SCIENTIFIC BASIS OF COANDA'S WORK IN 1910

Anniversary Session ***"Celebrating 100 year of the first jet aircraft invented by Henri Coanda"****, Romanian Academy, 15 December 2010, Bucharest, Romania*

Iosif RUS*

DOI: 10.13111/2066-8201.2010.2.4.5

32 years ago, on November, 25, 1972, Henry Coanda, the world-class Romanian scientist, an illustrious inventor and builder of aircraft, took off to the infinity leaving us a rich heritage of over 2000 inventions along with over 250 Romanian and foreign patents, 33 of which addressing fundamental domains of contemporary science and technology.

Maybe in 2011 a part of these will be brought to attention again on the occasion of the celebration of the 125-th anniversary of the scientist's birth. (June, 7, 1886).

I consider that the fundamental achievements and scientific basis of Coanda's creation in 1910 can be understood better if we take into account a few of the messages that we received in various moments of his activity and that offer insight on his approach to life, study, struggles and his inventions. Thus he is quoted as saying:

"To design a flying machine is almost nothing. To build it is hard. To make it fly is everything!"

We think that the basis of his success was the perseverance and intelligence, about which he used to say: "*A human quality that is very important to me is the perseverance. The essential one is intelligence. The endless possibilities of the human intelligence can only be developed by continuous perseverance."*

Another quote on **evolution**: *"…man must fight to go forward, always forward… to make himself useful to the community in as many domains as possible, in as many occasions as possible. I think that only then can one be satisfied about oneself..."*

Henry Coanda had the potential to become a good sculptor or a violin player or maybe a professional military with diplomatic abilities or a cold tech engineer. But he chose aeronautics. It was a very new research domain, mostly unexplored and of relatively low interest at the time. It could not be understood as a real profession in those times. It was 1904. Coanda's interest in aeronautics became certain and inspired others to follow. How did this interest appear? Who or what determined him to become interested in such a domain, poorly defined at the time and that could not provide a career or an occupation?

When he chose this area of interest, a century was ending, another one was just beginning. Had he anticipated that aeronautics was to become a dominant element in the new century? Had he anticipated the airplane would spark a new and spectacular revolution of locomotion!? It seems obvious he had a very strong awareness of his own time. He read in various publications about Clement Adler, but paradoxically, he was interested in a completely different thing!

He confessed making a journey to Spandau to see the places where Otto Lilienthal made his glider experiences and the research documentation he had left. It is thus possible he heard about Lilienthal's table of lift values as a function of the wing incidence, and if not, he surely read his paper "*Le Vol des Oiseaux consideré comme base de l'Aviation*" (Birds' flight as a basis for aviation).

The first confirmation of these facts comes in 1905 when Henry Coanda received an approval to test rocket powered craft, at the Army's Arsenal in Bucharest. He certainly had

some information on rocket power as a result of his various lectures. It is also possible that his father may have helped him with his experiments, having in view that the latter wrote a study named "Projectile si focoase" (projectiles and warheads) in 1884. Attaching a rocket to an aerodynamic body and increasing the propulsion accordingly was not a real problem! But the experiment could throw some light on the behavior of the considered profile at the rocket-induced speed: a steep climb followed by a crash. It is possible that his vision on mechanized flight became clearer and he formed a multitude of ideas he wanted to verify. Matei I. Oroveanu, considers in his work *"Inceputurile creatiei tehnice si aeronautice romanesti, 1880-1918"- ("The beginnings of Romanian aviation and technical creation, 1880-1918"*) (Military Publishing House), that these ideas constituted the beginning of Coanda's aeronautical research.

He lived life to the fullest, frequenting artistic gatherings in Germany, working in Rudolf Marcuse's workshop. Then, later, in Rodin's sculpture workshop he discovered the beauty and equilibrium of carefully crafted forms, fascinated by their symmetry and discovering the philosophy of the contour (V. Firoiu, *Din nou acasă... Convorbiri cu Henri Coandă*, Ed. Tineretului 1969, p. 93*)*.

Coanda exhibited plastic artist abilities, leaving a few remarkable works to posterity **(Prometeu, Dejunul Muncitorului, Catre bunica, - bronze works**), and formed an artistic culture that he later used in technics, as can be witnessed by the build of his aircraft.

He created his own scale of values in which *change,* as a motive force of the future, had to be radical. He approached aeronautics following this conception, trying to obtain as much information as possible. He had the intellectual capacity to do this selectively. To the end of the first decade of the 20th century he was self-taught, even if, according to his confessions, he was directed at times by various recognised specialists in several domains. Nothing bad in this fact, as in those times most of the aircraft builders and designers were self-taught. There were no specialty institutions to ensure even a minimal level of preparation.

His occasional meetings with Ferdinand Ferber, in Nisa in 1906, another pioneer of heavier-than-air flying machines, happened under such circumstances. We don't know exactly what plans and theories did Coanda present to Ferber but, as V. Firoiu wrote in the aforementioned paper, (page 104) that *in H.Coanda's mind new ideas flourished, ideas that would rise the level of all these attempts by several decades, to recouperate the time humanity lost for so many centuries, to push these technics forward, revolutionary, ahead in time and space. He wanted a means of flight that would not expect its evolution but to give man the deffinitive and great potential of the limitless infinite, without losing successive investments and evolutionary expectations.* Firoiu points the source of these ideas to be an intimate diallogue of Coanda, in those times, when he possibly revealed them to the author cooperating in the writing of a book. From an unpaged and undated notebook used by Coanda for his autobiography we learn of an answer received from **Ferber**: "*Young man... you are probably right and if you are convinced of what you say and provided you have enough time, maybe you will succeed"*. What answer could Ferber give him when he was looking for a sollution to lift his own machine off-ground? ! Without speed there would be no flight. But how to obtain speed? The Wright brothers' sollution using an incline or a catapult had no future.

