MINI BEE PERSONAL AIRCRAFT

Mini-Bee

Hybrid Octocopter, Beginning of TRL2

(Technology concept and/or application formulated)

v1.1 – 4 July 2016

Agenda

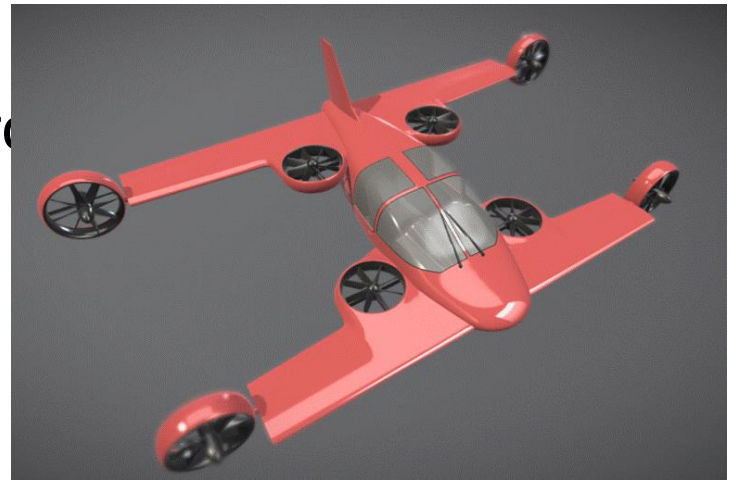
- Mini-Bee description
  - Concept and technical description
  - SWOT analysis
- TRL1 project
  - Partners and project history
  - TRL1 Tasks
  - Aerodynamic studies
- TRL2 project launch

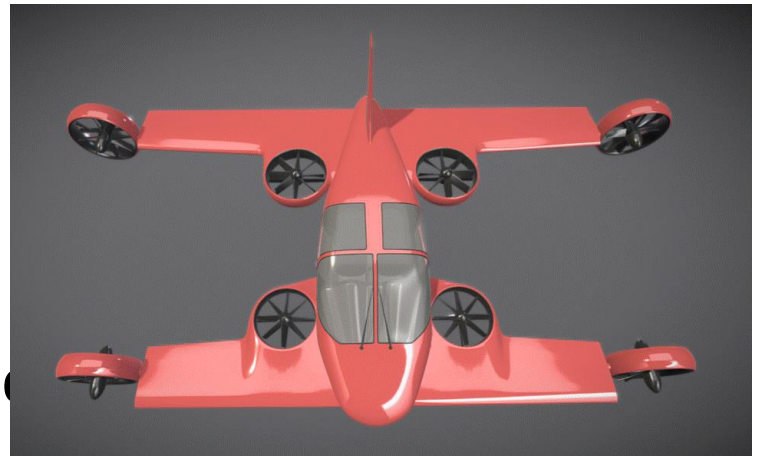
  - Annexes : State of the art, Other innovative projects

Mini-Bee : 2PAX VIP VTOL

Mini-Bee description

- Project state : beginning of TRL2
  - Electric octocopter : 4 vertical + 4 tilt r
  - Hybrid energy : fuel + batteries
  - 2 seats, VIP configuration
- Characteristics :
  - VTOL capacity, short wings, 1.2 ton
  - Range 600km, max speed 300km/h
  - Electric controls and engines
- Goals and market
  - VIP, Air Ambulance, Individual Air Vehi
  - Estimated price 1m€ (for VIP)





Architecture

External tilt quadcopter

Central vertical quadcopter

Rear electric generator

Gullwing doors

Fuel generators

Biplane

Battery kits

Electric flight controls

Tailwheel-type landing gear

Low noise nacelle

Retractable front landing gear

3D printed metallic structure

Technical description

Aircraft characteristics

2 seats, VTOL, Short wing for cruise flight
MTOW 1200 kg, Range 800km , Cruise speed 220 km/h
Wing surface 15m², no control surface

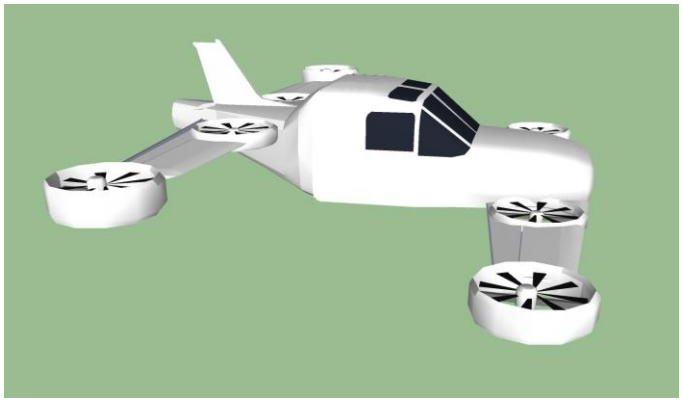
Engines

Central vertical quadcopter + External tilt quadcopter
4 hybrid fuel generator for central quad copter
4 electric engines for external tilt quadcopter
Electronic control of engines power and tilt angles

