



MINI BEE

PERSONAL AIRCRAFT

# Mini-Bee

2PAX VTOL Hybrid Octocopter



# Agenda

- Mini-Bee description
  - Concept and technical description
  - SWOT analysis
- TRL1 project
  - Partners and project history
  - TRL1 Tasks
  - Aerodynamic studies
- TRL2 project launch  
(TRL2 = Technology concept and application formulated)
- Annexes : State of the art, Other innovative projects

# Mini-Bee : 2PAX VTOL Hybrid



TECHNOPLANE

MINIBEE

HAMZA FOUATIH © LESSER OPEN BEE LICENSE 1.3

# Mini-Bee Project partners



Lesser Open Bee License 1-3

Coordinator :



Institution & financial partners :



Universities :

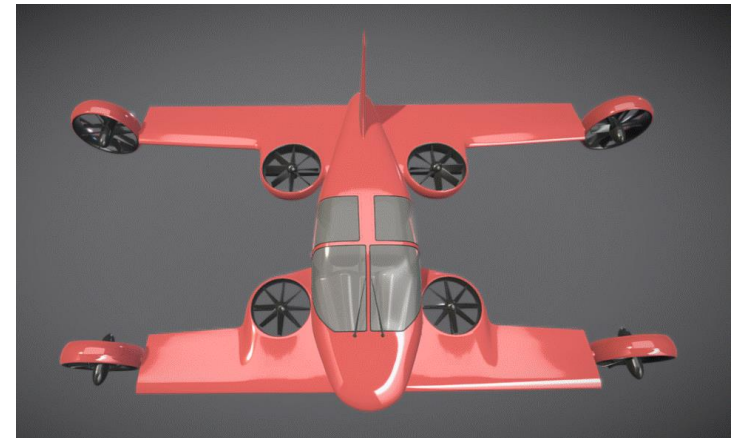
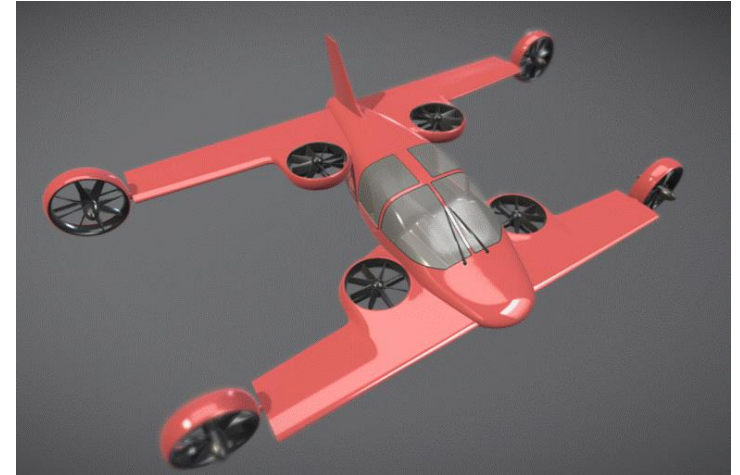


Design:



# Mini-Bee description

- Project state : beginning of TRL2
  - Electric octocopter : 4 vertical + 4 tilt
  - 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 aircraft
  - Estimated price 1m€ (for VIP)



# Architecture

External tilt  
quadcopter

Central vertical  
quadcopter

Rear electric  
generator

Gullwing  
doors

Fuel  
generators

Battery kits

Tailwheel-type  
landing gear

Low noise nacelle

Retractable front  
landing gear

3D printed  
metallic  
structure

Biplane

Electric flight  
controls



# Technical description

## Aircraft characteristics

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

## Engines

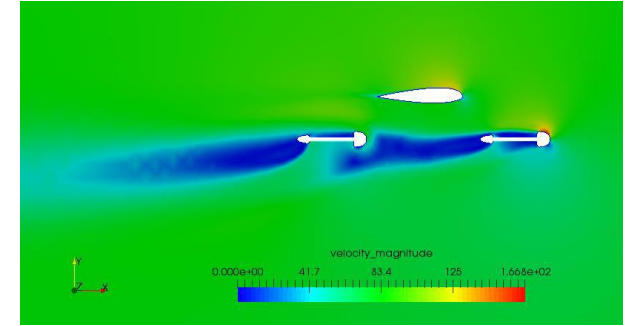
Central vertical quadcopter + External tilt quadcopter  
4 hybrid fuel generator for central quad copter  
4 electric engines for external tilt quadcopter  
Electronic control of engines power and tilt angles

