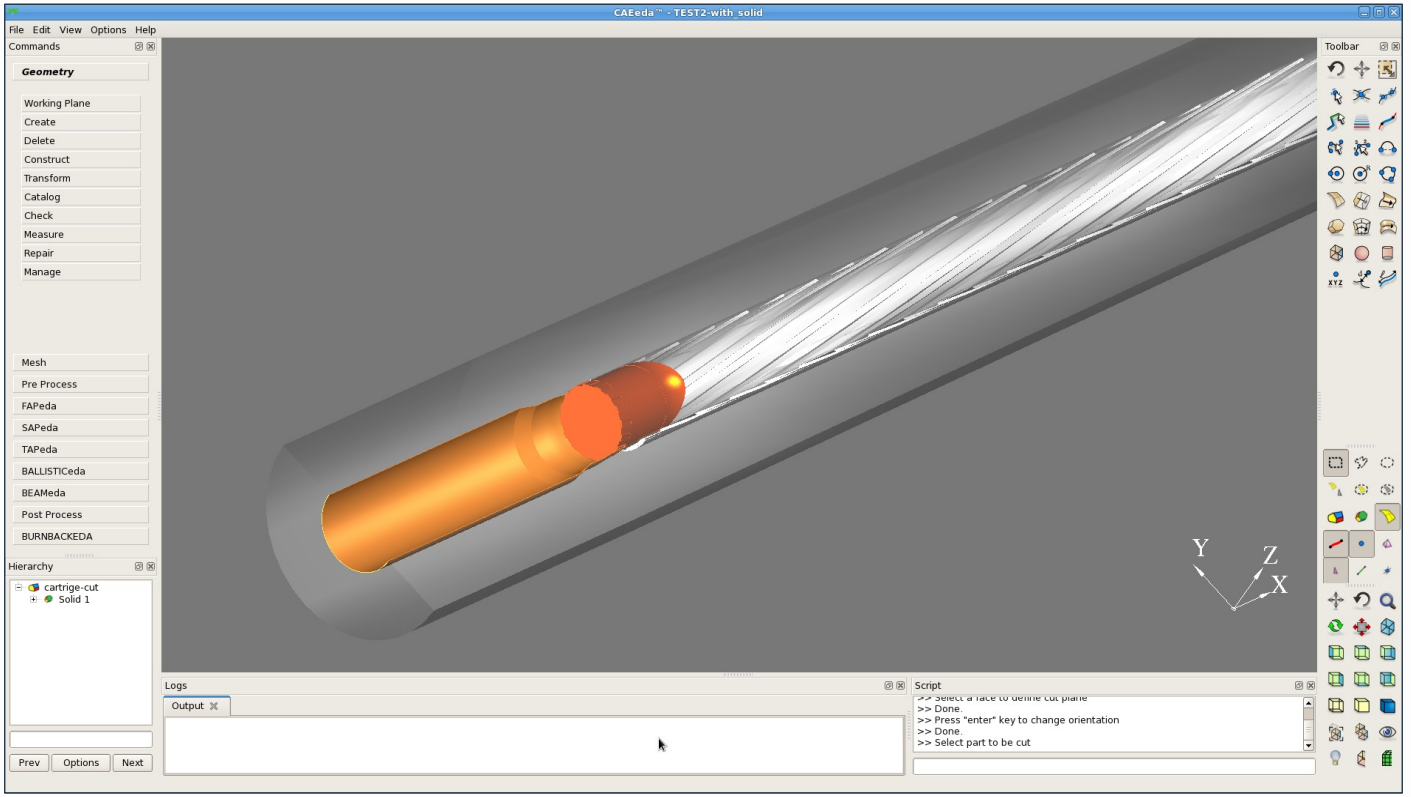
Internal Ballistics Module

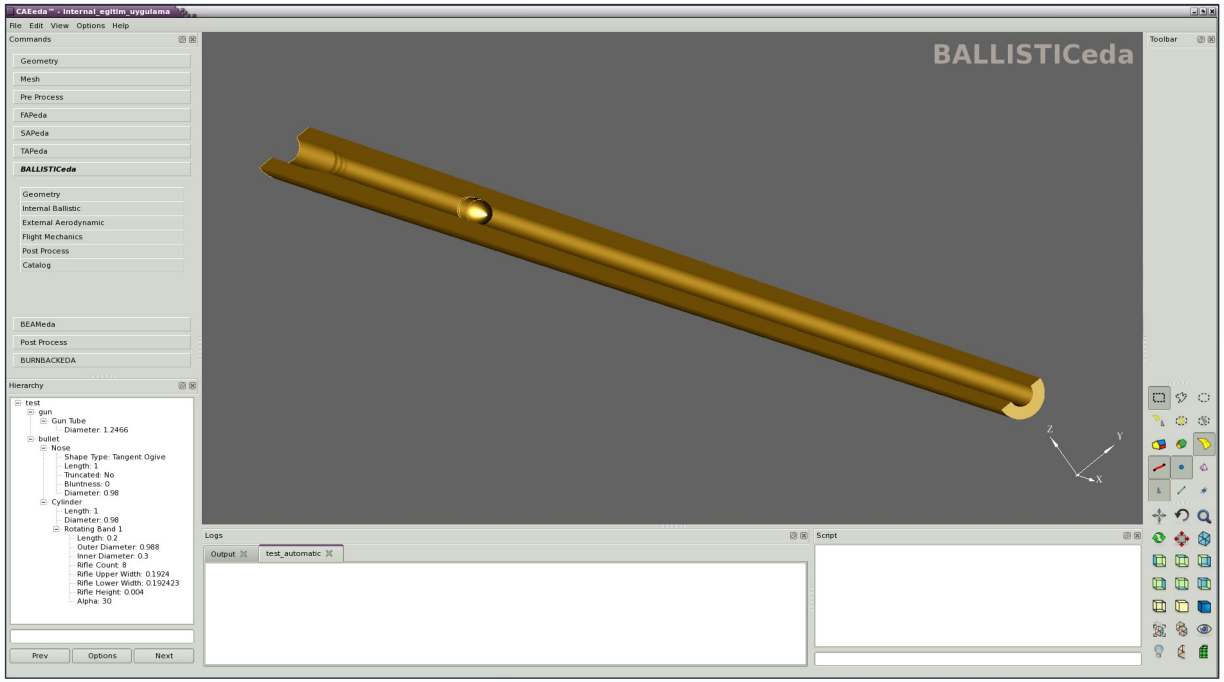
- One-dimensional thermodynamic internal ballistic modeling with global parameters
- Bullet rotational motion simulation in a rifled barrel
- Combustion, thermodynamics and gas dynamics calculations
- Resistance pressure and drive ring wear calculations
- Rearranging internal ballistic calculations according to fuel temperature to match combustion chamber pressure