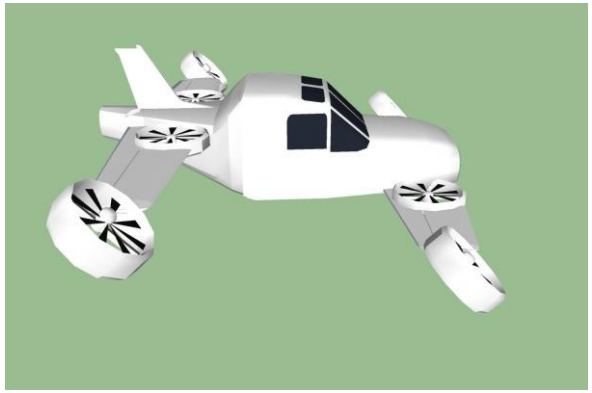
Cockpit interface

« Car like » pilot interface : Steering wheel, foot pedals, central screen

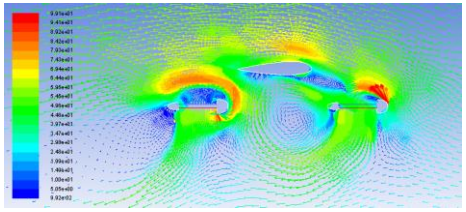
Take-off and flight transition

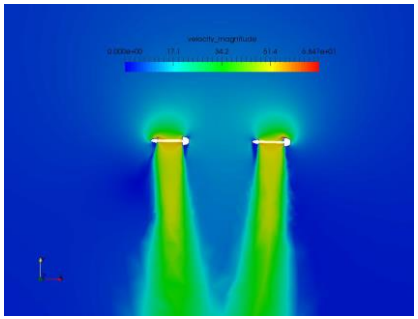


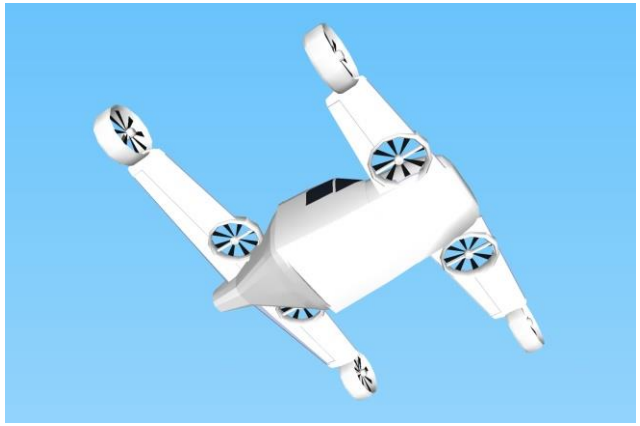
Vertical take-off



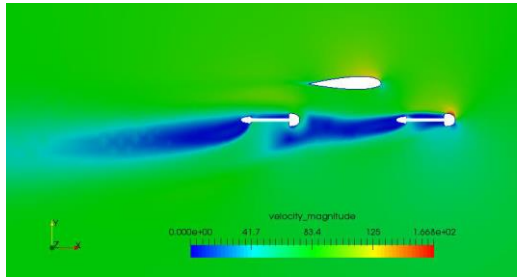
Tilt transition







Cruise flight



Supméca 2016

Take-off and tilt transition



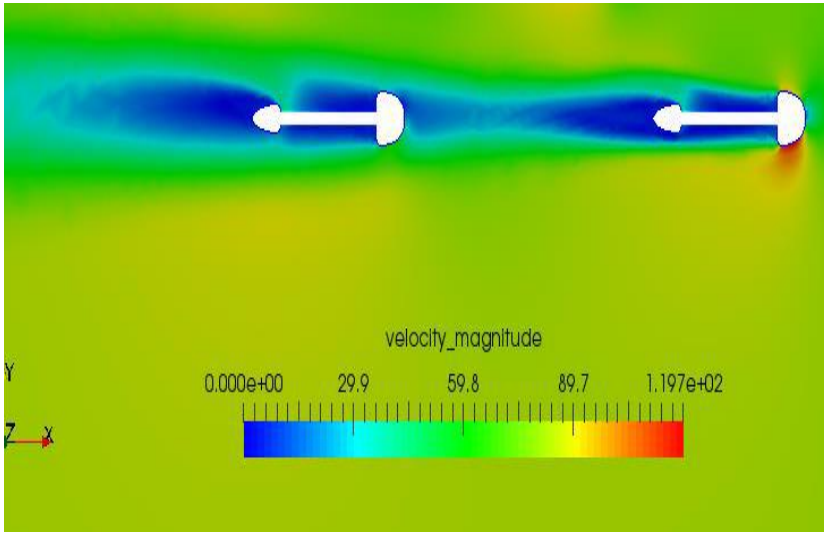






By Estaca 2016

Cruise flight



Technical data

MTOW : 1200 kg

- Structure : 320kg
- Fuselage : 80kg
- Payload : 220 kg (2 PAX)
- Systems : 125 kg
- Engines : 240 kg (4 * Hybrid160kg + 4 Electric 80kg)
- Batteries : 80kg
- Fuel : 140kg

Target for TRL3 : MTOW 1000 kg

Costs

Total costs : 700k€

- System : 200k€
- Fuselage : 150k€
- Wing : 100k€
- Engines : 100k€
- Landing gear : 50k€
- Interior : 50k€
- Other : 50k€

