BRAZILIAN AVIATION HISTORY: THE UNIVERSITY OF SÃO PAULO CASE

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Abstract

In 1934 the Institute of technological Research (IPT) was created as a successor of the Materials Testing Laboratory (attached to the Polytechnic School of the University of São Paulo). The participation of the State of São Paulo's IPT in the development of technological and manufacturing research in the field of aviation and the aeronautical industry was initiated. The IPT Aeronautical Section created as an evolution of the timber section has designed and built 17 aircraft from 1935 to 1956 including single-engine and twin-engine aircrafts and jet. Also, designed and built more than 750 propellers. When the activities in the IPT stopped in 1956, Romeu Corsini after working in the São Paulo Air Transport Department until 1970 moved to São Carlos Engineering School of University of São Paulo where he created the Industrial Research and Improvement Center (IPAI) to support among others the aeronautical design and research. The group of teachers created with the actions of Romeo Corsini, understanding that the formation of human resources was essential for the continuity of Brazilian aeronautical engineering which resulted the creation of the Aeronautical Engineering course at EESC-USP in 2002. This work will detail the history of the contribution of the University of Sao Paulo in Brazilian aeronautical engineering and aerospace industry.

1 Introduction.

Santos Dumont a Brazilian aviation pioneer went to Paris in 1882 to study mechanics, chemistry, physics and electricity but soon was very interested in ballooning and in 1898 he designed and flew his first balloon called Brazil Fig 1.

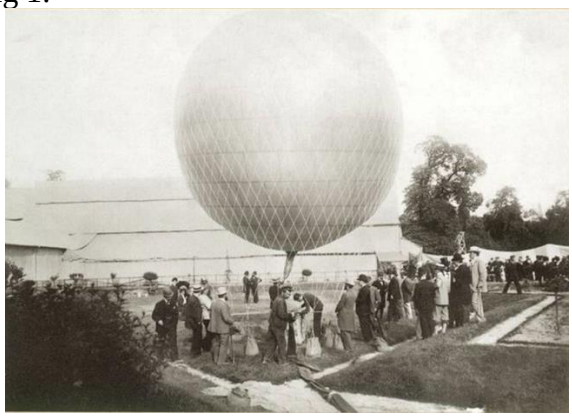


Fig. 1 Santos Dumont first balloon the Brazil. [4]

After three more balloons design he turned his attention to designing and flying airships or dirigibles and three months later after his first ascension with Brazil balloon he designed and flew the project number 1 his first airship with an engine designed by himself.

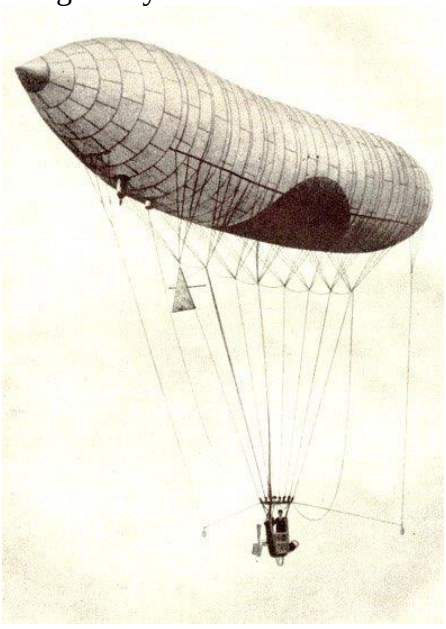


Fig. 2 Santos Dumont first airship the No. 1.

In 1898 the Aéro-Club de France was founded and, in 1900, organized the Grand Prix Deutsch de La Meurthe. The one hundred thousand Franc prize was to be given to the first dirigible which, starting from Saint-Cloud, went around the Eiffel Tower and back to the starting point in less than 30 minutes

Between 1898 and 1901 he built four more different dirigibles, powered with internal combustion engines, naming them No.2 to No.5. He tried to win the Grand Prix Deutsch de La Meurthe with No. 5 which was specially design for that purpose. He did not succeed and after modifications on project of the No. 5, he construct the No. 6. In October, 1901, he summoned the jurors of the Aeroclub of France and with his airship No. 6 he won the Deutsch de La Meurthe prize, proving the air navigation was possible Figures 3 and 4 show the No.6 airship and the trajectory of the flight.