Coanda perseveered in his belief that he could change the present. Here he included Traian Vuia himself! He was with Ferber "to the first aerodynamic tests in the south of France" (see *Henri Coanda and the jet plane in Building a Bleriot and discovering the pioneers of aviation, nr. 73, Hachette Collections, 2002, p.259, and A researcher of prime*

rank: Henri Coanda, in Pioneers no.25 of 15 of July 1970, Year 6, p.29). He had seen his writing, he followed his building of the plane and apparently he manifested his disagreement on the propulsion system and the low efficiency of the propeller.

At his return to Germany, he continued his experiments and declared that "*Ferdinand Ferber appreciates this machine in a report to the government regarding German aviation"*. A meeting with Ernest Archdeacon, a great personality of French aviation, followed. By him he met Gustave Eiffel. The french engineer was more than 70 years of age..."*I understood that in this person I met another passionate researcher of the problems of aerodynamics, just like myself,* -recalled Coanda- *and now, as he neared the twillight of life the engineer become a savant, he had vast knowledge that would have really helped me*".

Henri Coanda

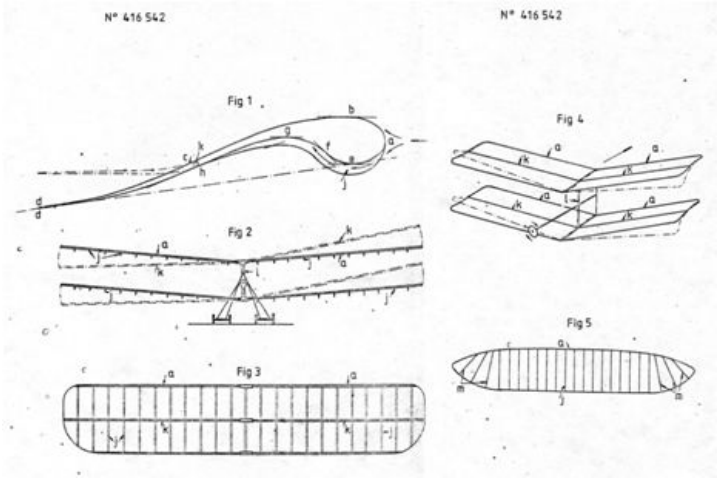
Gustave Eiffel gave the Romanian engineer a signed copy of his work, intitled: *"Nouveles recherches sur la resistance de l'air et l'aviation, faites au laboratoire d'Auteuil".* Surely this was not the only specialty book he read. There were a few "mandatory" titles of the epoch that would interest all the serious enthusiasts of aeronautics. They were: *Recherche sur le vol des oiseaux et l'art aeronautique* a lui Dubochet appeared in 1834, *Vol d'Oiseau et Machine Volante* by the Swiss Carl Steiger, *Le Vol des Oiseaux* by Etienne-Jules Marey published in Paris în 1890, where he presented his results of applying cronography to the flight of birds, the famous work *L'Empire de l'Air - Essai d'Ornithologie appliquée a l'Aviation*, issued in 1881 by the Masson Publishing House-...*Experiments in aerodynamics, Smithsonian Contributions to knowledge* by S.P. Langley and published in Washington în 1891, tranlated later and, republished in 1899, by M. Lauriol in the French specialty journal *Revue de l'Aéronautique, Experiences sur la resistance de l'air* and then, in the *Bulletin de la Societe d'Encouragement pour l'Industrie Nationale.* The access to these works confronts Coanda with a vastly French repertoire of technical specialty work.

Eiffel helped him meeting the great science celebrities, that he needed to clarify aspects of some of his preocupations in creating an airplane. About this, Coanda wrote: "*The engineer, of an exceptional lucidity, was not afraid to say that in a certain domain concerning the air friction we would have to meet another specialist in aerodynamics, and he did so only because he wished to help me. So I had the opportunity to meet and receive a genuine support from proffesor Paul Painleve".* This former Sorbonne colleague of the general Constantin Coanda was, at the time of the meeting of the two, an Institute member and proffesor at the Faculty of Sciences in Paris and at the Politechnical School, author of very important works in air friction. Coanda recognized the importance of meeting Painlevé: "*The scientific diallogue we had then helped me to mentally approach my dream very much;*

my knowledge of propulsion were appreciated, but my lack of knowledge in the optimal airfoil design were not overlooked. I remember this episode just to show that the joining, the value comparaison and company of well-meaning scientists can determine that revolution that would lead to discoveries and boost of the will in a force comparable phisically only to that produced by the jet's propelling thrust..."

Painleve accompanied Coanda to the meeting with Louis Bleriot, the only man that, in the great matematician's opinion, could help Coanda understand lifting wings. Coanda was shocked by the shape of the new airplane, *Blériot VI*. We are approaching 1907 and Bleriot's genius is in its finest hour. Doubtlessly inspired by Vuia, he prefigured the later , modern airplanes: a monoplane with wheeled fuselage, controls up front and a way to balance the aircraft on three axes. Bleriot explained to Coanda that *".. before propulsion you must understand what a flying machine is, and that the Chanute- Ferber system is not the sollution*". Coanda's conception was entirely different " *..for me, the flying machine is a whole, propulsion and lifting system"*. He had an insight of the essential in aeronautics of the beginning of the century- that within the French technical repertoire, the flying machine was not understood. If the study of lifting surfaces moved forward, it still would not mean a warranty for the building of a perfect airplane.

Bleriot XI monoplane. Note the wing profile.



Study of the reaction effect over the wing

It was this conception that set Coanda apart from most of the aircraft builders of the time. **It was his reffusal of entering their group that gave him the role of protagonist of the historical moment that aeronautics was in, but also the reason for which he would miss the normal disputes between builders, and the exchange of ideas and opinions**.

