Middle East Technical University
2008 Annual AHS International Student Design Undergraduate Competition

Supervisor

Dr. İlkay Yavrucuk

(Faculty Advisor)

Supervisor

Assist. Prof. Dr. Oguz Uzol

(Faculty Advisor)

Burak Yağlıoğlu
Derya Aksaray
Erkan Günaydınoğlu
Metin Fırat Özcan
Yunus Emre Arslantaş
Pınar Işık
Şevket Eser Kubalı
Özge Polat
Hakan Aydoğan
Filiz Vargun

Objectives

- Minimizing Energy Consumption
- Low Noise
- Optimised Configuration
- Ecolonomic Life Cycle

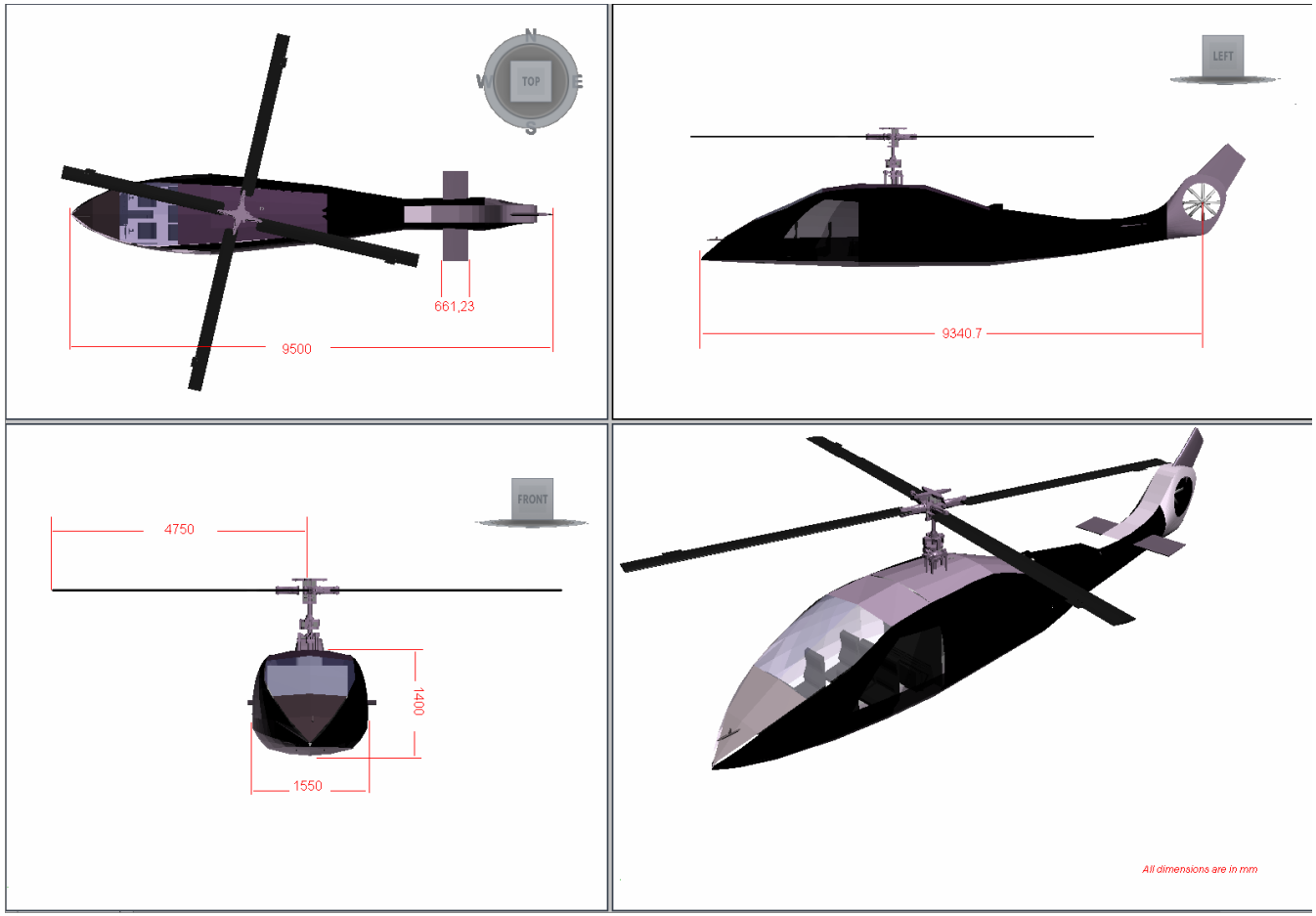
www.ae.metu.edu.tr

Design Features

- Green Power Plant
- Low Noise Configuration
- Optimized Rotorcraft Configuration
- Ecolonomic Life Cycle
- Autorotation Capability
- Level 1 Handling Quality
- Enhanced Safety
- Multi-Purpose Oriented Interior Design
- Wide Operation Range