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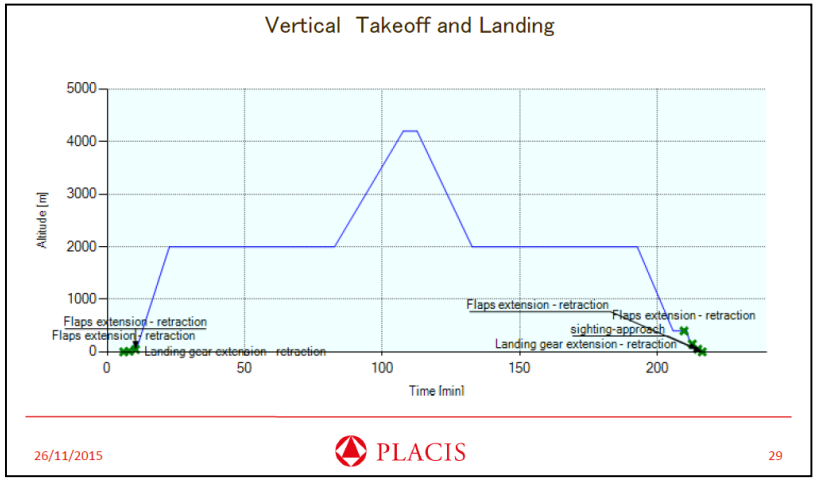
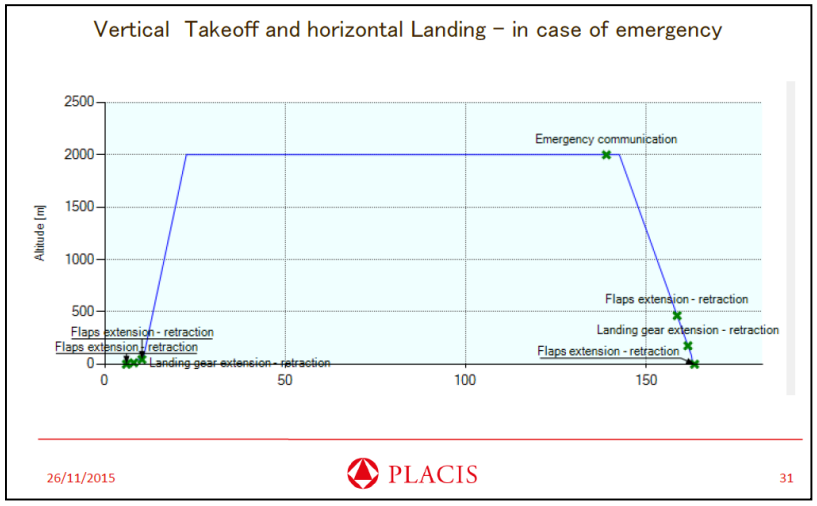
Mission profile





Phase	Duration		Altitude (start)	Altitude (end)	Speed	Climb rate	Specific Consuption
	hour	Min	m	m	km/h	m/s	lb/Hp/h
Engine start-up	0	0,3	0	0	0	0	0
Taxi out	0	4,5	0	0	60,0001	0	0,44
Flaps extension - retraction	Start time	60	-	-	-	-	-
Vertical Take off	0	0,8	0	45	0	0,9375	0,46
Landing gear extension - retraction	Start time	25	-	-	-	-	-
Rotors orientation	0	2	45	45	100,0001	0	0,45
Flaps extension - retraction	Start time	85	-	-	-	-	-
Climb	0	12	45	2000	200,0002	2,7153	0,45
1° cruise	1	0	2000	2000	299,9999	0	0,4299
obstacle deviation (climb)	0	25	2000	4200	249,9998	1,4667	0,45
Mini-cruise	0	5	4200	4200	249,9998	0	0,44
obstacle deviation (scent)	0	20	4200	2000	270	-1,8333	0,435
2° cruise	1	0	2000	2000	300	0	0,4299
Descent	0	13	2000	400	240	-2,0513	0,435
Holding	0	5	400	400	200	0	0,4331
Flaps extension - retraction	Start time	80	-	-	-	-	-
2° rotors orientation	0	1	400	200	100	-3,3333	0,45
Vertical Landing	0	4	200	0	20	-0,8333	0,447
Landing gear extension - retraction	Start time	25	-	-	-	-	-
sighting-approach	Start time	75	-	-	-	-	-
Taxi in	0	2	0	0	60	0	0,44
Flaps extension - retraction	Start time	30	-	-	-	-	-
Engine shutdown	0	0,2	0	0	0	0	0

26/11/2015 PLACIS 30

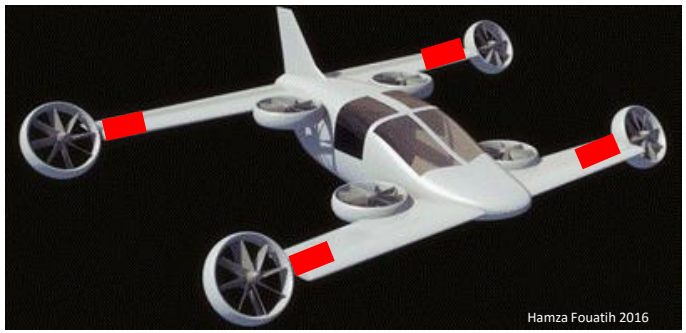
Engines for vertical rotor

Equipement proposed : 4 electric engines Yuneec Power Drive 40

		Yuneec Power Drive 40 [11]
Dimensions	Length	163 mm
	Width	240 mm
	Height	240 mm
Weight		19 kg
Power		40 kW at 2400 rpm
Power to weight ratio		***2,1 kW/kg***