It is plausible that at the time, Coanda would have mentally designed his plane. Just as he did in reality, a few years later. Coanda's vision on the aircraft was, possibly, already well defined. Details remained. **Maybe that, in a relatively short time for Coanda, part of his mental projection of the build was to become obsolete. He lives the genius' drama that tries to put order in his work, but ideas come very quickly and do not allow time for practical testing. It is like a permanent assault that makes and un-makes his airplane. He had to decide thus how to stop the new ideas. In such moments he felt the need for a break to settle his ideas** –and for this he would find very few answers in the time's builds.

V. Firoiu claims that Coanda would have presented a model for a turboprop aircraft at a German exhibition, in 1907, but it failed to raise interest (p. 114). Between 1907 and 1908 he attended courses at the Montiflore Technical Institute in Belgium, and gives a public lecture on the "*Problem of Aviation*" that was also published in the Romanian journal Adevarul, in 1909.

Around that time Coanda met Giani Caproni, an Italian engineer graduate of the Munchen Polytechnic Institute, a student of the Montiflore Institute like himself. It was a providential encounter. "*Caproni was for me- said Coanda later-all what I missed at the time. He eased the testing of some theories, without which I'd had serious doubts about the viability of the concepts, and his Mediterranean cheerful and tumultuous temper made me remain forever confident in the success of my actions and in everything I undertook. Caproni lived under a forever bright sky and tried to keep me there, by his side". (*V. Firoiu, cit. work, p. 118).

In cooperation with this new friend, he built at Blaumal in the Ardens a glider that used constructive sollutions from both Chanute's and the Wright brothers' gliders.

Coanda Caproni glider

Coanda Caproni glider

We think that the design of the glider started in the autumn of 1908. Coanda left very few notes on general conception, on what and how he wanted to build this aircraft. *It is really hard to understand how he thought of creating the first motojet plane, without propeller*. But so it happens with the great inventions that bring the future in the present. Even if we could interview Coanda right now on this subject, we could not find a great deal. We must search, presume, and obviously, speculate.

According to some texts, he "*did not try to overcome the air resistance using an engine but by having above and below (the aircraft) a void in which it would dash ahead"*. (see. *Coanda and the jet powered aircraft* in the aforementioned paper- .p.250 *and in 1910, thirty years before the first jet*"*... A Romanian engineer, Henri Coanda, flied in France with a jet powered aircraft, without raising any public authorities interest*- in the cited paper, p.565). It is possible these texts are based on accounts of Coanda himself, fact that makes us grant them a special attention, relating them to some of his research and notes on experimenting on various wing profiles available at the time. **The key to the whole conception was to be able to take over the force of the air streams and make it instantaneously supporting and propellig the aircraft**. A force taken from the environment that could be used to break this resistance of air to airplane movement. It is still a mistery what did Coanda really know about fluid dynamics, and about lifting surfaces.

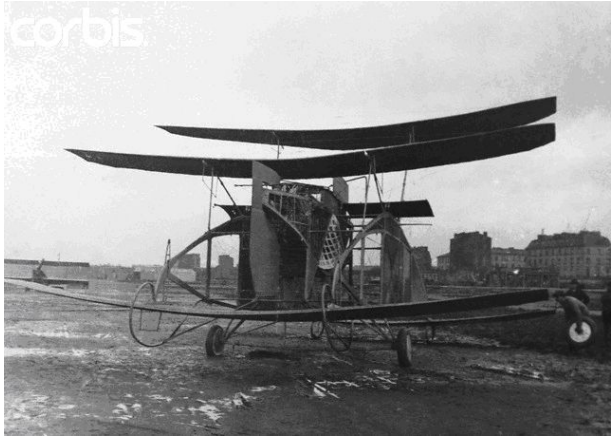
He was not the only one considering these things. The first experiments about fluid drag were conducted by Galileo Galilei, then Isaac Newton, by letting various bodies drop. Edme Mariotte repeated these experiments and also made new ones, measuring wind pressure or water stream pressure on some bodies.

The problem was in constant study throughout the XVIII-th century, and the list of papers focused on the air resistance become even greater in the XIX-th. The research of the times led to too few positive results in aircraft construction. Most builders took into account only their own ideas. Hence, we reason today, a series of bizarre looking and oddly-built machines appeared, without any aerodynamic basis whatsoever. Looking at their pictures, they seem to be some creations illustrating the *ready- made* art syle invented in 1913 by the French artists Marcel Duchamps et Andre Breton. An evocative example could be *L'Autoplane* shown by Salmson and Aimé at the First International Exhibition of Air Locomotion in 1909, the biplane *Bonnet-Lambranche n^{o}. 1*, the stangest ever seen *canard*

triplane Bousson-Borgnis built in 1908, the plane of the Portuguese Gomez da Silva built in 1909, the *monoplane DFD* no 2 built by Armand Deperdussin after the project of a peinter-decorator and shown in 1909; the pilot seat was to the rear and in front of him there was an enormous fuselage with two rows of wings; we could also mention Captain Dorand's *Aéroplane dirigeable, Marquis* D'Ecquevilly's strange airplane with two circles filled with 50 small wings, the cylindrical multicell flight aparatus built by Givandan at the Vermorel Works in 1908-1909, or that strangeness named *L'Uniplan*, invented by Arthur and Georges Gonnel, almost impossible to describe, a kind of canvas boat rolled over the fuselage, Kauffmann's monoplane exhibited in 1910, Koechlin brothers" plane, sort of a flywheel where the pilot lay prone, the entirely metallic device belonging to the millionaire John B. Moisant from 1910 which had a kind of wavy roof instead of wings, Paulhan's flying machine from 1910 which had an unmistakeable embroidery on the leading edge that seemed inspired by a bed canopy, Pischof's aeroplane also from 1910 with a 50 hp automobile motor, the *Papillon* by Robart with the upwards bent wingtips, SACAA *Avionnerie* from 1910 with the downwards bent wingtips, the *Vedovelli* with a conglomerate of surface elements that looked like an avant-garde piece of art, the 1908 *Witzing-Lioré-Dutilleul* with three rectangles of cloth arranged as a flight of steps.

