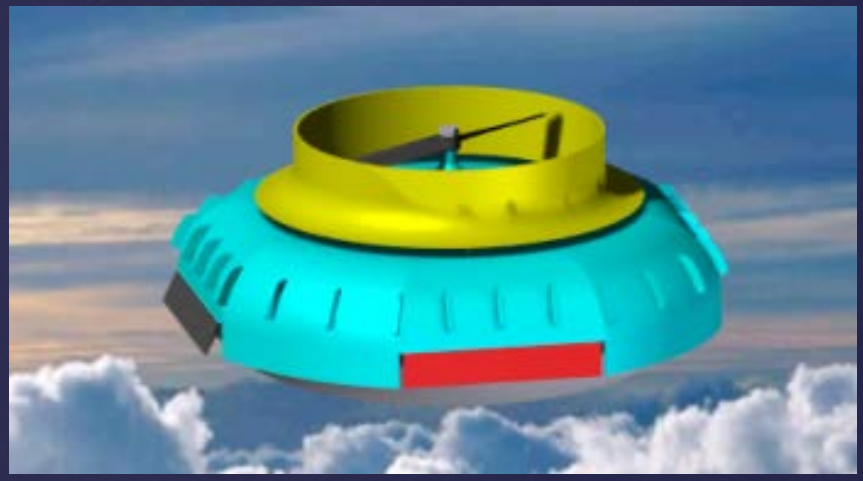
CEDREN

Centre for Environmental Design of Renewable Energy

Seminar on UAV-based remote sensing in fluvial research

Trondheim, Nov. 13, 2014



Coandă Effect aerodyne – a new platform concept for a fluvial and ecological remote sensing aerial vehicle

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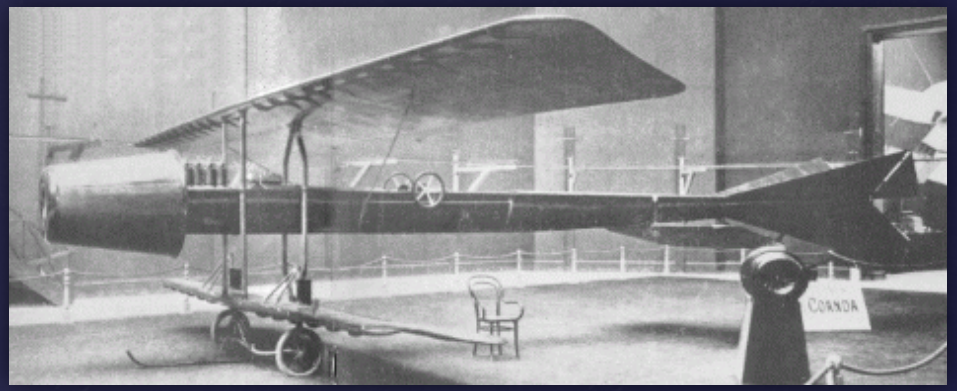
Coandă Effect *aerial vehicles (AV)*

Coandă Effect is a classic phenomenon in fluid mechanics and one of the fundamental discoveries of the Romanian inventor **Henri Marie Coandă.**

Henri Marie COANDĂ
Romanian engineer and famous inventor
(1886 – 1972)



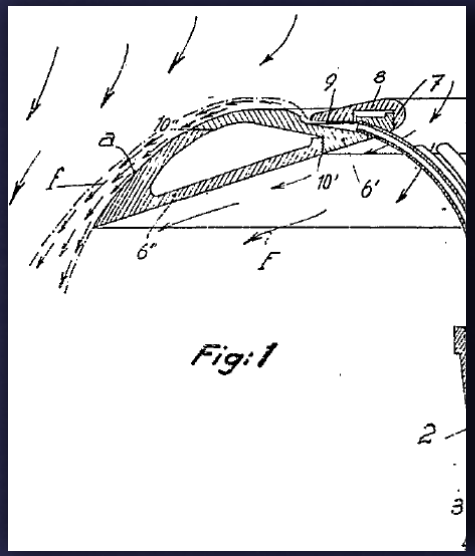
Coandă 1910 - *the first jet aircraft of the world*, *designed, built and tested, 100 ago by H. Coandă*