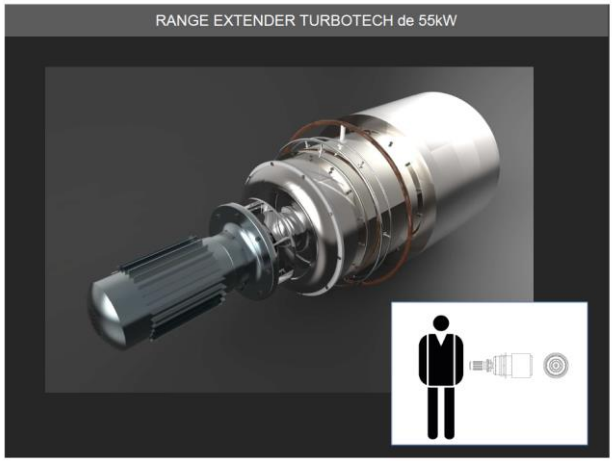
Power 160 kW

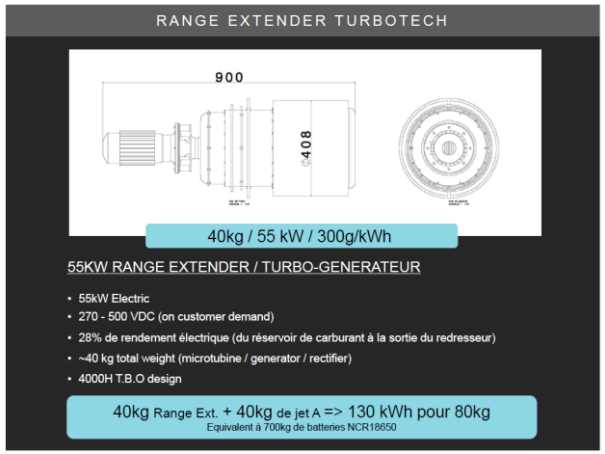
- provided by 80kg of batteries (at 150kW/kg) during take-off
- and by fuel generator during cruise flight

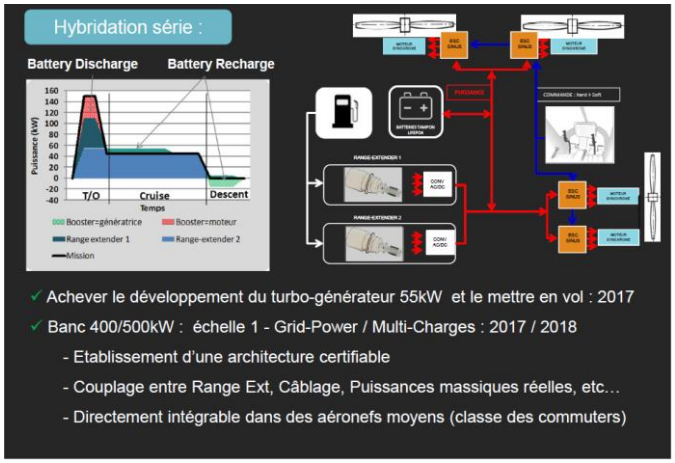


Electric generator for vertical quadcopter

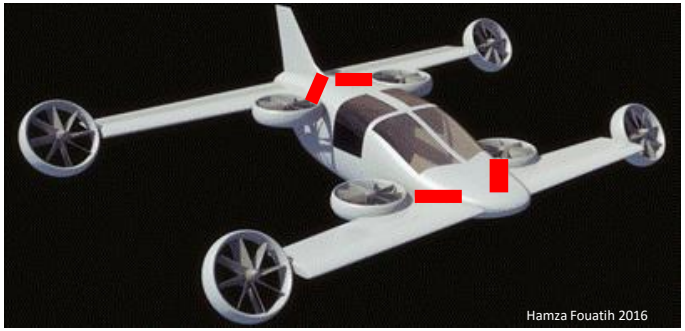
Equipement proposed : 4 Turbotech 55kW for central quad copter







Fuel energy : 220 kW for take-off and low speed flight



SWOT analysis

Strengths

- VTOL capacities
- Speed of an aircraft
- Double quadcopter back-up in case of engine failure
- Fuel energy range

Weakness

- New configuration
- Project at low TRL
- Aerodynamic and leight weight structure
- Propulsion and energy storage
- Project implementation
- Project funding

Opportunities

- Cost reduction :
  - Overall flight cost reduction compared to helicopter
  - Low purchasing & maintenance cost of engines
- New design space: tilt, octocopter
  - Weight / VTOL
- Project investment

Threats

- All electric helicopter
- All electric aircraft
- Tilt rotor (bi and quadri)
- Hybrid energy

Partners for R&D

Project coordinator

TECHNOPLANE
AERONAUTICAL INNOVATION

TRL1 Basic Definition

supméca

POLITECNICO DI TORINO

ESTACA ÉCOLE D'INGÉNIEURS Groupe isae

PLACIS

TRL2 Detailled Definition

supméca

POLITECNICO DI TORINO

ESTACA ÉCOLE D'INGÉNIEURS Groupe isae

NAE Normandie AeroEspace La passion de l'Excellence

In launch

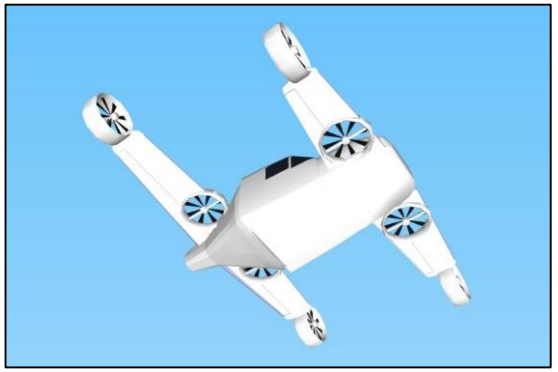
PLACIS

Project history

TRL0 Project Launch (2015)

Studies 2015/2016

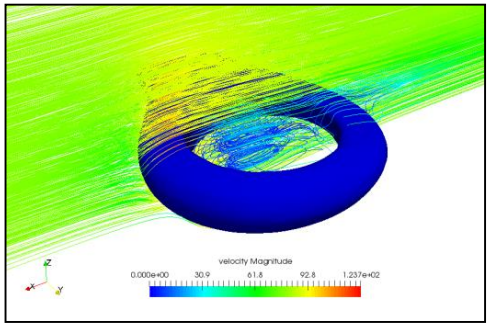
TRL1 Basic Definition (2016)