## Cockpit interface

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

# Take-off and flight transition

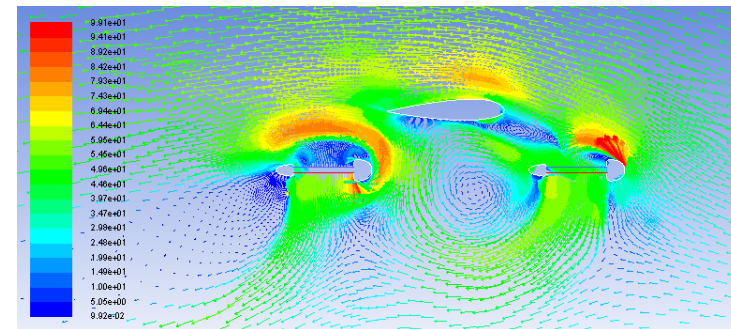
Cruise  
flight



Tilt  
transition

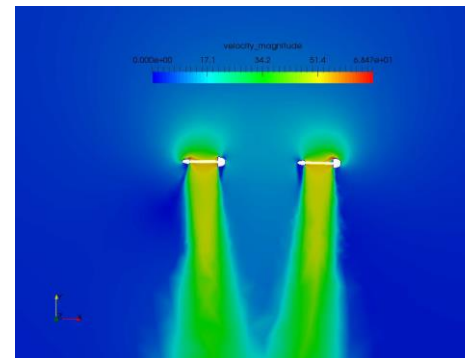


Estaca 2016

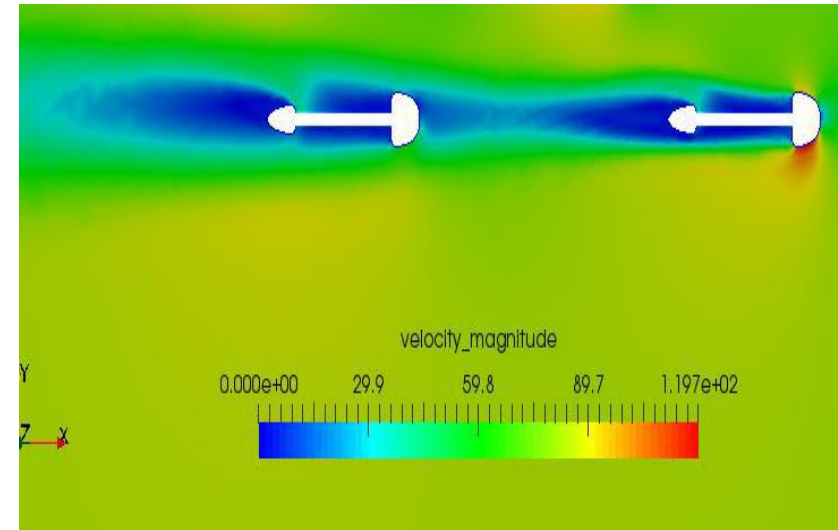


Supméca 2016

Vertical  
take-off



# Cruise flight



# Take-off and tilt transition



By Estaca 2016

# Technical data

MTOW : 1200 kg

- Structure : 310kg
- Fuselage : 80kg
- Payload : 220 kg (2 PAX)
- Systems : 125 kg
- Engines : 240 kg (4 \* generator + 8 Electric engines)
- Batteries : 90kg
- Fuel : 140kg