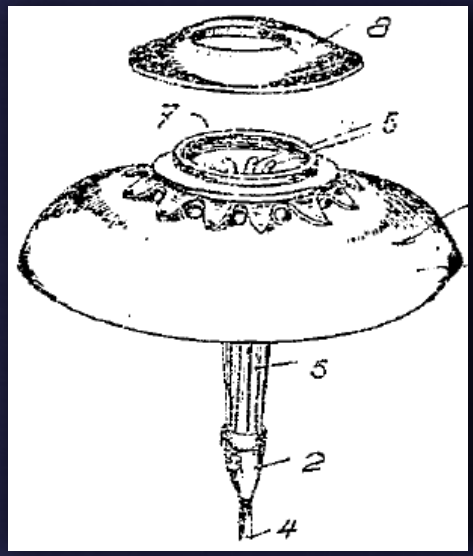
H. Coandă was a Romanian inventor, aerodynamics pioneer and the **designer** and the **builder** – 100 years ago – of the **world's first jet powered aircraft**, the **Coandă-1910**, a revolutionary plane of the beginning of the 20th century.

Coandă Effect *aerial vehicles (AV)*

In 1935, 25 years after his first flight, H. Coandă proposed, in a French patent, the first Coandă effect application for aerial vehicles.

This new invention is used nowadays by **a new class of UAVs**, that we named **Coandă UAVs**.



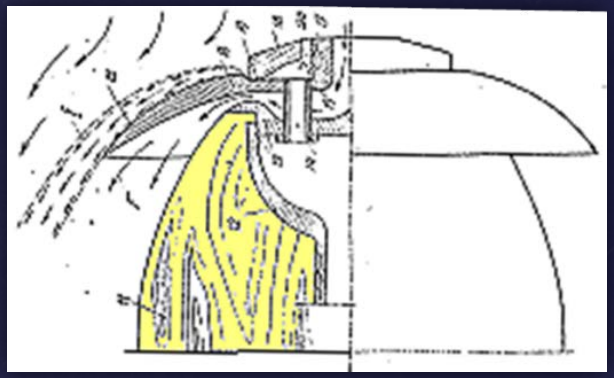


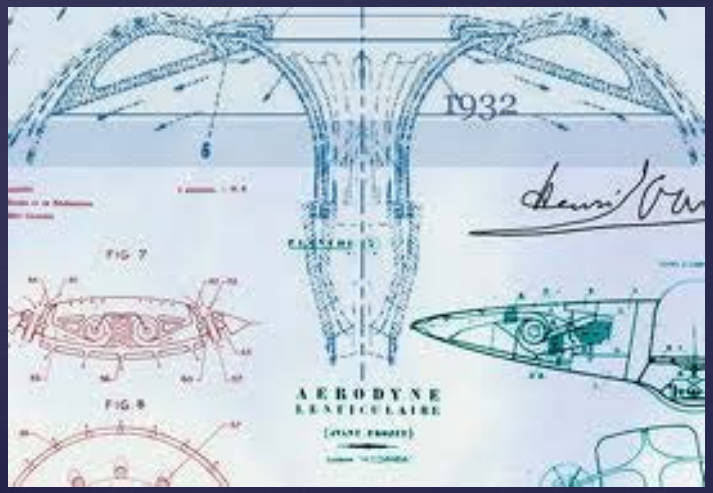
H. Coandă - *„Perfectionnement aux propulseurs”*
Brevet d’invention France, no. 796.843 /15.01.1935

In his first patents, in order to generate the jet of fluid over the upper surface of the fuselage, H. Coandă was using a rotor or other gazeous fluid sources, i.e. a burner or a combustion chamber.