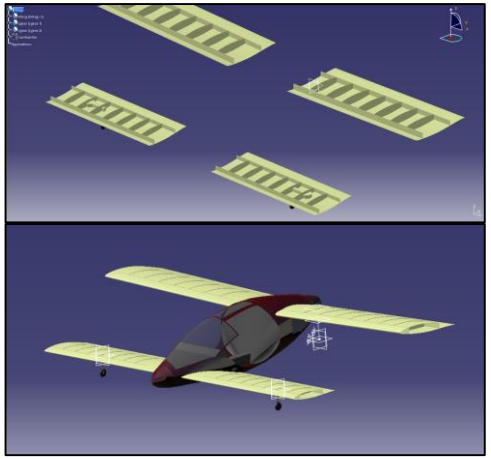
TRL2 Concept (2016)

TRL1 project tasks

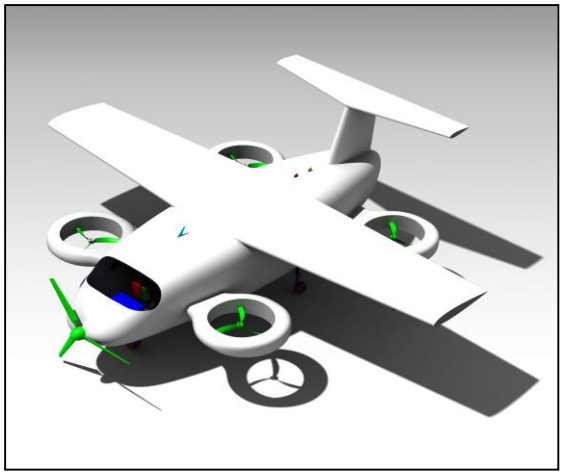
Polito 2015



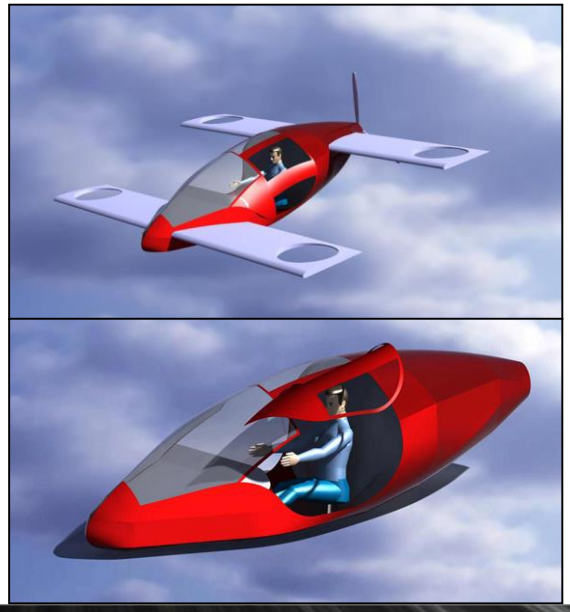
Supmeca
2016



Estaca
2016 group1

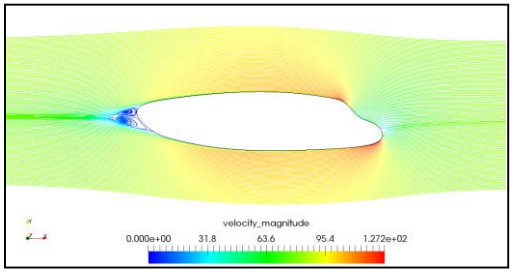


Supmeca & Polito
2016 (Placis)