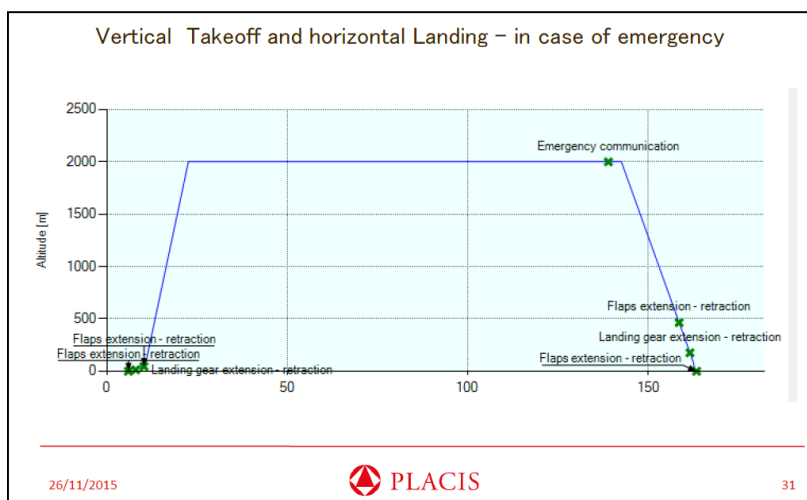
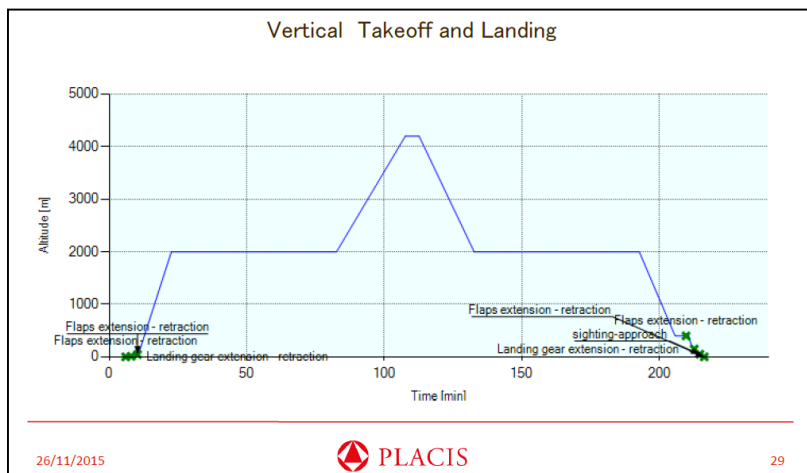
Target for TRL3 : MTOW 1000 kg

# Estimated costs

Total costs : **700k€**

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

# Mission profile



| Phase                               | Duration   |     | Altitude (start) | Altitude (end) | Speed    | Climb rate | Specific Consumption |
|-------------------------------------|------------|-----|------------------|----------------|----------|------------|----------------------|
|                                     | 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                    |

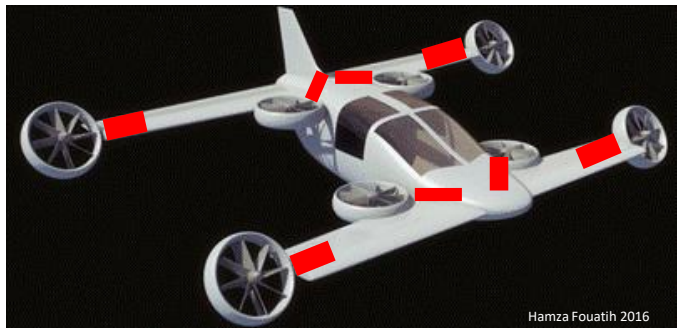
26/11/2015

PLACIS

30

# 8 Electric Engines

**Equipement proposed : 8 electric engines 55k (50kg)**



55kW special designed engines (12kg/engine)  
Or 8 engines Yuneec Power Drive 60kW