Coandă Effect *aerial vehicles (AV)*

As a natural phenomenon, Coandă effect describes **the tendency of a fluid jet to follow a nearby surface** (flaps or airfoils), even it is not a planar, but **a curved** one.

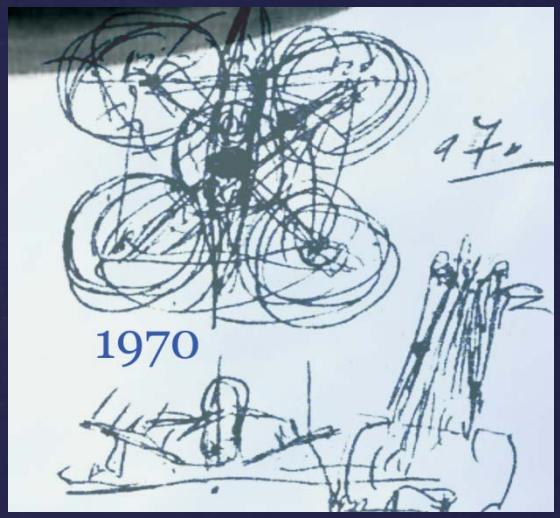




In the 40's, H. Coandă also designed, a flying machine, he later called **aerodyne**, resembling with what we call now as *a flying saucer*.

Coandă Effect *aerial vehicles (AV)*

H. Coanda
and his
Aerodyne Lenticulaire



A Coanda effect scale model

Coandă Effect *aerial vehicles (AV)*

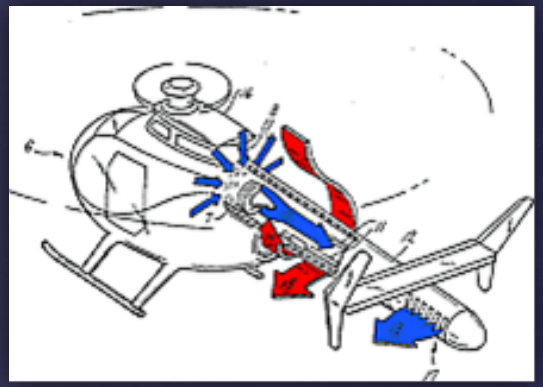
The **US Aerodyne**
– artistic image

In the US, after 1945, a number of experimental ***saucer shaped craft*** were apparently developed as **black projects** by **Lockheed Corporation for the USAF**, and by **Convair for the CIA**. The saucer had the advantages of being a **VTOL design** (so avoiding the need for easily damaged runways), while the shape was well suited to diffuse the radar.

These early designs were apparently powered by turbojets, which powered **a horizontal rotor to provide lift using the Coandă effect**. Meanwhile in Canada, the **Avro Canada** funded by the Canadian government, developed **another kind of Aerodyne** .

Avrocar - in tests

Coandă Effect – NOTAR helicopter



The air flow through the NOTAR system

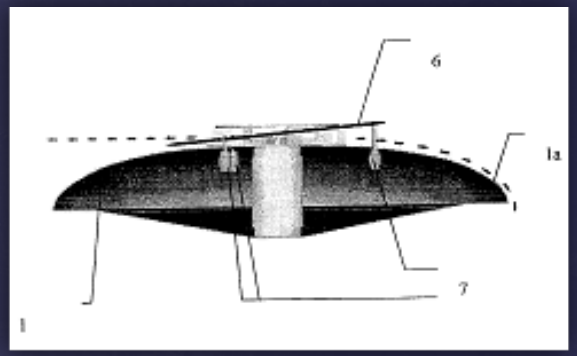
In aeronautics, Coandă effect is used today primarily in helicopters that have **no tail rotors**, as in NOTAR system. NOTAR is the name of an anti-torque system which replaces the use of a tail rotor on a helicopter.

