Multiplier Event | 25 May 2023

International Technical Semester

Interdisciplinary Scientific Project

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AGENDA

1. Presentation of the LTTA

2. Purpose, topics and approach

3. Case study: Materials selection for UAV’s frame

4. Photo snapshots

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Learning Teaching & Training Activity (LTTA)

Interdisciplinary Scientific Project

	LTTA – Interdisciplinary Scientific Project Athens, Greece, Feb 20- Feb 24, 2023				
	Monday **Feb 20**	Tuesday **Feb 21**	Wednesday **Feb 22**	Thursday **Feb 23**	Friday **Feb 24**
Time					
08:00 - 09:20	Brief introduction to EUCTS & LTTA Prof. Ang. Koutsomichalis	IT systems for UAVs Prof. C. Pavlatos	Composite Materials for UAVs Prof. E. Georgiou & A. Koutsomichalis	Work Group study on Project tasks	Project presentation
09:20 - 10:15	Short guide to HAFA premises. Ice-breaking event	Electronics for UAVs **A** Prof. P. Papakanellos			
10:15 - 10:35	snack & coffee	snack & coffee	snack & coffee	snack & coffee	
10:35 - 11:20	Project description. High Altitude Long Endurance unmanned system	Design of the UAV - visualization I. Tourlomousis	Energy systems for UAVs Prof. I. Templalexis	Work Group study on Project tasks	
11:30 - 12:15	Prof. T Lekas	Visit to the Hellenic Air Force Museum			Course Evaluation
12:25 - 13:10	UAVs Low Speed Aerodynamics Prof. T. Lekas	Electronics for UAVs **B** Prof. P. Papakanellos		Work Group study on Project tasks	Closing ceremony (certificates)
13:20 - 14:00	Students familiarisation with cadets		Self study	Work Group study on Project tasks	
14:15 - 15:30	Lunch Break	Lunch Break	Lunch Break	Lunch Break	
Afternoon	Free	Self study/Free	Free time visit to the Golden Mall	Sightseeing, Short trip for the participants Visit ot the Akropoiis Museum	

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No.	Subjects				ECTS
1	**Applied Informatics**	Network of teachers	RO MTA	RO MTA	3
2	**Applied Automation for Engineering Systems**	Network of teachers	PL MUT		3
3	**Integrated Weapon Systems**	Network of teachers	RO MTA	FR FASFA	3
4	**CSDP for Technical Systems**	Network of teachers	FR FASFA		3
5a	**Computer Networks**	Network of teachers	BG NMU	PL MUT	3
6a	**Programming Languages**	Network of teachers	RO MTA		3
7a	**Signal Processing**	Network of teachers	GR HAFA		3
8a	**Microcontrollers**	Network of teachers	RO MTA		3
5b	**Propulsion Systems**	Network of teachers	GR HAFA	BG NMU	3
6b	**Dynamic of Flight**	Network of teachers	PL MUT		3
7b	**Mechanics and Material Science**	Network of teachers	GR HAFA		3
8b	**Computer-Aided-Design and Numerical Analysis**	Network of teachers	BG NMU		3
9	**Interdisciplinary Scientific Project**			GR HAFA	6
10	**Intercultural communication (Bulgarian/French/Greek/Polish/Romanian)**				2
11	**Physical Education and Sports**				2
	TOTAL				**34**

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Purpose

Preliminary approach of a **High Altitude Long Endurance** (HALE) unmanned system, to be used as a cheap satellite for surveillance, intelligence, atmospheric research and relay. The HALE should have an endurance of three (3) months (90 days) and be in station at 25000 m. The duration of this project will be one (1) week.

Topics involved

- Electronics
- Electric energy sources
- Electric propulsion
- Composite materials
- Low Reynolds aerodynamics

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The approach

STEP 1

Find off the shelf electronic devices of proven efficiency and lowest weight, energy consumption and acquisition cost. The required devices are: synthetic aperture radar, navigation and real time encrypted communication systems and various sensors. First approach of the shape, size, weight, aerodynamic characteristics and number of motors of the aircraft. (**Electronics and Aerodynamics and Flight Mechanics**).

STEP 2

Find of the shelf electric motors and the propellers combinations suitable for this kind of flight conditions. The requirements are: highest possible propulsive efficiency and lowest motor weight, energy consumption and acquisition cost. Shape, size, weight, aerodynamic characteristics and number of motors of the aircraft revisited (**Electrical Power and Aerodynamics and Flight Mechanics**).