or muzzle velocity to experimental results due to uncertainties in fuel properties
- Time dependent calculations (back and wedge pressure, gas and surface temperature, projectile speed, acceleration, rotation, path, total and detailed energy losses)
- Barrel structural strength analysis due to mono-block and multilayer thin wall structures

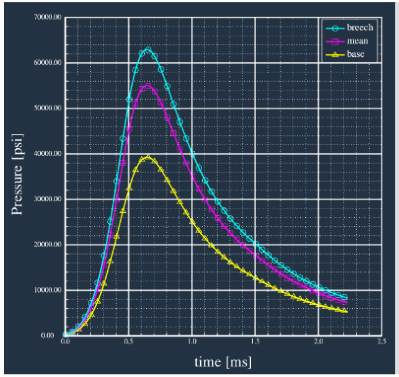




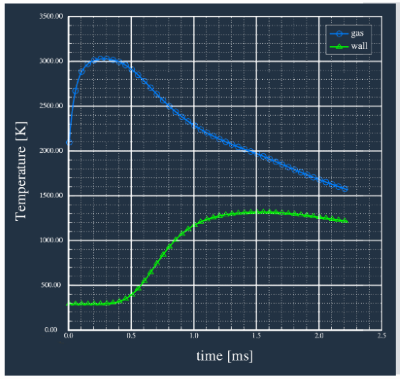
Design & Analysis of Projectile and Barrel