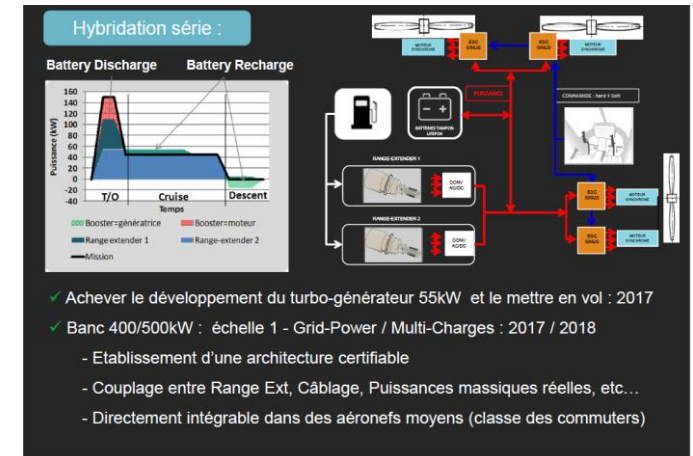
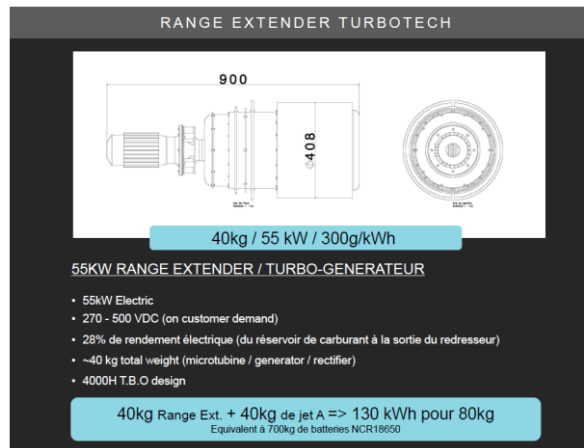
**Power needed 220 kW**  
**Installed power 440kW**

provided by

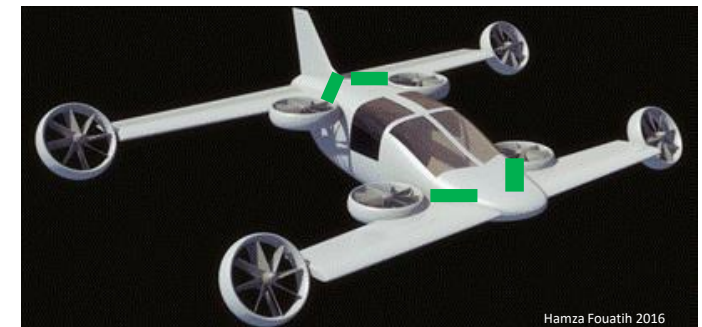
- 90kg of batteries during take-off and vertical flight
- 4 fuel generators during cruise flight

# 4 Electric fuel generator + Batteries

Equipement proposed : 4 Turbotech 55kW (160kg)



Batteries : 1800 NCR 180650 in 10C (90kg)



# SWOT analysis

## Strengths

- VTOL capacities
- Speed of an aircraft
- Double quadcopter back-up in case of engine failure
- Fuel energy range
- Aircraft Design and configuration
- Lesser open source collaborative project

## Weakness

- New configuration
- Project at low TRL
- Aerodynamic and light 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
- Others innovative projects

# Partners for R&D

Project coordinator



## TRL2 Detailed Definition



POLITECNICO  
DI TORINO



In launch

## TRL1 Basic Definition



POLITECNICO  
DI TORINO



# Project history

## TRL0 Project Launch (2015)



## Studies 2015/2016



## TRL1 Basic Definition (2016)



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## TRL2 Concept (2016) in Process