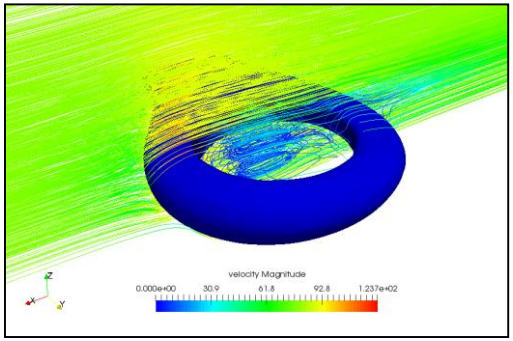


Estaca
2016 group2

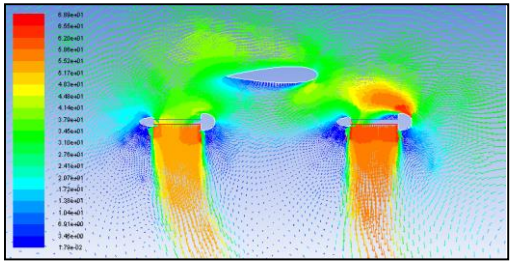
Aerodynamic studies



Cockpit shape optimization
Supmeca 2016

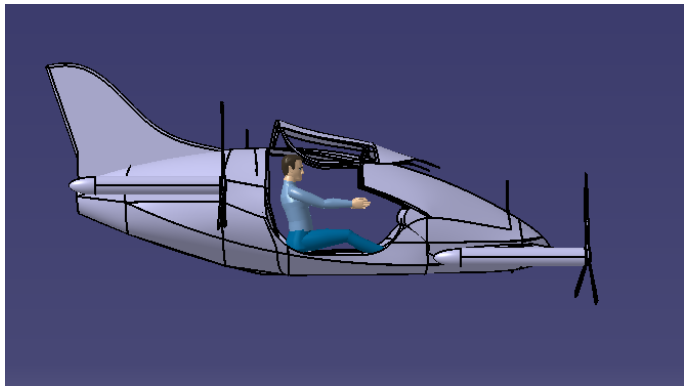


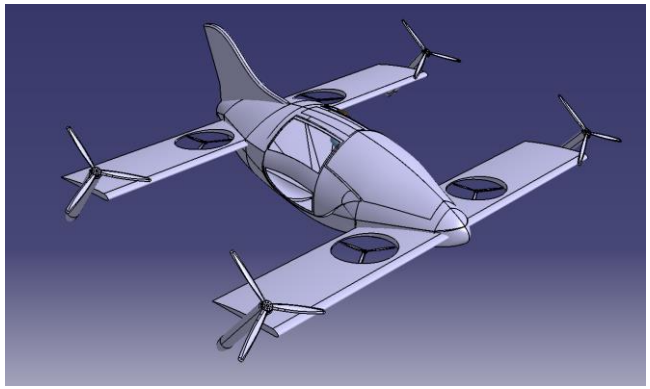
Rotor shape optimization
Supmeca 2016

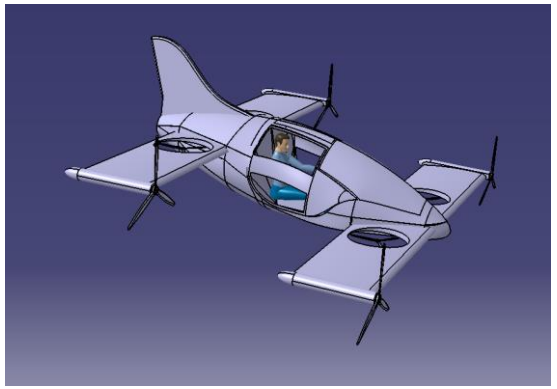


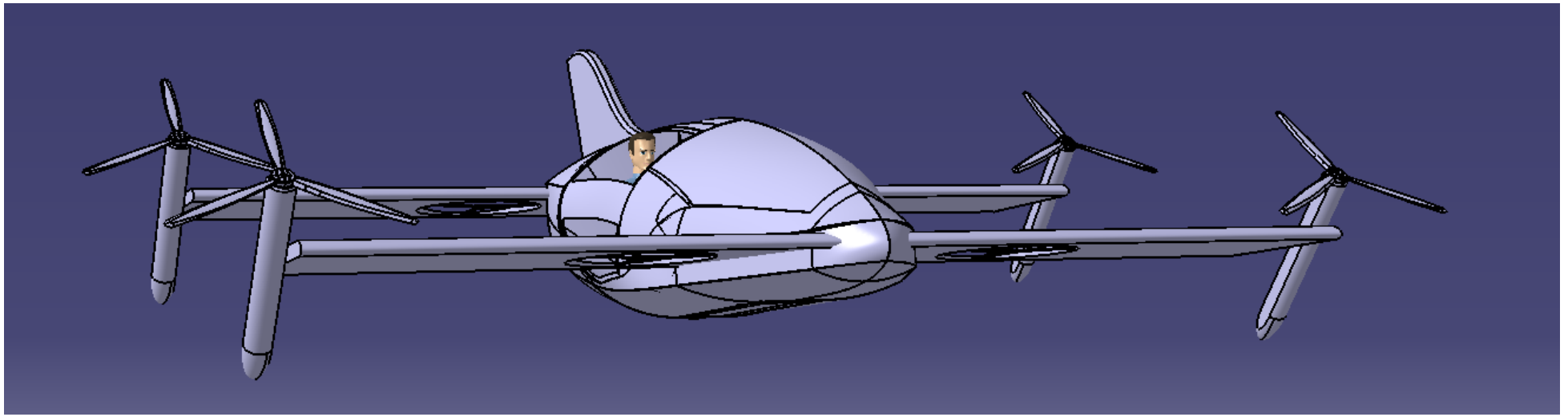
Vertical rotor air flow studies
Supmeca 2016

Configuration at end of TRL1



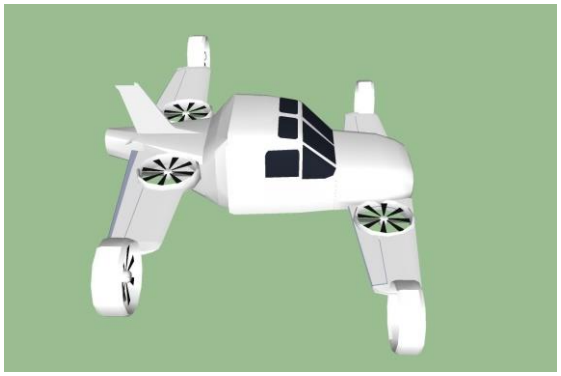


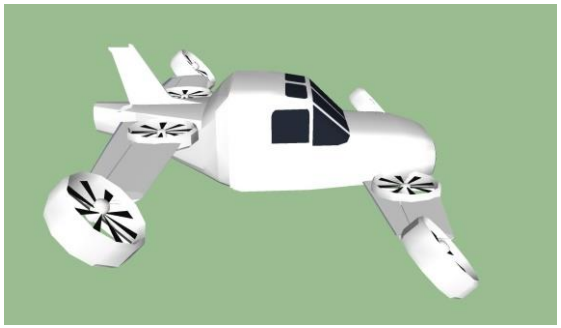




Estaca Laval 2016

Mini-Bee project for TRL2





Mini-Bee (at end of TRL1)
2 PAX VIP
Electric Octocopter
Tilt quadcopter & vertical quadcopter
Hybrid energy : batteries & fuel

Overall main beeplane Project partners

Lesser Open Bee License 1-3

Coordinator : TECHNOPLANE AERONAUTICAL INNOVATION

Universities : CentraleSupélec, supméca, POLITECNICO DI TORINO, ESTACA ÉCOLE D'INGÉNIEURS Groupe ISAE