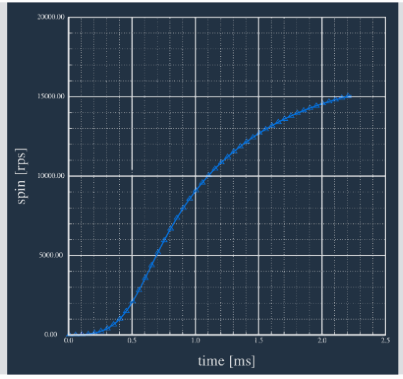


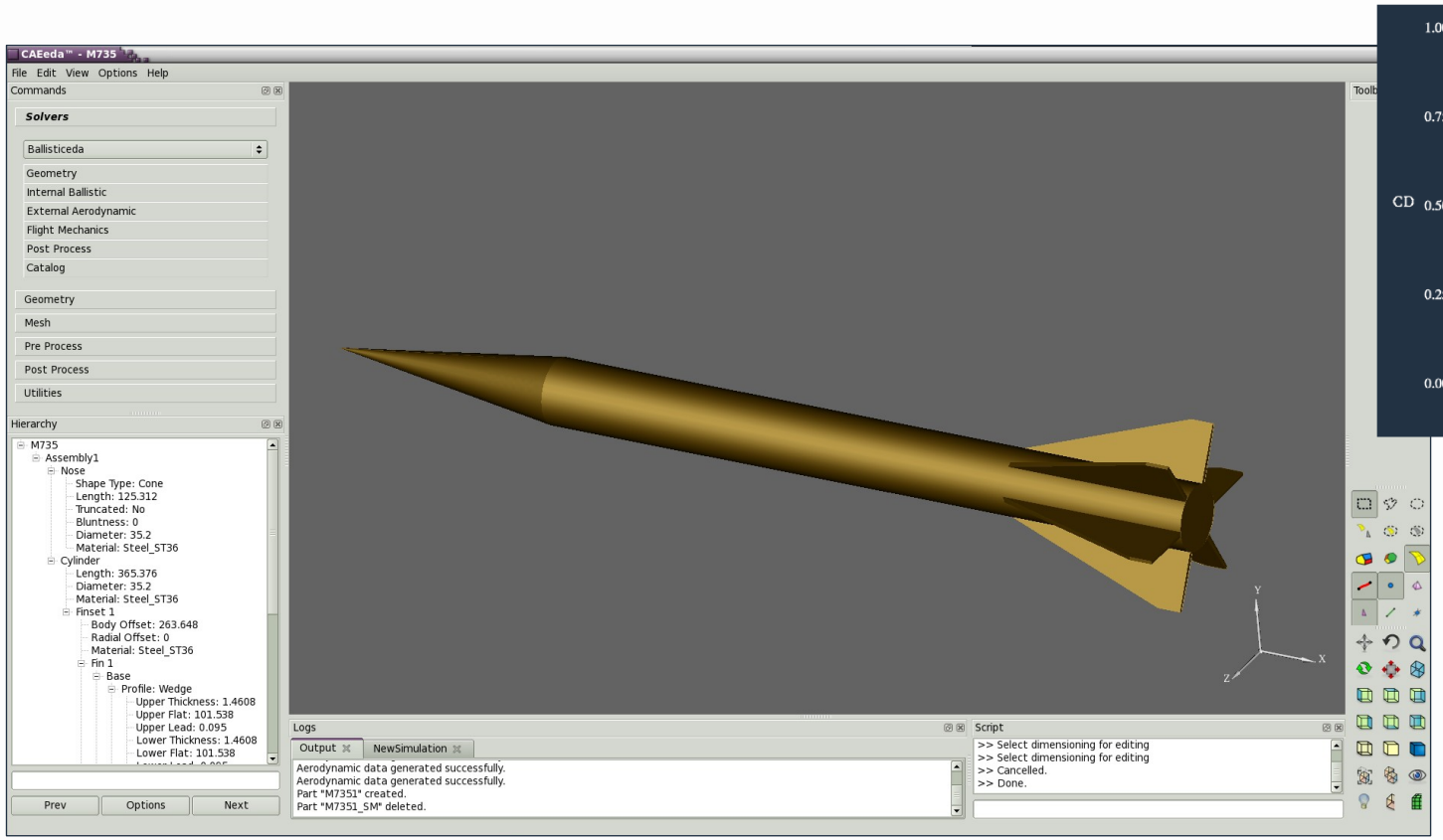

CAEeda™ - TEST2-with_solid
File Edit View Options Help
Commands
Geometry
Working Plane
Create
Delete
Construct
Transform
Catalog
Check
Measure
Repair
Manage
Mesh
Pre Process
FAPeda
SAPeda
TAPeda
BALLISTICeda
BEAMeda
Post Process
BURNBACKEDA
Hierarchy
cartrige-cut
Solid 1
Prev
Options
Next
Toolbar
Logs
Output
Script
>> Done.
>> Press "enter" key to change orientation
>> Done.
>> Select part to be cut
Y
Z
X