## 2016/2017

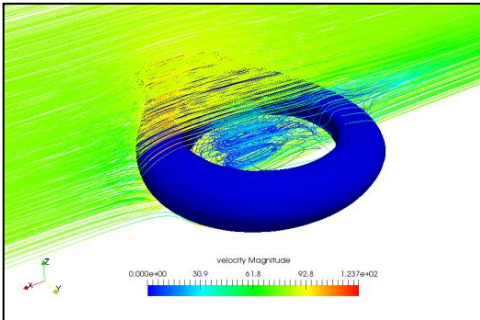


Meet us in  
**Le Bourget Air Show 2017 !**

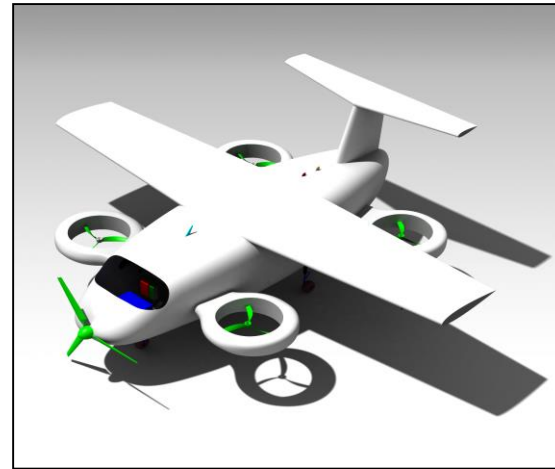
# TRL1 project tasks



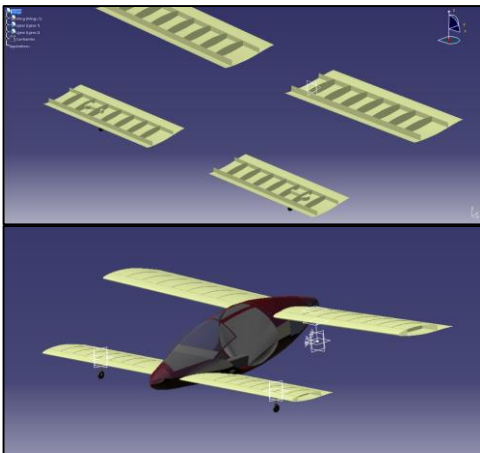
Polito 2015



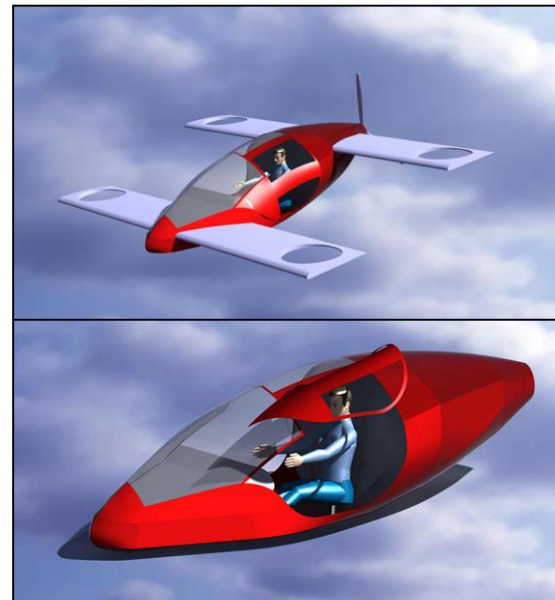
Supmeca  
2016



Supmeca & Polito  
2016 (Placis)