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The approach

STEP 3

Find the most suitable energy source among solar cells, fuel cells and batteries. Off the shelf material should be found and analyzed from energetic efficiency, weight, cost and delays of acquisition point of view. Shape, size, weight and aerodynamic characteristics of the aircraft revisited. (**Electrical Power, Energetics and Aerodynamics and Flight Mechanics**).

STEP 4

Choice of off the shelf composite materials able to sustain repeatedly the ambient temperature difference between S.L. (takeoff and landing) and long duration flight at the prescribed altitude. High strength and low specific weight and cost are mandatory. Weight of the aircraft and aerodynamic characteristics revisited. (**Technology of materials and Aerodynamics and Flight Mechanics**).

STEP 5

Shape, size, weight, number of motors, aerodynamic characteristics and performance of the HALE based on the findings of steps 1, 2, 3 and 4. (**Aerodynamics and Flight Mechanics**).

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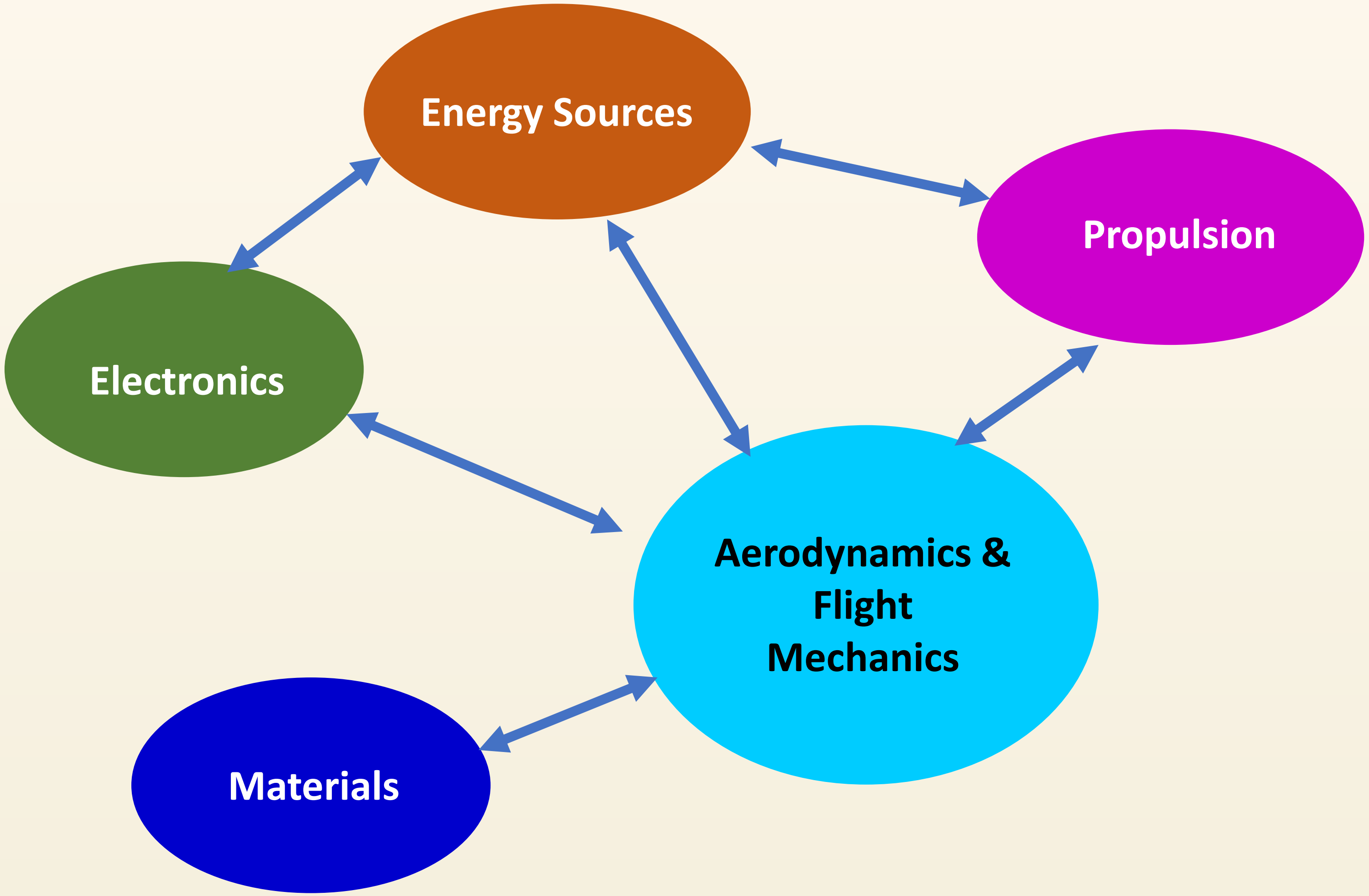