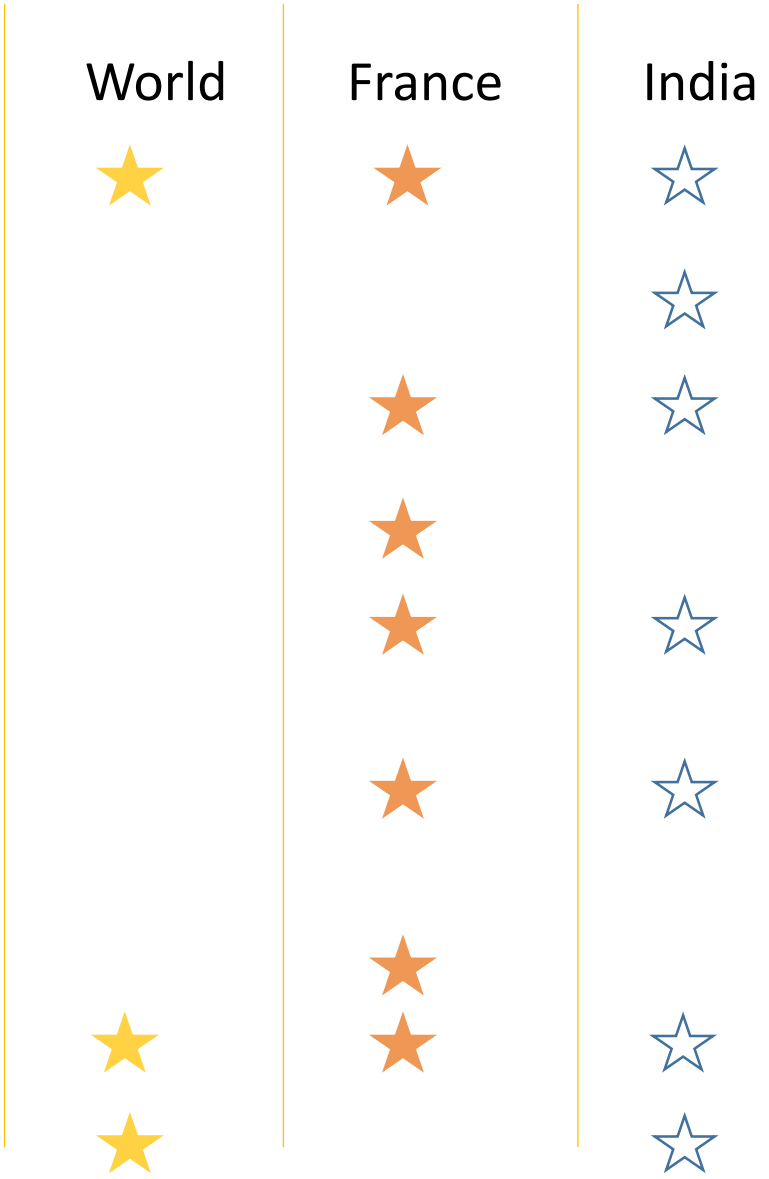
Institution & financial partners : NAE Normandie AeroEspace, PLACIS, seinari, Région Haute Normandie, oséo Prêt à la Création d'Entreprise, CCI EURE, CCI NORMANDIE, CCI International Normandie, NORMANDIE-SEINE Le bon sens a de l'avenir, BGE Vos initiatives ont un avenir, pole-emploi.fr, iNOCÉANE, enterprise europe network, HAUTE-NORMANDIE ACTIVE FINANCEUR SOLIDAIRE POUR L'EMPLOI