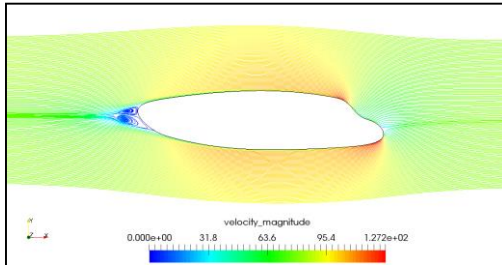


Estaca  
2016 group1

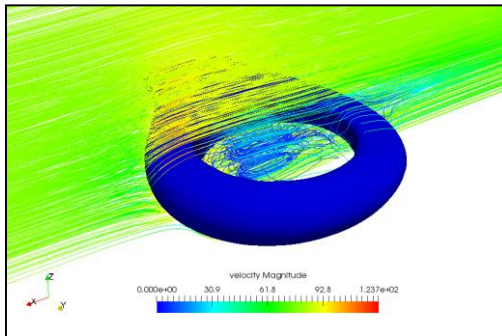


Estaca  
2016 group2

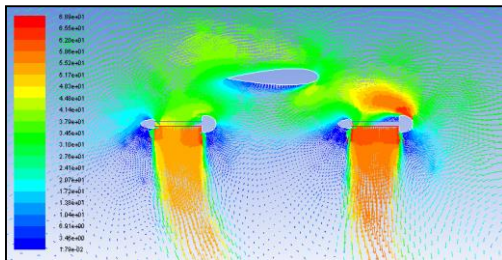
# Aerodynamic studies



Cockpit shape optimization  
Supmeca 2016

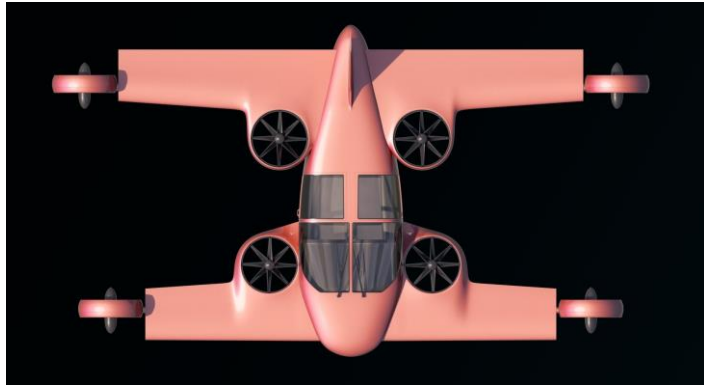


Rotor shape optimization  
Supmeca 2016

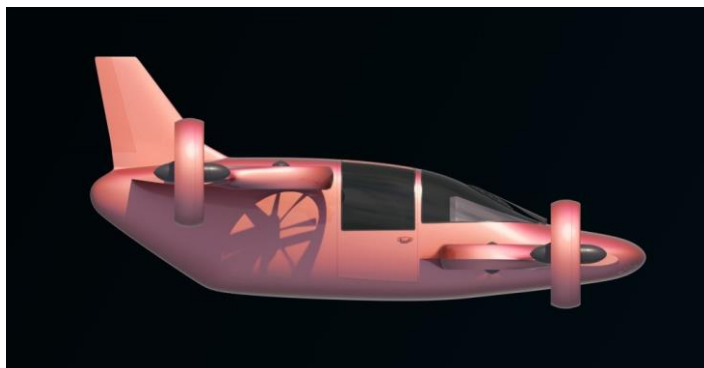


Vertical rotor air flow studies  
Supmeca 2016

# Mini-Bee project for TRL2



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



Estaca Laval 2016



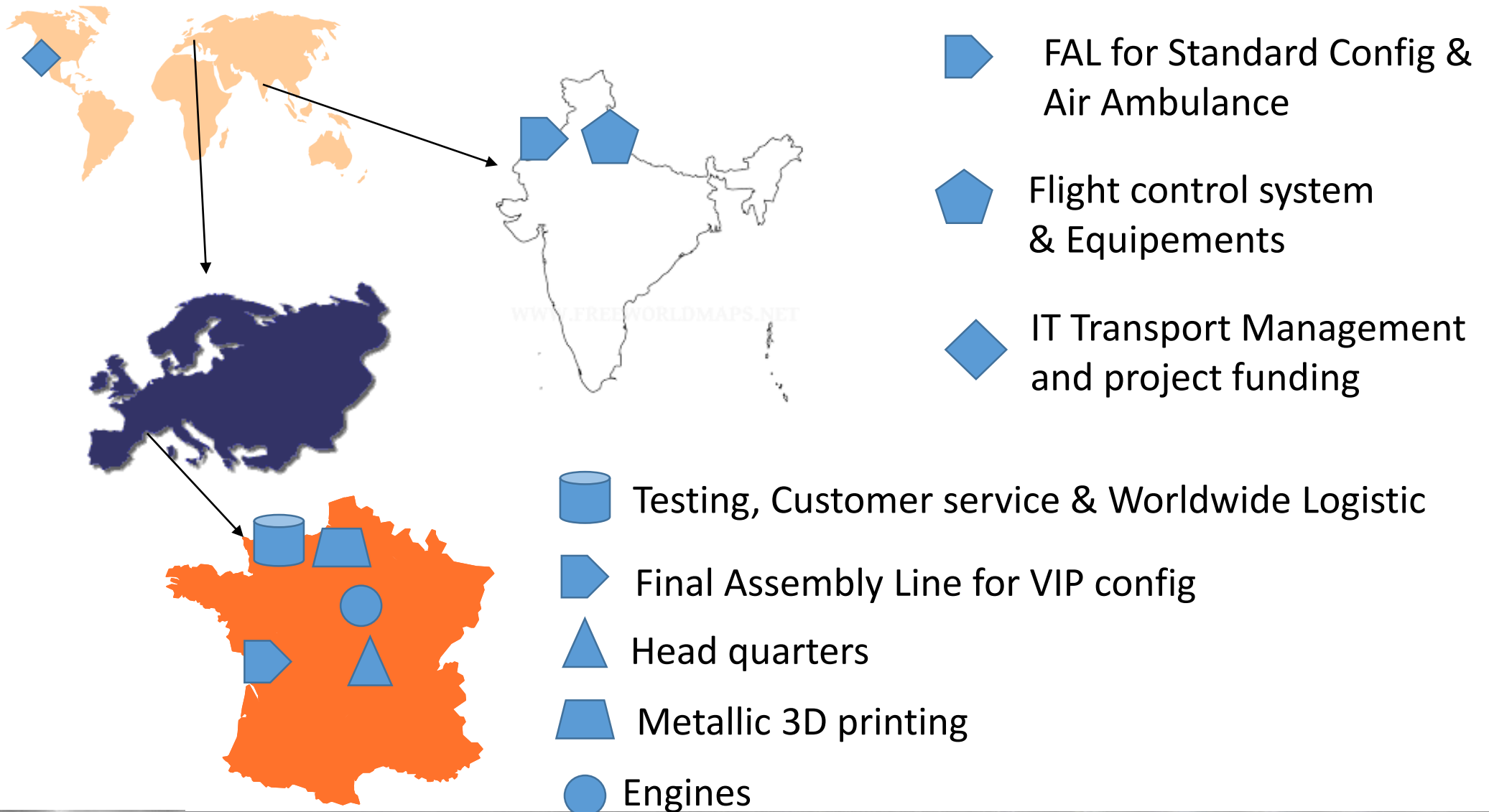
# Actions for Mini-Bee TRL2 Project

- Launch Mini-Bee TRL2 project :
  - Assess detailed 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

|                                           | World | France | India | US |
|-------------------------------------------|-------|--------|-------|----|
| Project sponsors & finance                |       | ★      | ☆     | ★  |
| Electronics and equipment integration     |       |        | ☆     |    |
| Aircraft flight management control        |       | ★      | ☆     | ★  |
| Cockpit interface and project integration |       | ★      |       |    |
| Structure metallic 3D printer             |       | ★      | ☆     |    |
| Aircraft manufacturer                     |       | ★      | ☆     |    |
| Luxury firm for VIP configuration         |       | ★      |       |    |
| VIP end users                             | ★     | ★      | ☆     | ★  |
| Air Ambulance end user                    | ★     |        | ☆     |    |