Metu-Copter

- 3-D View of the Metu-Copter

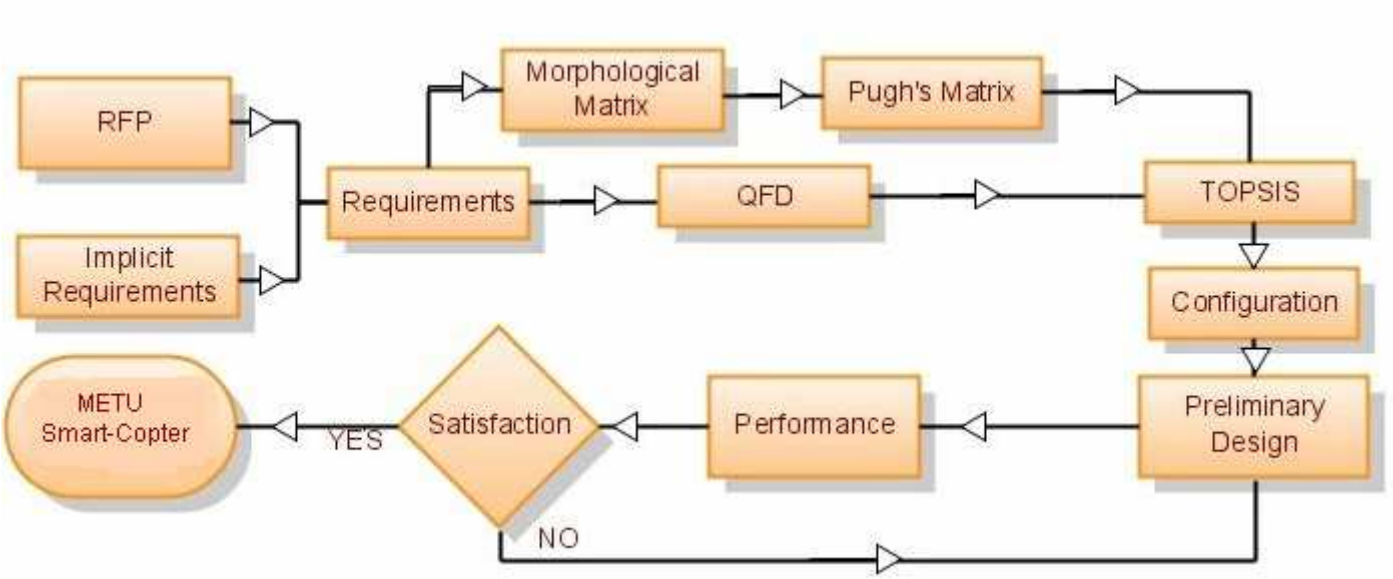


All dimensions in mm

Mission Profile

- Optimization of cruise flight with a target speed of 120 knots
- Hover-out-of-ground-effect (15 min) with Maximum Take-off Weight at 1500m - ISA+20
- Minimum cruise speed 100 knots
- Range 300 nautical miles

Design Methodology



Configuration Selection

- Alternative configurations
- Morphological Matrix
- Quality Function Deployment analysis

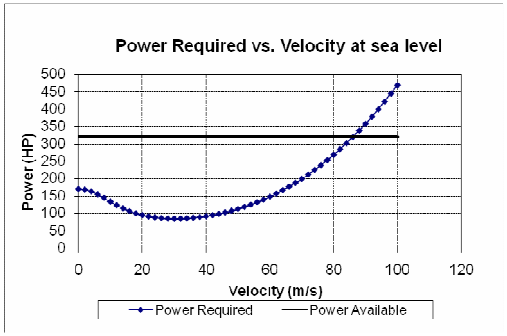
Configuration Matrix			
Power Plant	Hybrid Engine	**Night Vision Capability**	NVG/FLIR GEN II
Rotor	Single	**Flight Control System**	Basic Swash Plate
Hub Type	Hingeless	**Fuselage Structure**	Semi-monocoque
Anti-Torque	Fenestron	**Tail Structure**	Semi-monocoque
Transmission	Sun & Planet	**Navigation**	IMU + GPS + Altimeter
Landing Gear	Tractable	**Control Mechanism**	Mechanical + FBW