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Case study:
Materials selection for UAV’s frame

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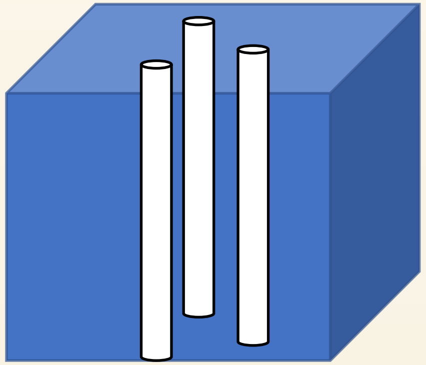
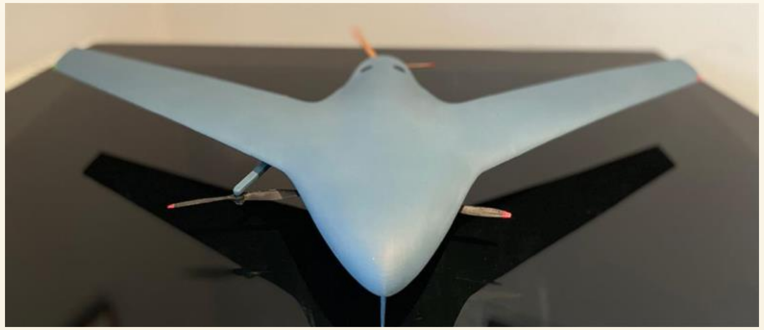
Prerequisites

Structure: continuous fibers
Young's modulus (MPa): ?
Tensile strength (MPa): ?
Weight (kgr): ?
Cost: ?





Question:

- Select a matrix and fiber reinforcement material
- Select Vol. % and diameter of fiber reinforcement
- Calculate its Young's modulus and Ultimate Tensile Strength to match requirements

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Material selection for UAVs frame | Data guide

Material	Specific Gravity	Tensile Strength [GPa (10^6 psi)]	Specific Strength (GPa)	Modulus of Elasticity [GPa (10^6 psi)]	Specific Modulus (GPa)
		Whiskers			
Graphite	2.2	20 (3)	9.1	700 (100)	318
Silicon nitride	3.2	5–7 (0.75–1.0)	1.56–2.2	350–380 (50–55)	109–118
Aluminum oxide	4.0	10–20 (1–3)	2.5–5.0	700–1500 (100–220)	175–375
Silicon carbide	3.2	20 (3)	6.25	480 (70)	150
		Fibers			
Aluminum oxide	3.95	1.38 (0.2)	0.35	379 (55)	96
Aramid (Kevlar 49™)	1.44	3.6–4.1 (0.525–0.600)	2.5–2.85	131 (19)	91
Carbon[a]	1.78–2.15	1.5–4.8 (0.22–0.70)	0.70–2.70	228–724 (32–100)	106–407
E-glass	2.58	3.45 (0.5)	1.34	72.5 (10.5)	28.1
Boron	2.57	3.6 (0.52)	1.40	400 (60)	156
Silicon carbide	3.0	3.9 (0.57)	1.30	400 (60)	133
UHMWPE (Spectra 900™)	0.97	2.6 (0.38)	2.68	117 (17)	121
		Metallic Wires			
High-strength steel	7.9	2.39 (0.35)	0.30	210 (30)	26.6
Molybdenum	10.2	2.2 (0.32)	0.22	324 (47)	31.8
Tungsten	19.3	2.89 (0.42)	0.15	407 (59)	21.1

[a] The term "carbon" instead of "graphite" is used to denote these fibers, since they are composed of crystalline graphite regions, and also of noncrystalline material and areas of crystal misalignment.