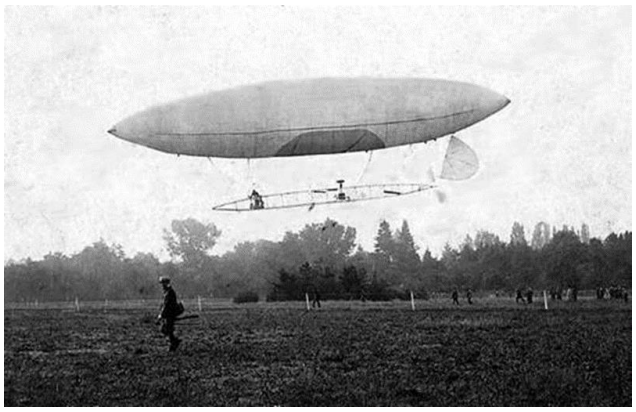


Fig. 3 The airship No.6 taking off to win the Deutsch de La Meurthe prize. [2]

After that, he designed eight more airships featuring the No. 9, named as "La Baladeuse". Dirigible No.9 was built to serve as a personal transport (he skipped No.8 due to superstition). Very small, 12 meters in length, 5 meters in height, it could land on small spaces and became known as the flying chariot.

Fig. 5 The airship No. 9. [4]

Santos Dumont last airship was the No. 14 as a fast, highly maneuverable aircraft. To motivate further advances in aeronautics the Aéro-Club de France instituted, in the end of 1905, a 1,500 Franc prize for the first aeronaut to realize a 100-meter-long flight on an airplane taking-off by its own means from level ground (a maximum 10% slope). At the same time Ernest Archdeacon, club president, offered 3,000 Franc for a 25-meter-long flight. Santos-Dumont and his assistants then started to work on a biplane aircraft based on Hargraves' box kite. In 23th October of 1906 After testing the model with the airship No.14 as

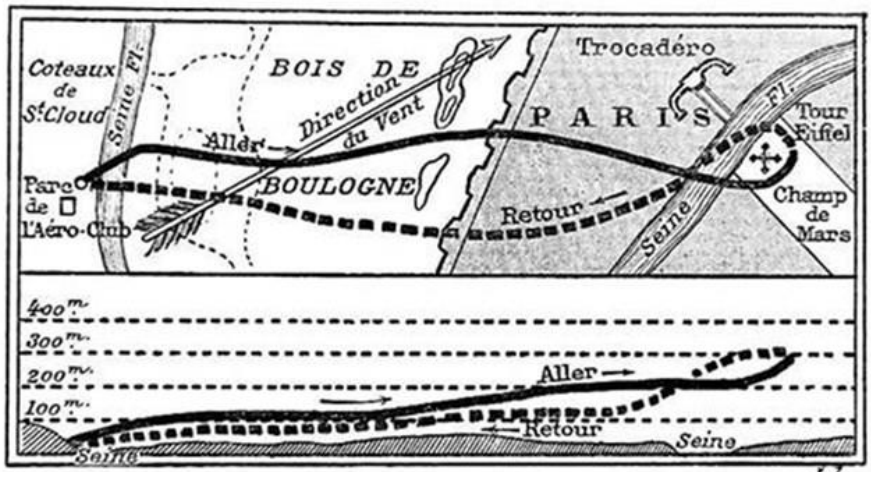


Fig. 4 Air navigation first confirmed with the No.6. [4]

a hybrid aircraft he named the aircraft only as 14-Bis. He made the first complete powered flight in Europe with his 14-Bis canard box winged aircraft winning the Archdeacon price. Santos Dumont flew a complete flight of over 60 meters using an engine of 24 HP. Figure 4 shows the event which was registered by the aeroclub de France.