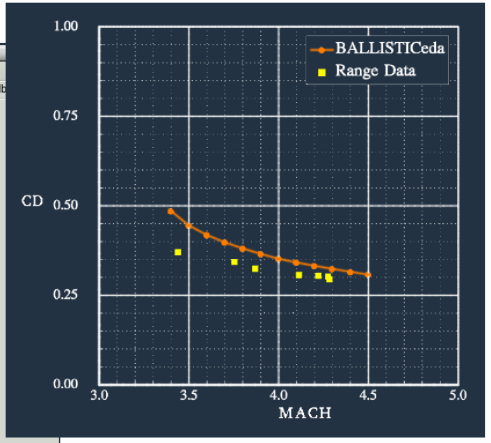

CAEeda™ - internal_egitim_uygulama
File Edit View Options Help
Commands
Geometry
Mesh
Pre Process
FAPeda
SAPeda
TAPeda
BALLISTICeda
Geometry
Internal Ballistic
External Aerodynamic
Flight Mechanics
Post Process
Catalog
BEAMeda
Post Process
BURNBACKEDA
Hierarchy
test
gun
Gun Tube
Diameter: 1.2466
bullet
Nose
Shape Type: Tangent Ogive
Length: 1
Truncated: No
Bluntness: 0
Diameter: 0.98
Cylinder
Length: 1
Diameter: 0.98
Rotating Band 1
Length: 0.2
Outer Diameter: 0.988
Inner Diameter: 0.3
Rifle Count: 8
Rifle Upper Width: 0.1924
Rifle Lower Width: 0.192423
Rifle Height: 0.004
Alpha: 30
Prev
Options
Next
BALLISTICeda
Toolbar
Logs
Output
test_automatic
Script