The public took amusement in these contraptions, taking part in a seemingly endless show. It is important for a builder to avoid starting going down on a wrong path, but who could guarantee what was the good one? How could you set apart a good avant-garde idea from a wrong one!?

Peculiar Machines- Aiglo



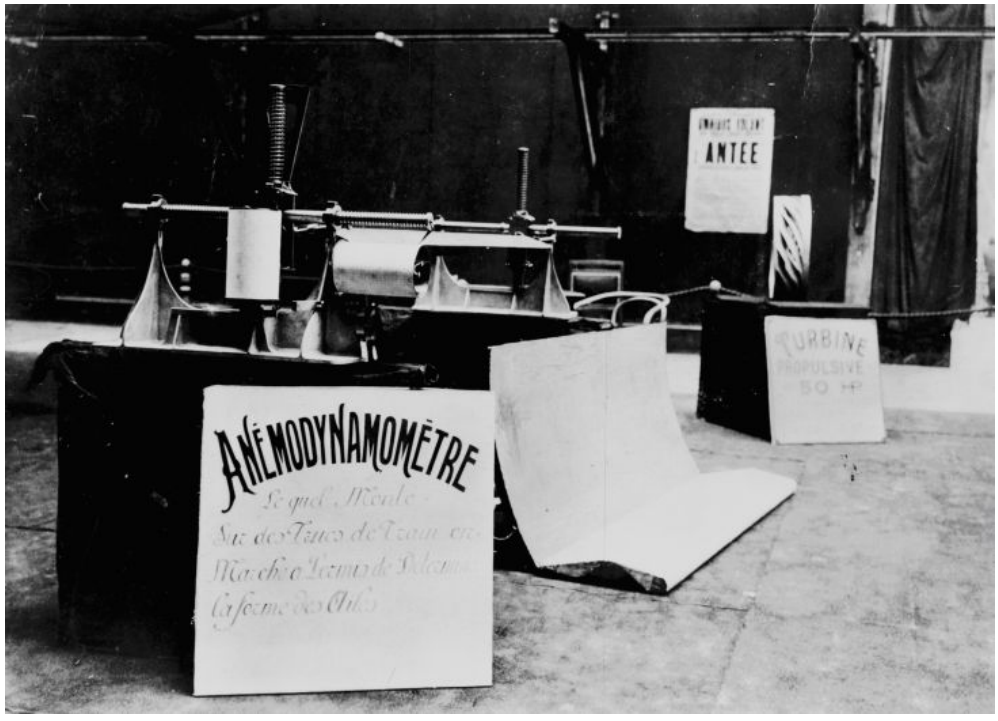
Strange contraptions – Vedovelli

Once returned to France, young Coanda decided to conduct his own experiments **to determine the correct aerodynamic shape of an airfoil**. This courage, probably due to his age, situated him on a favourable position among the researchers of the time.

The encounter with Painleve and Eiffel followed, Coanda proposing them to build devices for the wing study and air drag measurement. The three met the director of the Northern France Railway Company and Henry Coanda obtained an authorization to mount in front of a locomotive a 7 meter long platform that Gustave Eiffel designed, able to receive a lifting profile (*Pionniers*, N^{o} 25 of July, 15,1970, p. 29). The approval was given for the Paris- Saint Quentin route, this being, in our opinion, a proof of the confidence young Coanda inspired to people in high positions of authority having great responsibilities.

The novelty was that young Coanda brought the experiment closer to real conditions because he mounted a lifting surface meeting the air drag. Regarding the disputes and the impass of the aerodynamics research in the matter, Coanda declared: "*For several years the aviation has not registered the slightest progress regarding lifting surfaces, and, if the successes of some courrageous men gave the illusion that aviation reached its goal, all technicians must confess that aviation is in an absolutely primitive stage.., just as three years ago ....A few small modifications to the fusellage and engine allowed pilots to work wonders. But it was not enough. Considering airplanes from a totally different point of view than the one I consider to be justified was an impediment to progress*".

Well secured to the platform, he tried himself his registering instruments, which he called '*registering dynamo-anemometers'*. From these instruments a winged mock-up was attached.



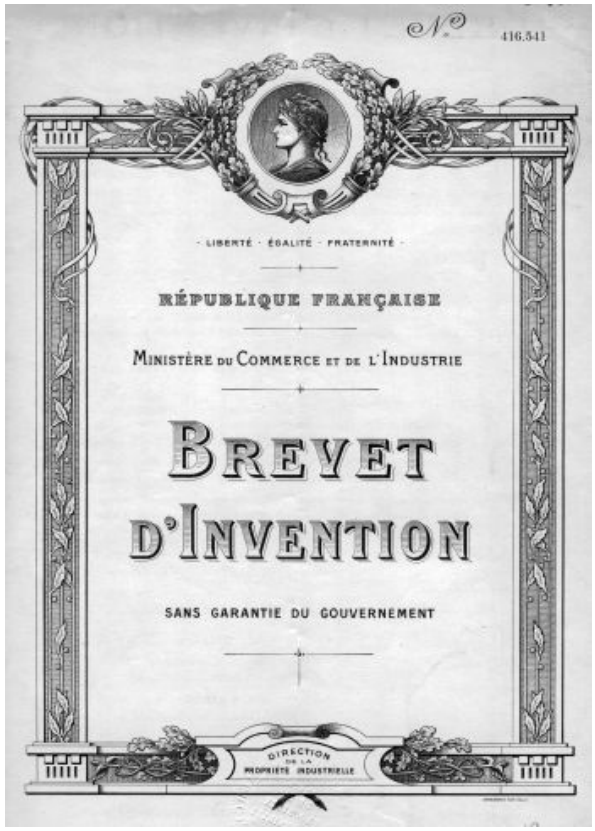
Measuring apparatus – Anemo-dynomoneter

The results of his research would offer Coanda a series of conclusions regarding the incidence angles of the lifting surfaces he experimented, the necessary work that the engine

should produce to maintain speed and the necessary force to travel with a determined speed having a wing load of several kg per square meter.