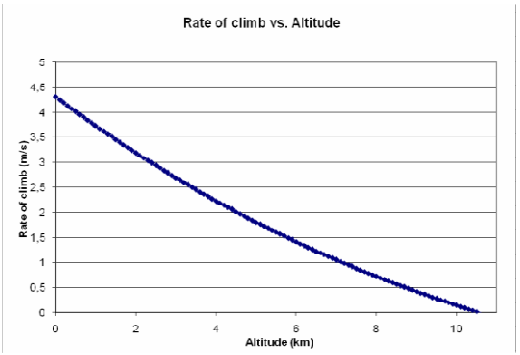
Sizing

- METU Aerospace Performance & Sizing Code (MAPS)
- MAPS: in-house developed helicopter performance and sizing program
- R_F Method: Solidity, tip speed and disk loading are varied for different gross weights and required and available fuel weight ratios are obtained
- Thrust and power is calculated through Blade Element Theory
- Feasible design points are selected and filtered
- Optimum configuration is selected

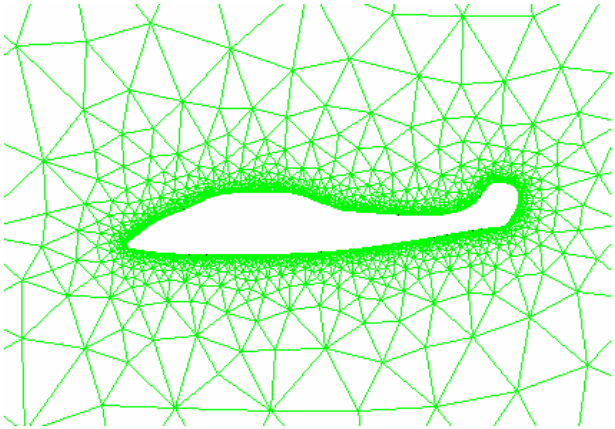
Performance Analysis

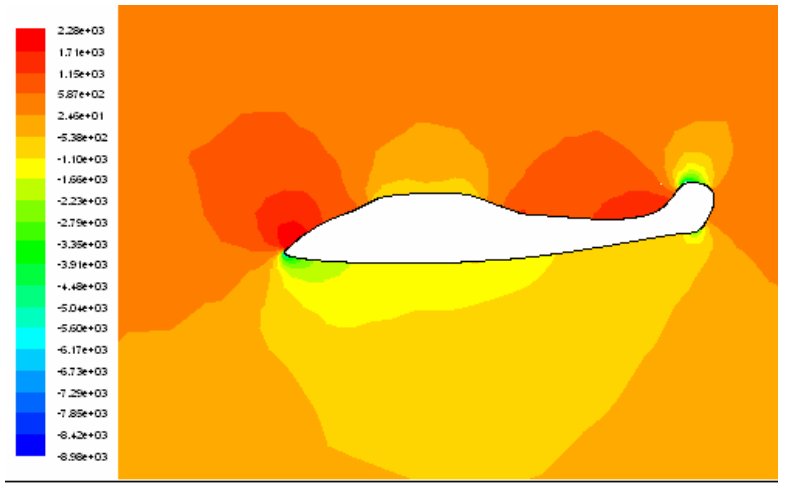
Power & Performance Calculations





Fuselage Drag Estimation through CFD



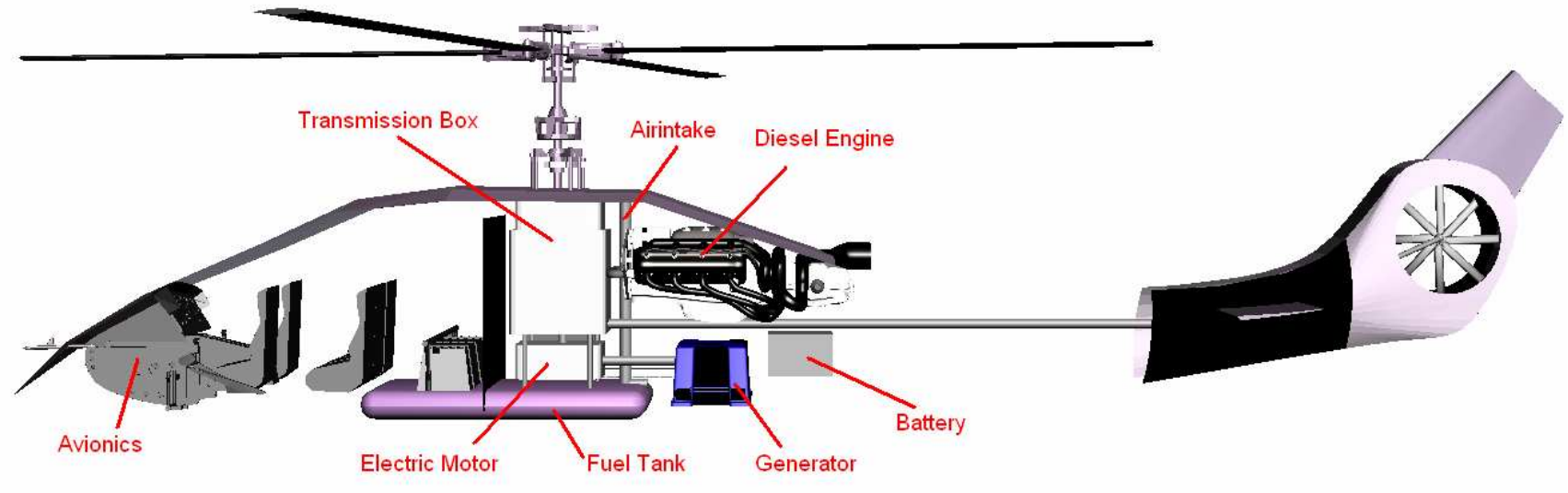


Engine

- Hybrid Engine

-Electrical Power of 30 HP

-BioDiesel Engine with 290 HP



Structure

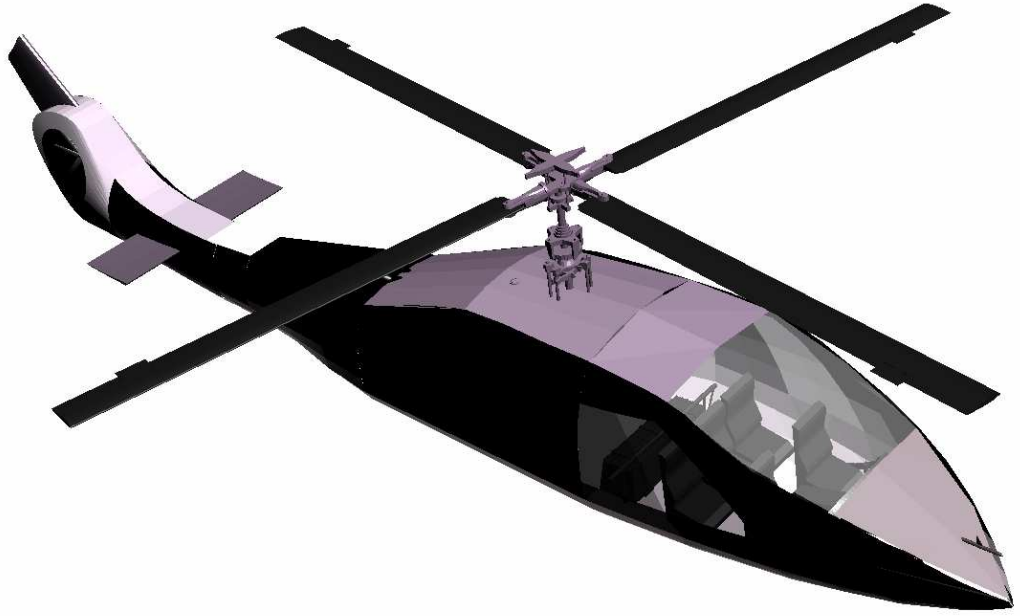
- **Basic Structural Elements:** Fiber Glass
- **Load Bearing Structures (i.e. spars, ribs, etc):** Hybrid composite of Aluminum and Fiber Glass
- **Outer Skin:** Aluminum
- **Blades:** Carbon Fiber
- **Landing Gear:** Carbon Fiber

Stability and Control Augmentation System

- Trim conditions for the Metucopter are obtained using our in-house helicopter trim code MRTrim
- The Metucopter has a primary SCAS that was designed using a LQR controller
- The controller resembles Level-1 handling qualities

Avionics

- Inertial Measurement Unit combined with Global Positioning System
- NVG/FLIR GEN II
- Altimeter



Cost

Standard Equipment	Manufacturing Cost(2007)	Manufacturing Cost(2020)
Fuselage	$49633	$63481
Main Rotor	$37693	$48209
Tail Rotor	$3332	$4262
Hub&Swash Plate	$15981	$20440
Landing Gear	$7118	$9105
Fuel Tank&Battery	$10621	$13584
Canopy	$10493	$13421
Furnishing	$10479	$13403
Engine	$142221	$181900
Transmission	$69742	$89200
Control Systems	$10706	$13693
Avionics&Instruments	$14322	$18318
Electronics	$6984	$8932
Total	$389332	$497955

Conclusion

- SMART-COPTER: Environmental friendly helicopter
- Green & sustainable engine
- Low noise configuration
- Ecolonomic lifecycle
- Operating in service around the world where landing is difficult