Material	Specific Gravity	Tensile Modulus [GPa (ksi)]	Tensile Strength [MPa (ksi)]	Yield Strength [MPa (ksi)]	Elongation at Break (%)
Polyethylene (low density)	0.917–0.932	0.17–0.28 (25–41)	8.3–31.4 (1.2–4.55)	9.0–14.5 (1.3–2.1)	100–650
Polyethylene (high density)	0.952–0.965	1.06–1.09 (155–158)	22.1–31.0 (3.2–4.5)	26.2–33.1 (3.8–4.8)	10–1200
Poly(vinyl chloride)	1.30–1.58	2.4–4.1 (350–600)	40.7–51.7 (5.9–7.5)	40.7–44.8 (5.9–6.5)	40–80
Polytetrafluoroethylene	2.14–2.20	0.40–0.55 (58–80)	20.7–34.5 (3.0–5.0)	—	200–400
Polypropylene	0.90–0.91	1.14–1.55 (165–225)	31–41.4 (4.5–6.0)	31.0–37.2 (4.5–5.4)	100–600
Polystyrene	1.04–1.05	2.28–3.28 (330–475)	35.9–51.7 (5.2–7.5)	—	1.2–2.5
Poly(methyl methacrylate)	1.17–1.20	2.24–3.24 (325–470)	48.3–72.4 (7.0–10.5)	53.8–73.1 (7.8–10.6)	2.0–5.5
Phenol-formaldehyde	1.24–1.32	2.76–4.83 (400–700)	34.5–62.1 (5.0–9.0)	—	1.5–2.0
Nylon 6,6	1.13–1.15	1.58–3.80 (230–550)	75.9–94.5 (11.0–13.7)	44.8–82.8 (6.5–12)	15–300
Polyester (PET)	1.29–1.40	2.8–4.1 (400–600)	48.3–72.4 (7.0–10.5)	59.3 (8.6)	30–300
Polycarbonate	1.20	2.38 (345)	62.8–72.4 (9.1–10.5)	62.1 (9.0)	110–150

Source: *Modern Plastics Encyclopedia '96*. Copyright 1995, The McGraw-Hill Companies. Reprinted with permission.

M. Ashby, Materials Selection in Mechanical Design, Elsevier

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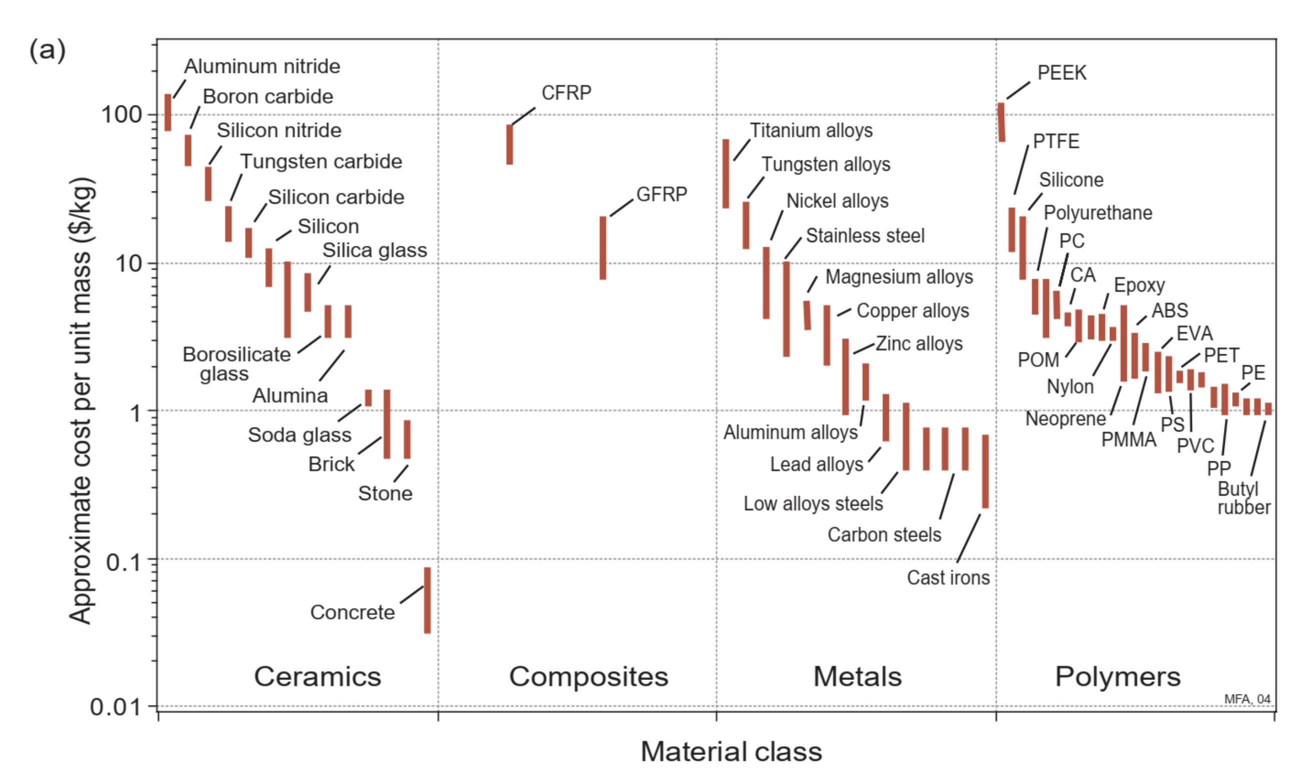
Material selection for UAVs frame | Chart guide