"*During one of his railroad tests he remarked that putting a hand in front of the wing's leading edge and thus reducing the distance to feel directly the airflow he obtained an increase in lift-and thus the slotted wing was invented*".

The conclusions were presented in a lecture he held at L'ecole Superieure d' Aerodynamique in Paris, with the title "*Wings as Reaction Machines*", (*Sur les ailes considerees commes machines a reaction*), published in *La Technique Aeronautique* in April 1910 (no.8). The same year,on 30th of May a patent appliance to the National Office for Industrial Property in France, followed for *Surface portante pour machines volantes*.



The patent nr. 0416541 for the turbine

In his theory on lifting surfaces, Henry Coanda started from Alexandre Goupil's assertions that "*the wing excels in this regard over the other propulsion systems, including the propeller, the paddled wheel or other direct and permanent discharge devices*" (page 65). In his patent it was "*a new point of view* "upon lifting surfaces and propellers. In his opinion, "*airplane wings and air propellers are reaction machines*". As with turbines, it was necessary for wings to incorporate in their layout a distribuitor, the front part, a receiver, the middle part, and a diffuser, in the back. "The wing is a reaction machine which should have an almost null axial effort and a normal one- drag- as large as possible. It was not a novel idea, as it was first formulated by the father of aerodynamics, the Englishman Philips Horatio Frederick since 1884 (in his patent "*Blades for Deflecting Air* –(no.13 768) further ammended by the one in 1891-*Flying Machines*, nr.13311).

Coanda critically analyzes some experiences and and conclusions and brings forth his own idea, *the production and absorbtion of its kinetic energy is simmultaneous, the airspeed never reaching the high value of detente*. Taking a bird's wing as an example he proves his theory. Why a bird's wing? Probably because the vast majority of the researchers in the area used such a profile as refference, and because his admiration for the force of winds was linked to the one for birds.

We remind you that in those times the "webbed flight" concept occured, describing the flight of those birds who only stretch and orient their wings to achieve flight, taking energy for propulsion and lift from the wind itself. There were opinions that webbed flight needed work to be done to be maintained. If the work did not come from the bird, then it had to come from an external force. *Studying the wings of birds, Coanda found all these elements of reaction*. The flexible trailing edge, the rigid leading edge. If with birds all motion was meant to channel air under the body and wings then all that remained to be done was to build these features into those wings and propelling device that would have the same effect birds obtain with their movements.

Based upon these considerations Coanda believed the future belonged to perfectly flat wings. The specific drag depended on the rugosity of the lifting surfaces, their curvature and the ratio between wingspan, chord and ellasticity, and on the quality of the lacquer and paint that covered those surfaces. Thus "*it was advantageous to build wings out of polished wood or steel".*

He considered that in high speed airplanes, that was then over 100 km/h, the three parts of the reaction machine were kept but having reduced dimensions, and the wingspan could be reduced without adversely affecting lift. He claimed his experiments found a practical confirmation. He was reffering to Bleriot's airplane (Bleriot XI), having wings that copied the curvature of the fast birds wings.

The concave hemispheric surface of one square meter tested by Coanda, horizontally positioned, proved that at windspeeds of 20 m/s could keep aloft a 100 kg weight.

It follows that"the relativity principle was doubted becouse the air stream gained a live force that modified their reaction. "Was everything perfect in Coanda's theory? Presenting the lifting surface in his theory it was obvious that oportunities for analysing the surface areas appeared, that identified sollutions to be incorporated in the build of the wings of his 1910 airplane and those he built afterwards.

In 1912, J. Bordeaux, an alumni of the Politechnical School of Paris, in his work *Etudes raisonne de l'aeroplane et description critique des modeles actuels* (with a foreword written by Lauren Seguin and published at Paris Gauthier Villars, Imprimeur-Editeur, du Bureau des Longitudes d'Ecole Politechnique, page 43) refers to Coanda's experiments and study on lifting wings. We quote: '*Mr. Coanda reached similar conclusions to those of Captain Eteve but by a different reasoning. He estimates that an airplane wing is analogous to a turbo-motor and therefore consists of a distributor which is the front part, a receiver, the central part and a diffuser, the back''.*

In 1914, Lancaster took ideas from the material published by Coanda in *La Technique Aeronautique* reffering to "*Wings as reaction machines*" and from his patent, and develops in his work a similar theory regarding lifting wings.

Vague rumors of the research activities of Coanda in Paris reached the Romanian Kingdom; the engineer Constantin N. Gheorghiu, a technical director of the Chitila Airport, wrote in his work *NaturalFlight and Mechanical Flight- Airplane*s, published in 1912, in

Bucharest: "*Our countryman, Engineer Coanda, also conducted excellent experiments, especially on the shape of wings"(p.31).*

And still the question of why Coanda's theories failed to raise an interest among **his emulators in aeronautics** remains. Was it because he was much younger than his contemporaries or other researchers who had preceded? Could that have inspired a mistrust of his results? Could it be that Eiffel and Painleve expected something entirely different? Could they have thought young Coanda was too insistent in his pursuit of a project they accepted but did not understand? Could it be that he, a foreigner, was not affiliated to any group of researchers, was not employed in any governmental or private institution such as The Civil Engineering Society of France? The truth is that during the time he carried out his research and wrote his conclusions coincides with the emergence of laboratories specialized in aerodynamics research, albeit limited to lifting surfaces and propellers. We mention Gustave Eiffel's and the Duc De Guiche's labs in France, the Aerodynamics Institute of Kouthcino, in Russia, the aerodynamics lab of Gottingen, Germany, the lab of the Military Aerostation Service in Italy, all these institutions having the benefit of superior equipment and financial basis as compared to Coanda and probably to other young researchers like him. It might have been the fact that he never built a plane until he published the research and got his patent.