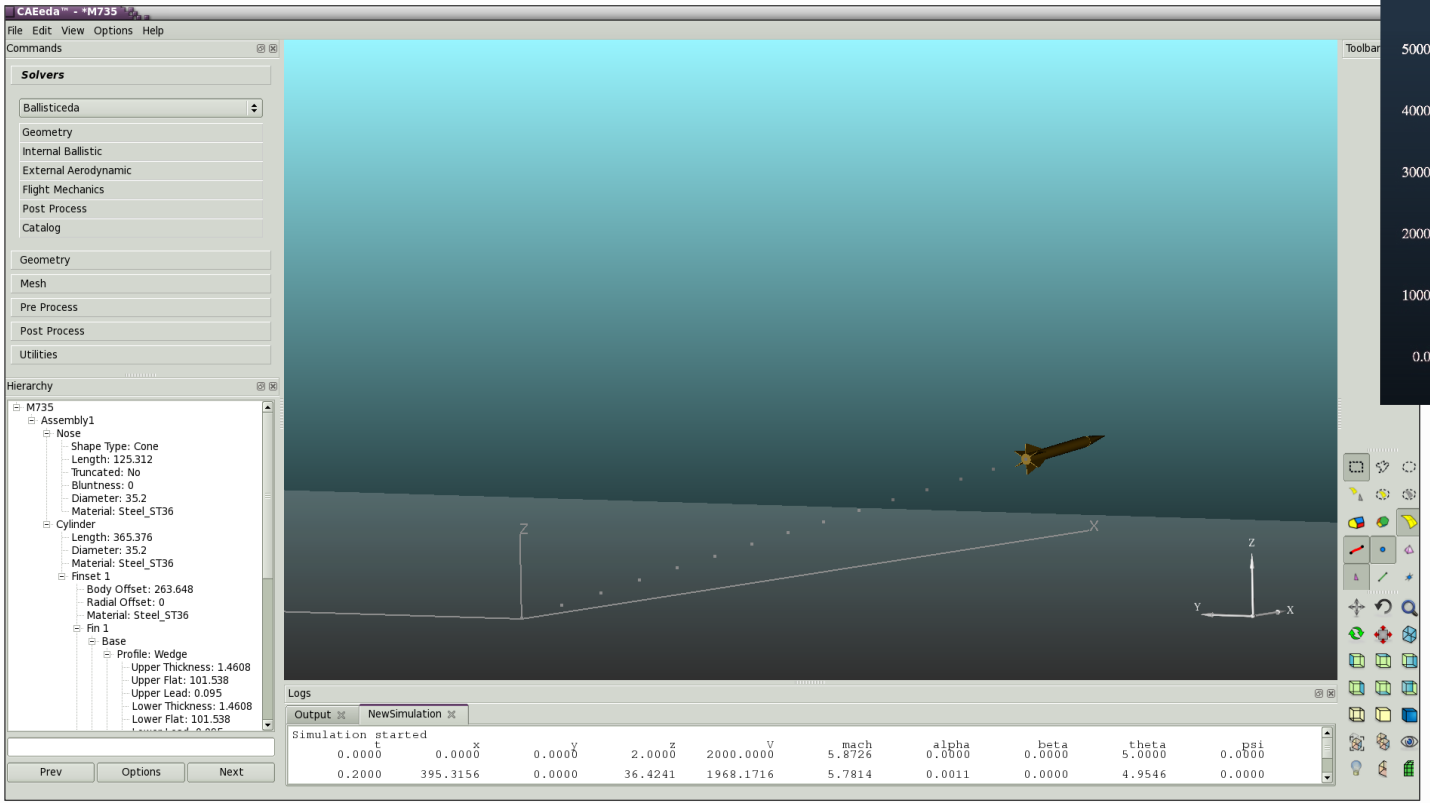

breech
mean
base
Pressure [psi]
time [ms]

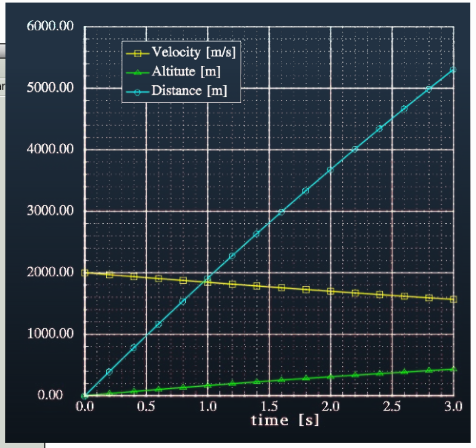

gas
wall
Temperature [K]
time [ms]


spin [rps]
time [ms]


CAEeda™ - M735
File Edit View Options Help
Commands
Solvers
Ballisticeda
Geometry
Internal Ballistic
External Aerodynamic
Flight Mechanics
Post Process
Catalog
Geometry
Mesh
Pre Process
Post Process
Utilities
Hierarchy
M735
Assembly1
Nose
Shape Type: Cone
Length: 125.312
Truncated: No
Bluntness: 0
Diameter: 35.2
Material: Steel_ST36
Cylinder
Length: 365.376
Diameter: 35.2
Material: Steel_ST36
Finset 1
Body Offset: 263.648
Radial Offset: 0
Material: Steel_ST36
Fin 1
Base
Profile: Wedge
Upper Thickness: 1.4608
Upper Flat: 101.538
Upper Lead: 0.095
Lower Thickness: 1.4608
Lower Flat: 101.538
Prev
Options
Next
Logs
Output
NewSimulation
Aerodynamic data generated successfully.
Aerodynamic data generated successfully.
Part "M7351" created.
Part "M7351_SM" deleted.
Script
>> Select dimensioning for editing
>> Select dimensioning for editing
>> Cancelled.
>> Done.
Y
X
Z