Design: HAMZA FOUAIH

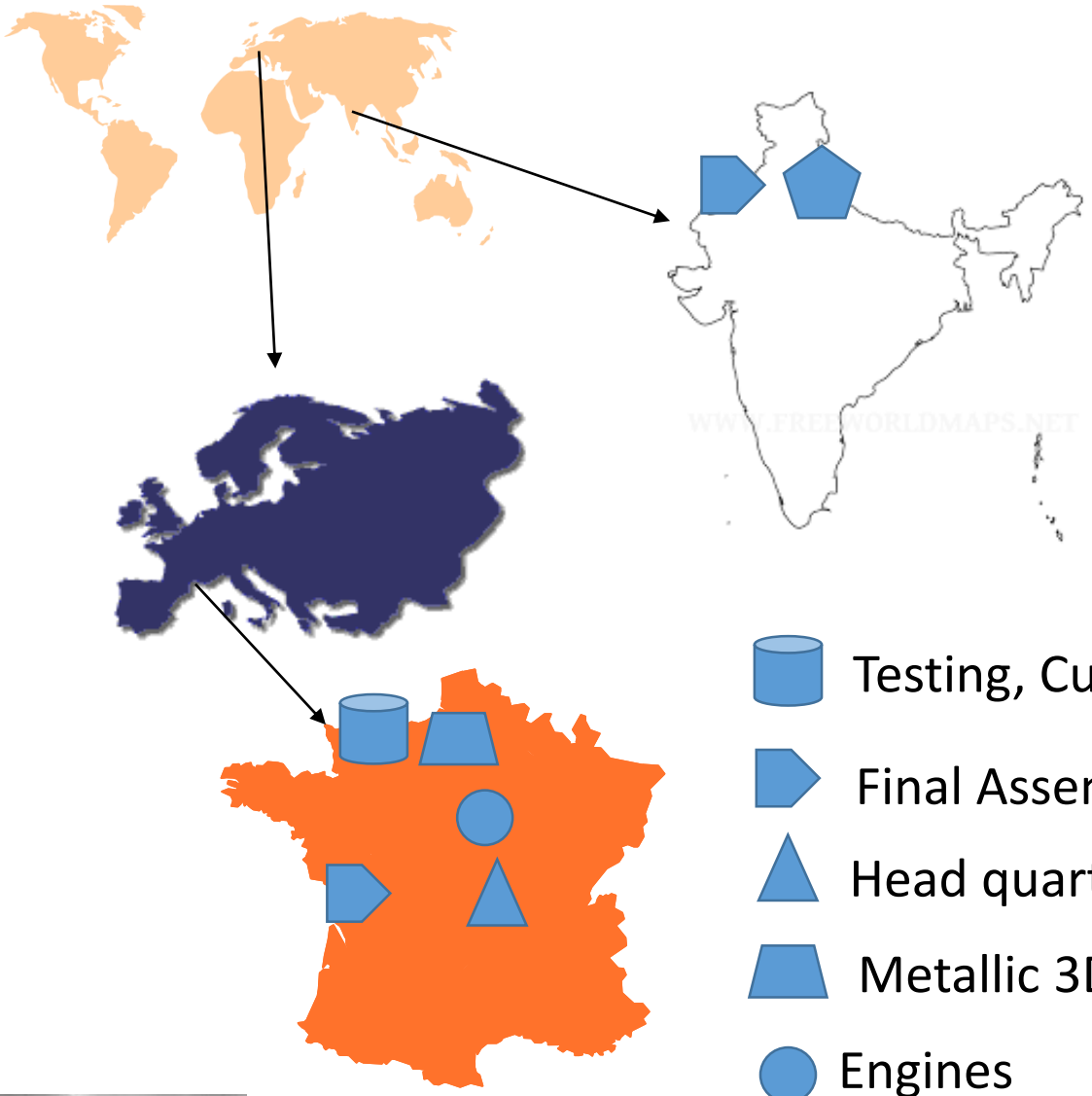
Actions for Mini-Bee TRL2 Project

- Launch Mini-Bee TRL2 project :
  - Assess detailled technical configuration
  - Evaluate market opportunities, production and flight costs
  - Define partnership for TRL2 and TRL3
  - Draw project financial path
  - Investigate for lovemoney phase

Partners to be defined



Targeted Industrial Schem



FAL for Standard Config & Air Ambulance

Flight control system & Equipements

Testing, Customer service & Worldwide Logistic

Final Assembly Line for VIP config

Head quarters

Metallic 3D printing

Engines

Financial project path

TRL	Statut	Début	Fin	Montant estimé (k€)
0	Terminé	2014	2015	20
1	Terminé	2015	2016	50
2	En cours	2016	2017	200
3		2017	2019	2 000
4				5 000
5				10 000
6				15 000
7				20 000
8				25 000
9				25 000

Estimated overall project 100m€

Annexes

Individual Air Vehicules

State of the art

Cessna Skylane

- Height: 2,84 m
- Wingspan: 10,97 m
- Lenght: 8,84 m
- Max Take-Off Weight: 1406 Kg
- Power: 230 hp
- Engine: lycoming IO-540-AB-1A5
- Maximum speed: 269 Km/h
- Range: 1695 Km
- Price: 277 300 $

Robinson R44

- Height: 3,3 m
- Rotor diameter: 10,1 m
- Lenght: 11,7 m
- Max Take-Off Weight: 1089 Kg
- Power: 248 hp
- Engine: lycoming IO-540-AE1A5
- Maximum speed: 240 Km/h
- Range: 560 Km
- Price: 456 000 $

Cessna TTX

- Height: 2,74 m
- Wingspan: 10,97 m
- Lenght: 7,68 m
- Max Take-Off Weight: 1633 Kg
- Power: 310 hp
- Engine: turbo TSIO-550-c
- Maximum Speed: 435 Km/h
- Range: 2315 Km
- Price: 733 950 $

Agusta Westland AW609

- Height:5,1-6,6 m
- Wingspan: 11,7 m
- Lenght:13,3 m
- Max Take-Off Weight: 7200 Kg
- Power: 1900 hp
- Engine: Pratt &Whitney Canada PT6C-67A
- Maximum speed: 616 Km/h
- Range:1390 Km
- Price: 10 000 000 $

Aeromobil 3.0

- Height:1,50 m
- Wingspan: 8,32 m
- Lenght: 6 m
- Power: 81 hp
- Engine: rotax 912
- Maximum speed: 200 Km/h
- Range: 700 Km

Other innovative projects

SoloTrek/Springtail

http://www.trekaero.com/

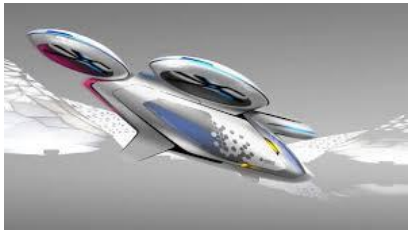
Trifan 600 XTI aircraft

Airbus E-fan (all electric)

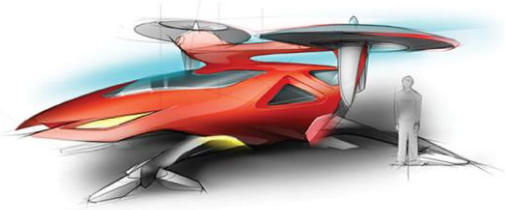
E-volo

eHang (fin 2015)

Xplorair (2016)



Airbus (2016)



Boeing (2016)

Mini-Bee

TECHNOPLANE

AERONAUTICAL INNOVATION

Mini-Bee
2PAX VIP Hybrid Octocopter