On 15th of November 1909 the official opening of lectures of the new Ecole Superieure D'Aerodynamique et Constructions Mechaniques was held, in presence of the President of The Deputy Chamber, Paul Doumer. The first students included also young Henry Coanda along with Raoul Bandin, Etienne Boutmy, Cammarota-Adorno H, Georges Clavel, Lenoir Pierre, Leroux Paul, Seguin Augustin. 66 students that would constitute the first promotion of this school. Coanda would intensely use his first months of study to perfect his scientific understanding of aerodynamics. We consider that, although brief, this period brought him important clarifications. It is hard if not impossible to state what exaclty happened during this time, but his ideas reach the value of an original technical creation. We mention one of Coanda's notes, answering a mundane question: how did he get his ideas? He answers that ideas cannot be called upon, they either come by themselves or don't come at all. Maybe that is a way to explain the remarkable leap his creation made. It is doubtlessly an expresion of his technical vocation, making him different from other creators of the time. He is about to produce a revolution in aeronautics; he is at the right age to look upon things with a fresh perspective. He does not want to follow old, beaten and dust-covered paths. He classes the fourth at the graduation. He is declared an aeronautics engineer.


ECOLE SUPÉRIEURE
D'AÉRONAUTIQUE ET DE CONSTRUCTION MÉCANIQUE
DIPLÔME D'INGÉNIEUR
DES CONSTRUCTIONS AÉRONAUTIQUES ET MÉCANIQUES.
M. Coanda
1886
Bucarest (Roumanie)
Paris, le 25 Mai 1912

Coanda's diploma

We do not know the precise date when Coanda begun working on his new airplane. In fact, during this time several legends appear around his 1910 airplane, deepening the mystery.

Considering a relatively recent article (of March 2006) published in the culture magazine *Brancusi* issued in Targu -Jiu, we must admit that in 1908, Coanda had already designed the airplane or at least some parts, and he was preparing to begin its construction. We quote (page46): "The story was recalled by Coanda, in 1970, in an interview, after accepting the invitation to return in Romania forever, and it was mostly avout their work (Coanda and Brancusi-a.n.) as sculpture adepts, in Rodin's worksops or at those in Meudon. The hidden purpose of Coanda was not the sculpture as an art but the technical achievement of a project, drawn on a very long piece of paper, rolled up, that he hadn't show The Master (Rodin-a. n.) yet. One day some Greek apprentices told on him and he had to confess; he wanted to study how he could sculpt in plaster and then cast the fusellage he carefully prepared, in detail, with his own hands, keeping the secret of the originality, building shapes in pieces, to calculate and cast in bronze for his engineering unique invention: the first jet powered aircraft, conceived, built and flown by himself.

Rodin understood his secret, and Coanda begun the plaster carving of the shapes. He worked alongside his countryfellow Constantin Brancusi. And there is the sensational detail, that was never talked about: in July-August 1908, Brancusi carved in marble his first *Pasare Maiastra* (Magic Bird)! After that, its in flight casting followed, after plaster casts. In the same poorly documented period Henry Coanda casts the spindle and arrow of his airplane (just when the world was getting accustomed to the stretched, tissued butterfly wings that were preparing the lift, float and pull of aircraft by the effort of the proppelers)."

Let's comment: It could not be that full size aircraft components were created, maybe only some for the turbine. Probably, Coanda made a mock-up or parts of the aircraft: wings, fusellage, and for the rest he experimented in his own windtunnel. Or he might have prepared molds to be plaqued on the inside, as we would later witness, celluloid covered wings. He could not have worked alongside Brancusi in Rodin's workshop because Brancusi had already left; most probably he could have worked in Brancusi's workshop but then it could not be helped by Rodin.

From the biography published by Paul Pasteur, entitled *La vie d'un savant - H. Coanda*, edited in 1967, it results that the event was preceeded by the need of solving two problems: finding the money needed to buy the necessary materials and arranging payment for the workers, and finding a capable mechanicist capable of materializing his take on aircraft propulsion. "Thanks to Archdeacon he meets James Hennessy. It was indeed providential. The first problem was solved. All that remained was finding a very good mechanic."

To solve the second problem, a recommendation from Louis Bleriot and a meeting with Louis Breguet and father Arbel led him to turn to "a very good mechanic, a real ace", called Pierre Clerget. 11 years older than Coanda, the French mechanic was working as an engineer at Adolphe Clement-Bayard, builder of airships, zeppelins and aircraft. When the two met, Clerget had already built several types of automobile engines. The engine Coanda wanted was the first aviation motor. His relationship with Henry Coanda was not the usual customer- seller one; he was told what was required, and he decided that his design he had submitted to Ernest Archdeacon a short time ago, (for a four in-line cylinder engine, water cooled, providing a power 50CP)-, was good for Coanda's craft. Weighing 80 kg, it had a bore and stroke of 110X120, a 4,56 cubic meters, and 1500 revolutions per minute (rpm).

(Henri Meulien, Henry Beaubois, *Pierre Clerget: Une vie de créations continues* în *Pionniers*, N°43, of January, 15, 1975, the 11th year, pages 20 and 27 and Hans Giger, Kolben-Flugmotoren,Geschichte und Entwicklung in Wort und Bilt, Motor Buch Verlag).