1.00
0.75
CD 0.50
0.25
0.00
3.0
3.5
4.0
4.5
5.0
MACH
BALLISTICeda
Range Data


CAEeda™ - *M735
File Edit View Options Help
Commands
Solvers
Ballisticeda
Geometry
Internal Ballistic
External Aerodynamic
Flight Mechanics
Post Process
Catalog
Geometry
Mesh
Pre Process
Post Process
Utilities
Hierarchy
M735
Assembly1
Nose
Shape Type: Cone
Length: 125.312
Truncated: No
Bluntness: 0
Diameter: 35.2
Material: Steel_ST36
Cylinder
Length: 365.376
Diameter: 35.2
Material: Steel_ST36
Finset 1
Body Offset: 263.648
Radial Offset: 0
Material: Steel_ST36
Fin 1
Base
Profile: Wedge
Upper Thickness: 1.4608
Upper Flat: 101.538
Upper Lead: 0.095
Lower Thickness: 1.4608
Lower Flat: 101.538
Prev
Options
Next
Toolbar
Logs
Output
NewSimulation
Simulation started
t x y z V mach alpha beta theta psi
0.0000 0.0000 0.0000 2.0000 2000.0000 5.8726 0.0000 0.0000 5.0000 0.0000
0.2000 395.3156 0.0000 36.4241 1968.1716 5.7814 0.0011 0.0000 4.9546 0.0000


Velocity [m/s]
Altitute [m]
Distance [m]
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
time [s]

FIRE CONTROL INPUTS (FCI)
&
TABULAR FIRE TABLES (TFT)

FCI Files

- Needed for fire control computer
- Consisting of four different files
- Contains ballistic performance information of the Gun & Bullet duo
- Must be rebuilt if the weapon or ammunition changes
- Required to create TFT

Weapon File

- Bore diameter, barrel length, riffle twist

Fuse File

- Type and specifications of the fuse

Projectile File

- Aerodynamic coefficients
- Diameter, mass and inertial moments
- “Fitting” inputs
- “Management” inputs
- “Probable Error” inputs
- Charge performance inputs
- Basebleed performance inputs
- Weapon information inputs
- “Fitting”, “Management”, “Probable Error” and weapon information inputs are calculated separately for each propellant charge

Tabular Fire Tables (TFT)

- These are tables used to calculate elevation and bearing of the barrel in order to hit the target, and fuse settings.
- They consist of A, B (B1, B2), C, D, E, F (F1, F2, F3), G (G1, G2), H, I, J(J1, J2), K tables.

TABLE F (i)
BASIC DATA AND CORRECTIONS TO BEARING

PROJ, HE, M111
FUZE, PD, M222

CHARGE
V_0 = 317.2 M

1	2	3	4	5	6	7	8	9
RANGE	QUADRANT ELEVATION FOR STANDARD CONDITIONS	FUZE SETTING FOR GRAZE BURST	CORRECTION TO FUZE SETTING TO CHANGE HEIGHT OF BURST DOWN BY 10M	EFFECT ON RANGE FOR INCREASE OF ONE MIL IN ELEVATION	FORK	TIME OF FLIGHT	CORRECTIONS TO BEARING ($\Delta_C A_{BG}$)	
							DRIFT (CORRECTION TO LEFT)	1 KNOT CROSSWIND
(X)	(A_{QE})	(FS)	(Δ_CFS/ -10M Y_b)	(ΔX/ 1 MIL A_{QE})	(F)	(TOF)	(A_d)	(1KT W_z)
M	MIL			M	MIL	S	MIL	MIL
0	0.0				0	0.0	0.0	0.00
100	5.1	0.3	1.24		0	0.3	0.1	0.00
200	10.0	0.7	1.10		0	0.7	0.2	0.00
300	15.0	1.1	0.97		0	1.1	0.3	0.00

TABLE F (ii)
CORRECTIONS TO RANGE FOR NON-STANDARD CONDITIONS

)J, HE, M111
E, PD, M222

CHARGE 5
V_0 = 317.2 M/S

1	10	11	12	13	14	15	16	17	18	19
RANGE	RANGE CORRECTIONS (Δ_c X)									
	MUZZLE VELOCITY (V_0) (1 M/S)		RANGE WIND (W_X) (1 KT)		BALLISTIC AIR TEMPERATURE (T_B) (1%)		BALLISTIC AIR DENSITY (D_B) (1%)		PROJ MASS (2 SQ STD) (1 SQ)	
(X)	DEC (-)	INC (+)	HEAD ($\overline{W}$)	TAIL ($\underline{W}$)	DEC (-)	INC (+)	DEC (-)	INC (+)	DEC (-)	INC (+)
M	M	M	M	M	M	M	M	M	M	M
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
100	0.7	-0.7	0.1	0.0	0.1	0.0	0.0	0.0	-2	2
200	1.4	-1.5	0.1	0.0	0.2	0.0	0.0	0.0	-3	3