It was developed by McDonnell Douglas Helicopter Systems and the name is an acronym derived from the name **NO TAil Rotor**.

NOTAR uses a fan inside the tail-boom to force a high volume of low-pressure air, to exit through two longitudinal slots and to create a boundary layer flow of air along the tail-boom, usingCoandă effect.

The NOTAR system used by NEO helicopter from YoungCopter

Coandă Effect AV – Coandă UAVs



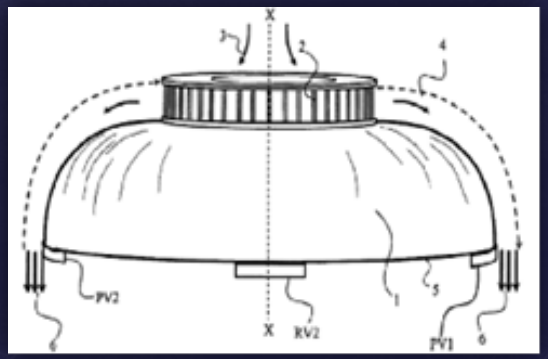
Robert Collin's *„Aerial Flying Device" – UK Patent Office GB 2,387,158 /08.10.2003*

Decades after, in UK, Robert Collins valued Coandă effect capabilities for aerial vehicles in one of his inventions, obtaining in 2003 a GB patent.

This new Coandă application was already presented in his paper „Coandă - A New Airspace Platform for UAVs" at the Bristol International UAV Conference, in April 2002.

Also after 2002, another inventor from UK, Geoffrey Hutton, together with the *GFS projects Ltd,* promoted another Coandă aerial device, with a similar circular shape canopy.

Geoffrey Hatton, Simon McIntosh, GFS Projects Ltd., *„Craft having flow-producing rotor and gyroscopic stability" UK Patent Office no. GB 2,424,405 /23.03.2005*



Coandă Effect AV – Coandă UAVs

When GFS projects built their first model, the circular shape turned to be octagonal, with flat flaps on four opposite sides of the trailing edge.

Geoff Hatton and his invention

In 2006, in France, Jean-Louis Naudin made and tested his first GFS-UAV (N 01A).

This one, propelled by an electric engine, was using the Coandă effect to take off vertically, fly, hover and land vertically (VTOL).

*In 2007, Jean Louis Naudin freely published the full plan of his GFS-UAV (N-01A) together a detailed tutorial to help UAV fans to replicate his GFS UAV.

J. L. Naudin's *first GFS-UAV (N 01A)*, with a design based on the Geoff Hatton' flying UAV*

Coandă Effect AV – Coandă UAVs

In 2007, Geoffrey Hatton presented an optimized control for his family of Coandă UAVs, this time improving the airflow over the outer surface, especially in open air, when it may be disturbed by a lateral wind.

Finally, in 2007, Geoffrey Hutton and GFS Projects Ltd. won a contract with the US government.
They had to design an unmanned aerial vehicle, as a demonstrator for the capabilities of a new Coandă UAV family.

Coandă Effect AV – Coandă UAVs

Also in Romania, in 2008, an academic consortium, with researchers from **Galaţi, Iaşi and Bacău** universities, coordinated by the speaker, obtained, for the researches on Coandă effect, a national grant.

According the contract, this new UAV, named **MEDIAS**, had to be in the same time a modern and a nonpolluting aerial vehicle, easy to maneuver and safe to the environment and people.

Coandă UAV – Mission specific design

- ✓ MEDIAS project developped as an **interdisciplinary** one, with specialists in environmental sciences joining their efforts together with engineering sciences ones.
- ✓ MEDIAS UAV has to be **a non-polluting aerial vehicle**, meant to monitor the environmental parameters, at the same time having the lowest possible impact on the environment.
- ✓ The project will use the well-known (yet not so much studied) **Coandă Effect**, in order to sustain, propel and steer the vehicle. This effect seems to be more promising then those used nowadays, regarding the **energetic efficiency** supplied.