In 1909 A.R. Garnier (W. Rolls) in his work *"Comment vole un aeroplane"* published at the Pierre Roger et Cie Publishers in Paris mentions the reaction propellers in a small chapter.He specifies this type of motor " was recently proposed to meet aviation requirements"...being " a totally new type of proppeling device that we quote not for its credibility but originality. The working principle is the reaction created by the fast flow of a gas". The author considered this sollution was not viable, a very high gas flow speed being required, inconceavable for that times. The same author estimated a very low efficiency of the jet propeller. (p.71). What propeller or who did the author reffer to? Patents for other motors would come along later, when Coanda's airplane was already displayed at the Air Show. Only in 1911 the Italian Canovetti's invention was made public, with details offered at a conferrence of the Engineering College in Italy.

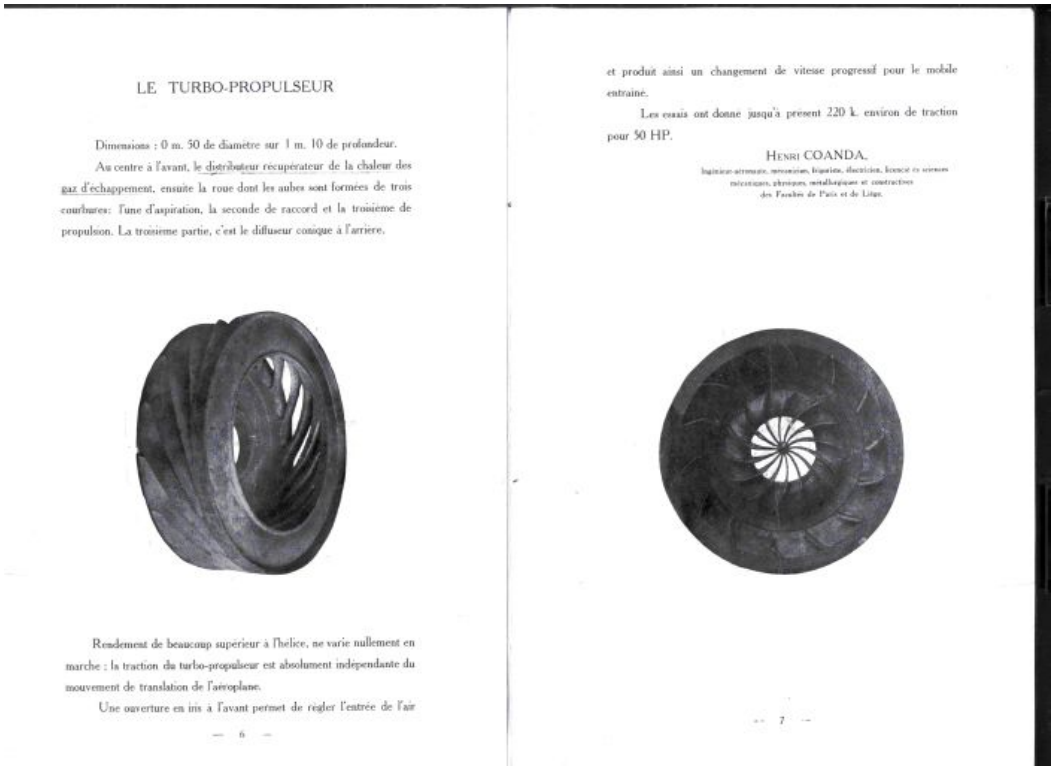
When young Coanda conceived the proppeling device, a series of studies on various motors for heavier or lighter-than-air machines were carried out. Most studies treated propellers. Unfortunately nothing conclusive. All had problems with propeller recoil, and Painleve and Borel said "for a complete turn of the propeller it advances by an inferior length to the thread, and the difference between this length that if constant could be called the experimental thread and the geometric thread is called the propeller recoil" (page 58-59). It was thought that if he surface of the propeller blades was larger the recoil would have been smaller. In 1910 the two reffused to approach the formula for the propeller because "nothing was clear". (p. 87)

With respect to recoil, Ion Stroiescu made an interesting annotation on the pages of engineer Mirea's paper, an adept of these theories. We quote: "recoil is necessary because, not having one meant the propeller to thread exactly its step at a turn, but in this case it would approach air tangentially and it would have no attack angle. And still we could have propellers efficiencies of up to 100%, without recoil, based on aspiration, namely, that work only with their back surfaces. There are special wings for this". Probably this idea was in Coanda's mind when he designed his engine. Thermodynamics had already defined most of its refference domain: it studied the ratio between heat and moving energy.In essence, heat could be transformed in moving power and the other way around. The first transformation was achieved in the steam engine and internal combustion engines, but Coanda tried to obtain caloric energy. How could he obtain it, and transform it into mechanical energy? He had the answer: using energy of a presurised fluid mass using a turbine.

The patent requested by Henry Coanda on May, 30, 1910 followed, that was granted on August, 9 the same year (nr.416541) for the invention called "Propulsion device". In this document Coanda made the assumption that his propeller, working like a propeller, transforms the rotation movement around its axis in a parallel motion along the axis. The propeller was, according to Coanda, independant of the speed and movement of the vehicle it moved *by reaction*.

The basis of the propulsion system was the air turbine and the propelling assembly consisting in **the distributer** with an iris similar to the photo cameras diaphragm, in front of the plane to allow the regulation of air admission and thus, change the speed of the plane, **the turbine**- the only moving part of the propelling system, and **the annular diffuser**.

A description: **The turbine** (photo front, profile), was mounted on a plate mounted perpendicular to the rotation axis. The blades consisting in helicoidal alveolas that allowed the air admission.The cowled propeller, having a tronconic shape with the small base backward allowed the diffuser to use the maximum power from the admitted air.



LE TURBO-PROPULSEUR

Dimensions : 0 m. 50 de diamètre sur 1 m. 10 de profondeur.