Figure: A part of a sample F table prepared for indirect firing

Tabular Fire Tables (TFT)

- Prepared by using FCI
- Prepared for a weapon and bullet combination specifically.
- Based on standard atmospheric conditions (ICAO)
- Prepared in a specific format in NATO standards
- Prepared different approaches for direct and indirect firing and each propellant charge separately
- Calculations for aiming can be done manually by using TTF, but it requires experience, and non-computerized manual calculations take time.
- TFT-based calculations are not as accurate as FCI-based computational simulations (nonlinear), as they require a lot of interpolation (a linear approach).

Development of FCI and TFT

Determination of Project Stages

The number of stages and their contents are determined depending on the requirements defined in SOW and the parameters affecting them.

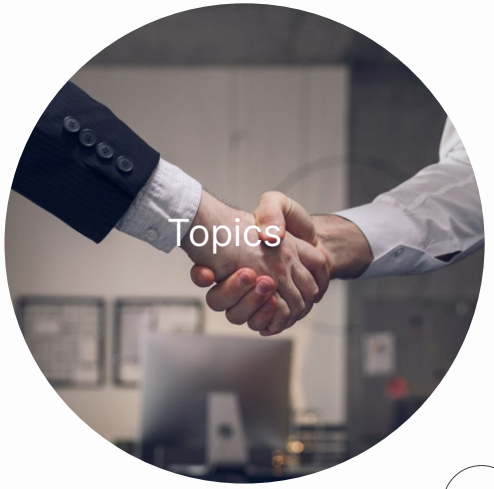
- **Requirements**
  - Sufficient information about weapons and ammunition
  - Existing FCI files for ammunition and weapons and the conditions for the preparation of these files (if any)
  - Actual fire test results for existing ammunition and weapon systems (if any)
- **Parameters for Requirements :**
  - Difficulty level of the engineering problem
  - Technical uncertainties
  - Expected performance and acceptance criteria limitations

Determination of Project Stages

Stage-1 Preparation of Preliminary Draft FCI & TFT	Examining the source documents and input information to decide their adequacy
	Determining the methods to be applied
	Planning R&D studies if necessary
	Planning the firing test for data acquisition and determining number of the necessary number of rounds, shots and conditions
Firing Tests for Data Acquisition (FTDA)	
Stage-2 Development of Draft FCI & TFT	Evaluation of results of the FTDA
	Updating Pre-Drafts and Developing new Draft FCI & TFT
Firing Tests for Verification (Accepted-or-not/Correction) (FTV) *	
Stage-3 ** Preparation of Corrected FCI & TFT	Evaluation of results of the FTV
	Updating Draft FCI & FTA
Firing Tests for Acceptance (FTA)	

** If the Draft FCI & TFT are verified by FTV, these tests are "Verification Tetst"; otherwise it is referred to as "Correction Tests" since it will be passed to Stage-3.*
*** Includes corrective action if FCI & TFT obtained in Stage-2 cannot be verified.*

PROJECTS TO BE INVOLVED IN



- Certification of ammunition for weapons (FCI, AAC preparation)
  - For mortars (indirect firing)
  - For howitzers (indirect firing)
  - For snipers (direct firing)
  - For mortars (indirect firing)
- Ammunition design, optimization and analysis
  - Heavy weapon ammunitions
  - Small weapon ammunitions
  - Rocket
- Weapon system/subsystem design, optimization and analysis
  - Howitzer
  - Tank
  - Mortar
- Firing and fligt tests

WHY EDA?

Thanks to completely independent and customizable engineering software infrastructure free from foreign and commercial software, and a core staff consisting of advanced experts in their respective fields ...

- The ability to offer high quality and innovative, time and cost effective services and products
- Being a "single source" (the uniqueness and differences in the content and procurement conditions of the services provided)
- The ability to develop new products, services and processes through continuous R&D activities
- The ability to offer unique services and customized products that respond to problems that customers cannot solve with existing software tools and engineering capabilities
- Direct, easy and fast access by the customer to the product developer and/or the engineering team providing services

Thank you

EDA Engineering Design & Analysis

eoktay@eda-ltd.com.tr