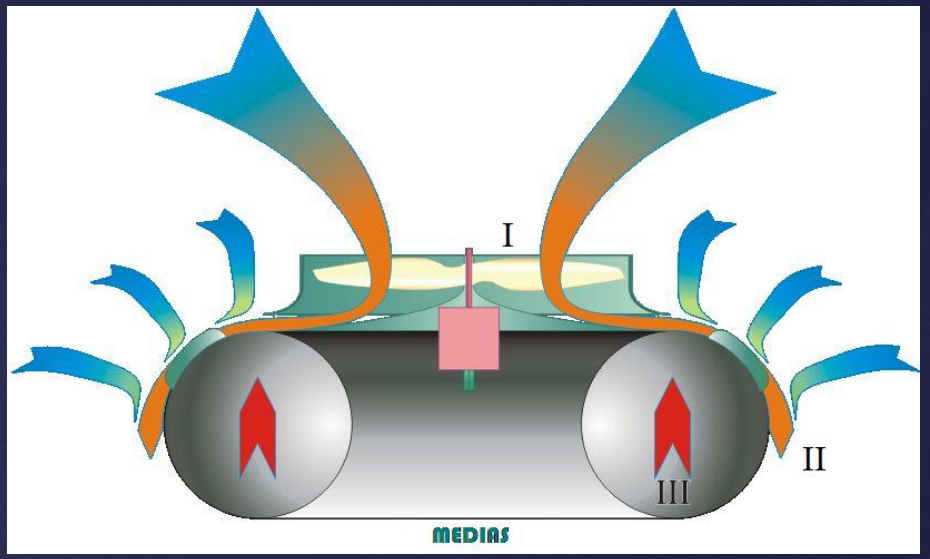
Major Design Requirements

When we had to design this UAV for **Environmental Surveillance and Parameters Monitoring**, we had in mind ***5 major requirements*** for the vehicle, as:

1. To create a non-polluting vehicle,
2. To obtain a maximum of autonomy (hours & km),
3. To have the possibility to hover over an designated area,
4. To have VTOL (Vertical Take-Off and Landing) capabilities, because a plane type is dependent of a long landing-strip.
5. To design a more efficient propulsion system.

Final design

Because of the requirements for the design on this aerial vehicle, our solution is characterized by the fact that this COANDA UAV shall use:



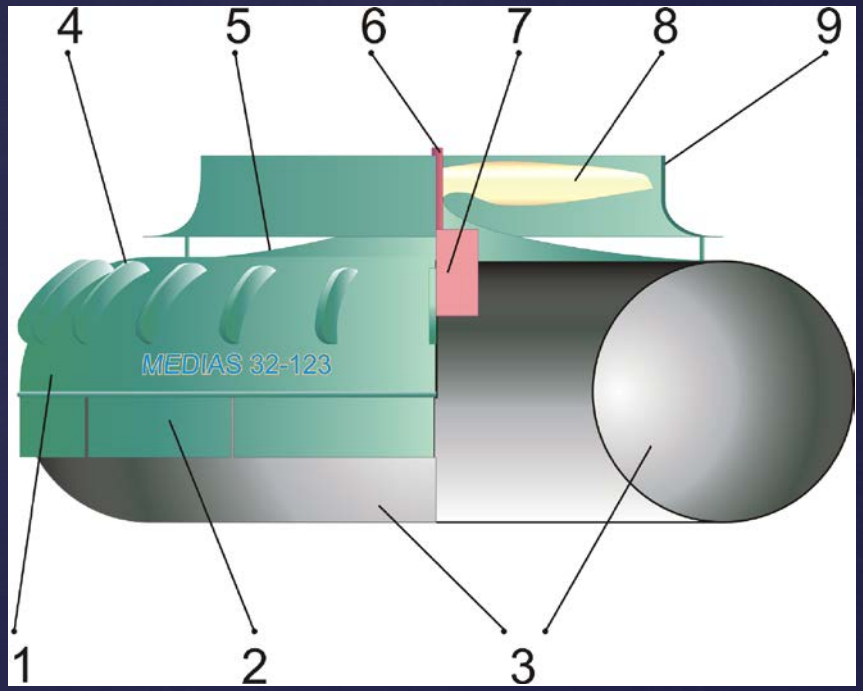
The lift force components of MEDIAS UAV

- ✓ An electrically driven propeller (I);
- ✓ Coandă Effect (II);
- ✓ An optionally added **helium inflatable chamber** (III), in order to **increase the autonomy** (and **to help** when the landing happens **in wetland type area**).

Final design

MEDIAS UAV has as components the following:

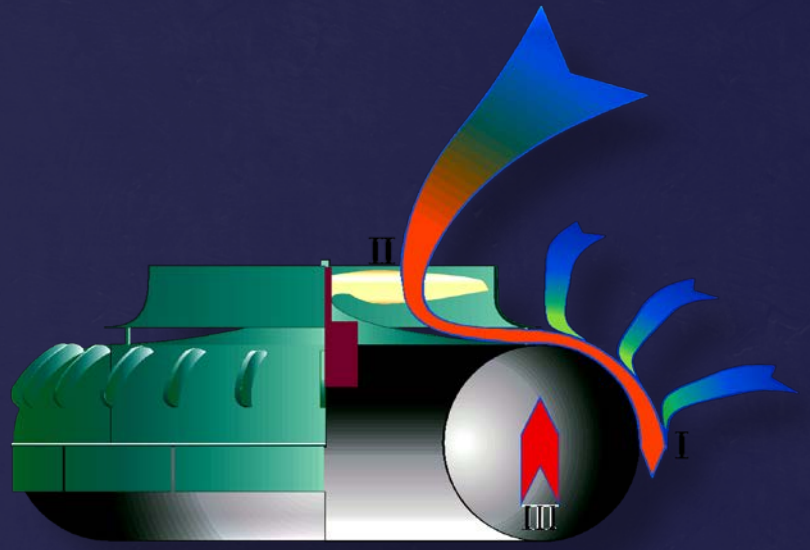
1-profiled upper cap
2-the steering flaps
3-toroidal Helium chamber
4-anti-torque rudders
5-inner exhaust profiled cap
6-propeller's shaft
7-brushless electrical motor & batteries
8-propeller
9-propeller duct



Partial section through MEDIAS UAV

Coandă Effect AV – Coandă UAVs

Coandă Effect will help us to **vertically redirect the exhausted jets** from the central propeller duct, adding more lift force, for either a greater **autonomy** or a greater **payload**.