# Targeted Industrial Schem



# Financial project path

| TRL | Statut | Début | Fin | Montant<br>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 |

Detailed numerical mock-up

First flight

Test flights

Final developments

Qualification

Commercialisation / Operations

Estimated overall project 100m€

Actual step : Lovemoney for 500k€ to 2m€

# Annexes

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## Individual Air Vehicules

# State of the art

**Cessna Skylane**



- Height: 2,84 m
- Wingspan: 10,97 m
- Length: 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
- Length: 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 \$

**X3 airbus**



**Osprey V22**



**Cessna TTX**



- Height: 2,74 m
- Wingspan: 10,97 m
- Length: 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
- Length: 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 \$

**Airbus H160**



**Aeromobil 3.0**



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

**Ecureuil**



**X2**



# Other innovative projects



Trifan 600 XTI (2015)



Helium (2016)



Agusta Westland  
Zero (2015)



Airbus E-fan (2015)



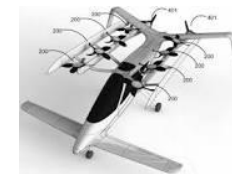
E-volo (<2014)



eHang (fin 2015)



Kitty Hawk (2016)



zee.aero (2016)



Joby (2016)



Moler skycar  
(<2016)



Urban aeronautics  
(<2016)



Xplorair (2016)



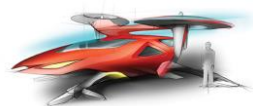
Lilium (2016)



SoloTrek Springtail



Airbus (2016)



Boeing (2016)



Macro industrie (2016)



Trekaero.com



Mini-Bee (2016)

# Mini-Bee

2 PAX VIP Hybrid Octocopter



TECHNOPLANE

MINIBEE

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**TECHNOPLANE**

AERONAUTICAL INNOVATION