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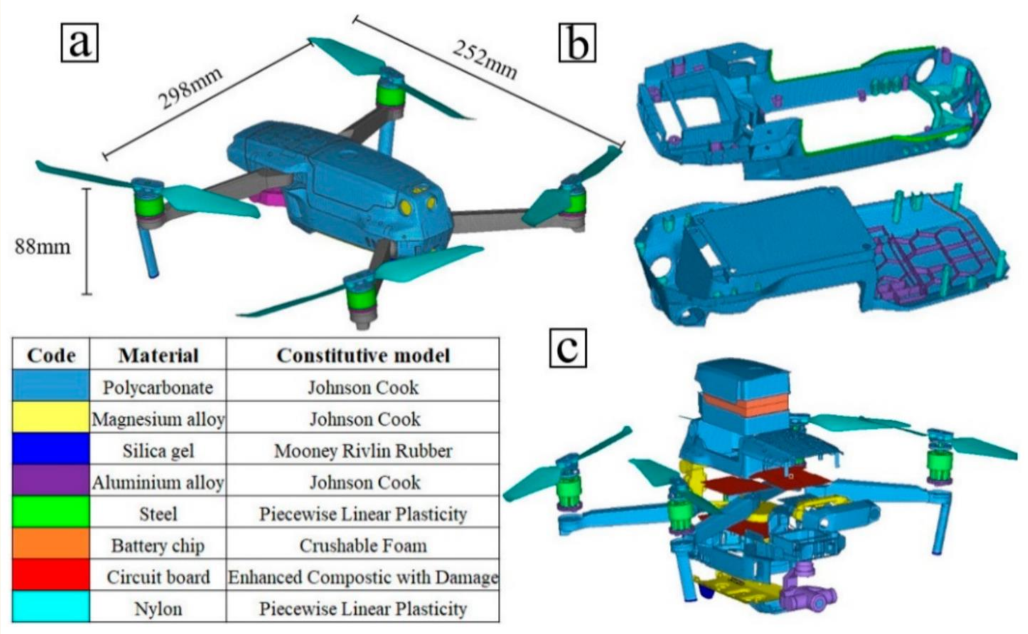

Code	Material	Constitutive model
	Polycarbonate	Johnson Cook
	Magnesium alloy	Johnson Cook
	Silica gel	Mooney Rivlin Rubber
	Aluminium alloy	Johnson Cook
	Steel	Piecewise Linear Plasticity
	Battery chip	Crushable Foam
	Circuit board	Enhanced Compostic with Damage
	Nylon	Piecewise Linear Plasticity

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Brainstorming

coaching

Calculating & solving

Presenting the HALE project

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Lunching

Team working

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Visit to HAFA's Museum

HAFA's Aviation yard

Commemorative closing photo

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Attending the project presentation

Commander's speech

Conferment of degrees

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QUESTIONS?

SUGGESTIONS?

RECOMMENDATIONS?

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