Au centre à l'avant, le distributeur récupérateur de la chaleur des gaz d'échappement, ensuite la roue dont les aubes sont formées de trois courbures: l'une d'aspiration, la seconde de raccord et la troisième de propulsion. La troisième partie, c'est le diffuseur conique à l'arrière.

Rendement de beaucoup supérieur à l'helice, ne varie nullement en marche : la traction du turbo-propulseur est absolument independante du mouvement de translation de l'aéroplane.

Une ouverture en iris à l'avant permet de régler l'entrée de l'air

— 6 —

et produit ainsi un changement de vitesse progressif pour le mobile entraîné.

Les essais ont donné jusqu'à present 220 k. environ de traction pour 50 HP.

HENRI COANDA.

Ingénieur-aéronaute, mécanicien, liquidateur, électricien, licencié ès sciences mécaniques, physiques, métallurgiques et constructives des Facultés de Paris et de Liège.

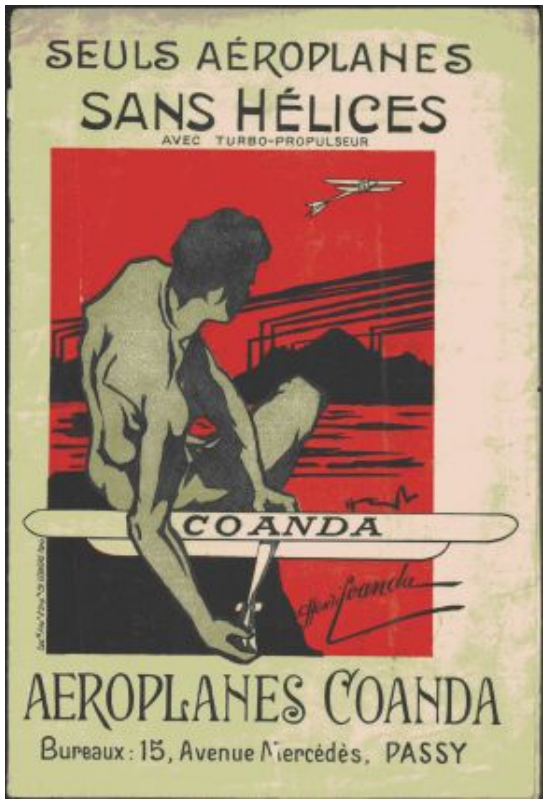
— 7 —

The turbine

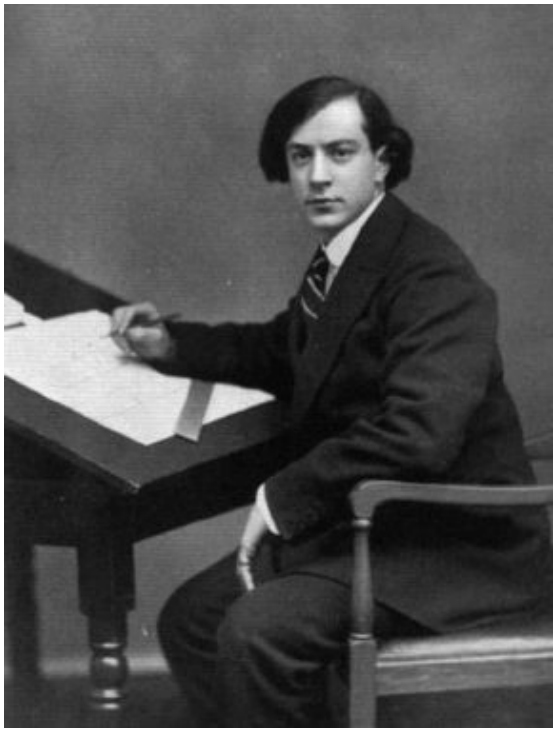
The second description of the propeller, after the one in the patent, and much simpler, was made by Coanda in the flyer he offered (probably on the occasion of the Aerial Locomotion Exhibition opening) titled: *"The only aircraft without propellers, with a turbo-propulsor."*

For the propulsion device to be crossed by a sufficient mass of air, the turbine needed to be rotated at a high speed. Coanda affirmed that due to the speed gear system created by Clerget, which was interposed between the engine and the turbine, 4000 rpm, resulting in a thrust of 220 kg, were obtained at testing. ... In the article published in "Pionniers" of July, 15, 1970 (p. 30), the data are completely changed. "The static thrust at 4000 rpm was modest: 17 kg, but Coanda hopes to obtain 24 kg in motion." It is interesting to note that this article appeared in the magazine following a visit to "Vieilles Tiges" Association. Perhaps the material content was written on the accounts of Coanda. What followed is known:

The airplane Coanda 1910 was exhibited at the Second Air Show in Paris. Henri Coanda, at the age of only 24 created the world's first jet plane.



The promotional poster for the Coanda airplane



Coanda at the age of 24 when he invented the jet propelled aircraft.

His talent, his skill, his intelligence and vocation led to a technical act of creation that others in those days and later could not even imagine, and much less understand. Coanda was part of a small group of scientists who proposed radical revolutions in the field of activity in which they activated. He noted in a letter from 1963 |*"If in Aerodynamics I am quite famous, it does not mean that I didn't found some interesting things in other branches too, such as ... in biology, electronics, crystallography, space studies, hydraulics, ... optics, thermodynamics, nuclear energy, etc."* There were times when the traditional classical physics of Newton and his followers was collapsing. As Jeremy Bernstein said, "to rebuild physics a revolution was needed "...." But if this revolution in physics was made by a person under 30 years old, named Albert Einstein certainly the revolution in aeronautics could also be initiated by a young man. And if Einstein's creative originality was disputed why Henri Coanda's innovative work would not be also contested?

*Corresponding author
Gen., President of the Romanian Association for Propaganda
and History of Aeronautics