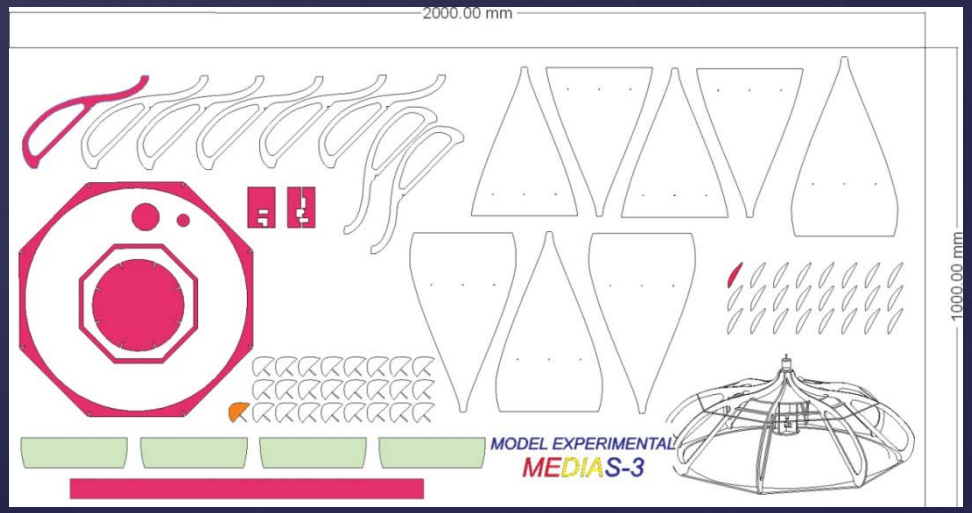


Partial section through MEDIAS UAV

Alongside these features, optional conversion & use of **solar energy** will improve the design and will compete at increasing the UAV's mission **autonomy**.

MEDIAS experimental models

Due to some major financial constrains – i.e. grant budget cuts of up to 63% – MEDIAS UAV remained only at the level of **demonstrator.**



MEDIAS experimental models

However our team managed to make 3 different **experimental models** and so, the design named MEDIAS-03 was finaly capable **to prove the Coanda UAV concept**.

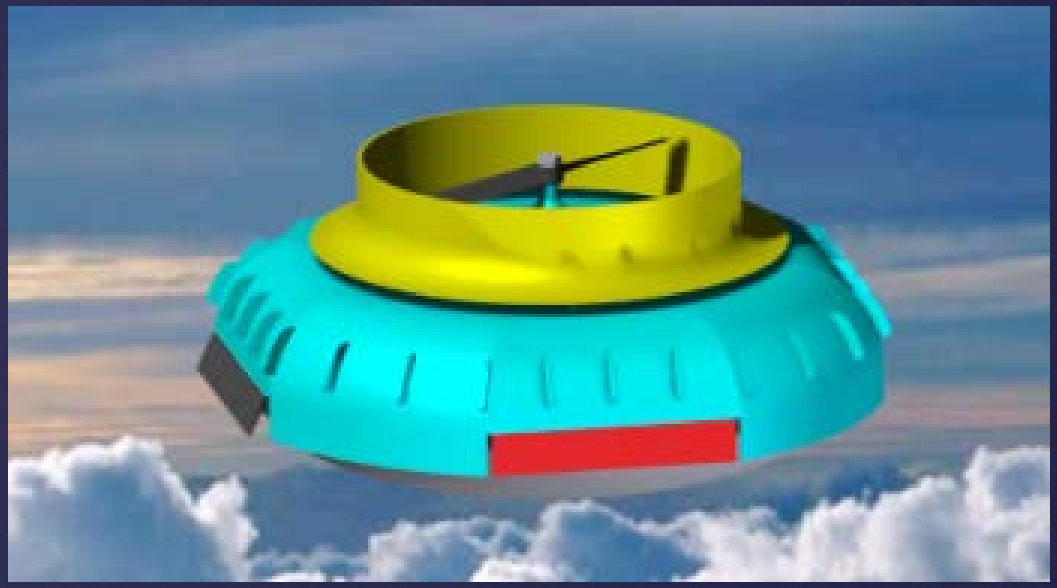
MEDIAS-01 model

MEDIAS-02
Fiberglass model

MEDIAS-03 Final model
(0.9m diameter 2.8 kg own weight w. batt., 1kg payload)

CONCLUSIONS

1. This Coandă type aerial platform (*aerodyne*) should be in the same time:
   - A modern aerial vehicle, with a higher energetic efficiency,
   - Nonpolluting, safe to the environment and people,
   - Having a good ratio: payload vs. total weight,
   - Easy to maneuver (it is a VTOL = vertical take-off and landing), and also – in case of MEDIAS concept:
   - Adequate for **wetland type areas** (i.e. with **a mix of ground or water**), being capable to **land** (or to **float**), with the help of its toroid shape gas chamber.



Thank you
for your attention !


We wait for you at the Small Wetland of Braila, in Romania!

AESIR – Coanda type UAV