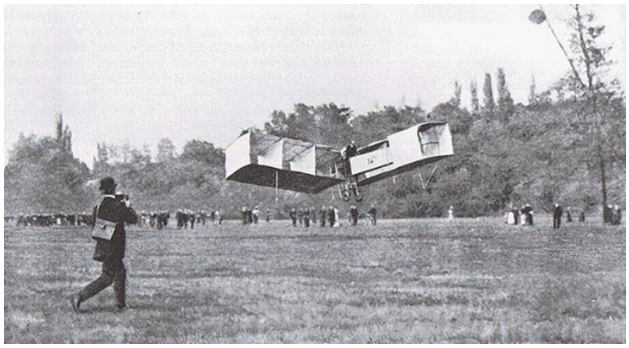


Fig. 6 First complete flight of the 14Bis in 23 October 1906. [4]

Later in 12 November 1906 Santos-Dumont with a 14Bis with ailerons and a 50Hp engine, set the first world record recognized by the Federation Aeronautique Internationale, by flying 220 meters in 21.5 seconds. Figure 7 shows the moment of the taking off (note the Bleriot model in the back ground).

Fig. 7 Taking off for the second flight of the 14Bis, 12 November 1906. [4]

Santos-Dumont's final design were the Demoiselle monoplanes (Nos. 19 to 22). These aircraft were used by Dumont for personal transport and there are considered the definitive aircraft design, produced in series by the Clement Bayard company, used as a trainer for European air forces and more than 200 were built in USA from drawing donated by Santos Dumont to the Popular Mechanics Magazine. Fig. 8 Shows the first flight of the No. 19 Demoiselle in November 1907 and Fig. 8 shows the Demoiselle No.20 in flight in 1910.

Fig. 8 First flight of the No. Demoiselle in 1907. [4]

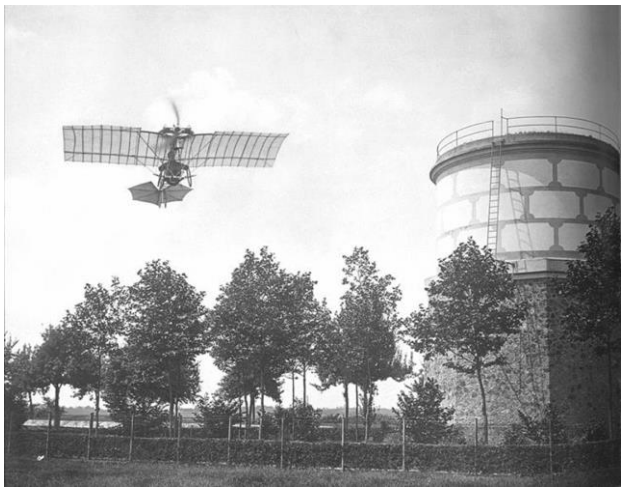


Fig. 9 The Demoiselle in flight 1910. [4]

Back in Brazil curiously, a Frenchman Dimitri de Lavaud developed the first aircraft in the Brazilian territory in 1910 the Sao Paulo aircraft and the Avelar in 1914. Santos Dumont's legacy was definitively established in Brazil. Santos Dumont quit aeronautical actives in 1911 and died in 1932. Two years later in 1934 the Institute of technological Research (IPT) was created as a successor of the Materials Testing Laboratory (attached to the Polytechnic School of the University of São Paulo). The participation of the State of São Paulo's IPT in the development of technological and manufacturing research in the field of aviation and the aeronautical industry was initiated. At the beginning of 1934, the IPT Wood Division was in charge of controlling the material for the construction of gliders in the Paulista Glider Club workshop. With this, the engineers and technicians were able to apply the results obtained in the research with Brazilian hardwoods. Thus, the development of IPT with aeronautics and aviation began simultaneously on three fronts, all linked to the application of national wood in the manufacture of aircraft:

research and testing of wood for application in aircraft, material control, design and construction of gliders and Airplanes as well their maintenance [3]. Mauricio Brotero was one of the main researchers and established technical specifications of the national wood specifically Freijó, a wood considered better than the spruce. Brotero remained as head of the aeronautical division of IPT until 1947 when he was replaced by eng. Romeu Corsini. The period was very active for IPT when its staff included engineers as Brotero, Corsini, Clay Presgrave de Amaral, Orthon Hoover and many others, most of them became influent in the Brazilian industry. The IPT Aeronautics Section created as an evolution of the timber section has designed and built 17 aircraft from 1935 to 1956 including single-engine and twin-engine aircrafts and jet. The first aircraft designed in 1937 and built at IPT in 1938 was the IPT-0 Bichinho (small animal),

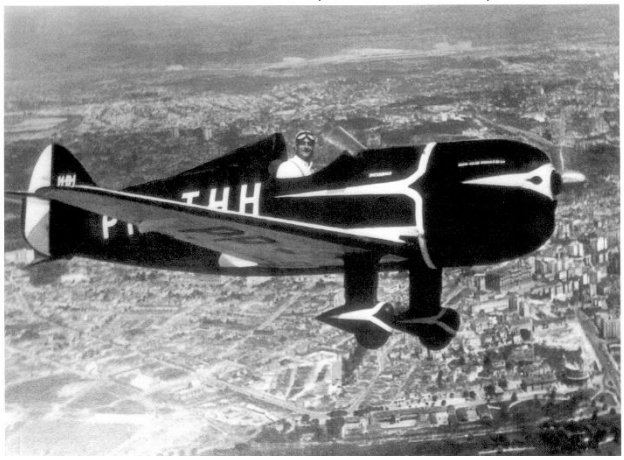


Fig. 10 The IPT-0 Bichinho in flight 1840. [3]

The IPT-0 made use of the aeronautical plywood and hard and light wood such as the “freijó” Cordia goeldiana Huber. Fig. 11 and 12 show the IPT workshop for aircraft construction and testing. The aeronautical Division of IPT was involved with all aspects of aeronautical engineering besides the aircraft design such as training pilots with gliders (designed by IPT) selling plywood for aeronautical construction (for both military and civil manufactures) as well as propeller design construction and testing. In 1944 were made 261 propellers 1 11065 plywood sheets. In 1945, 325 were made of propellers and 16011 sheets of plywood, including exports to other countries [3]. In addition to supporting glider clubs and the air club in São Paulo, the aeronautics section of IPT became an important partner of the civil aviation companies and gradually became a consultant to aviation companies such as the São Paulo Airline and Airline Services Cruzeiro do Sul.

Fig. 11 IPT workshop, gliders construction. [3]

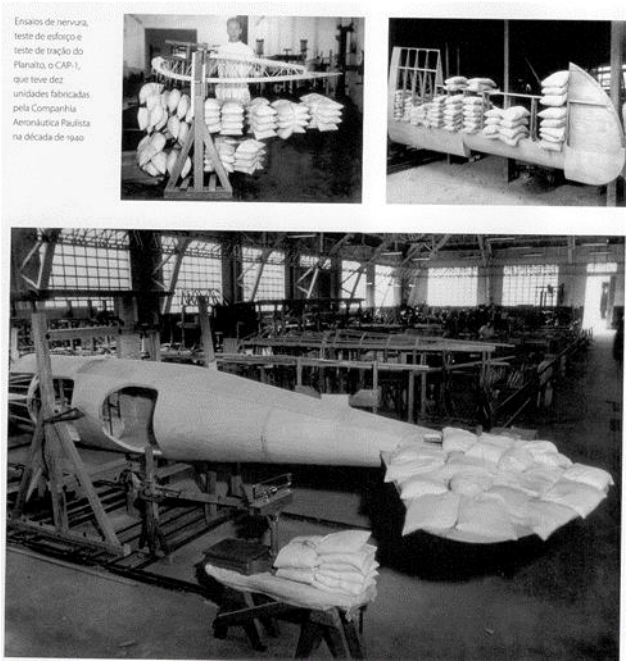


Fig. 12 IPT workshop, loading testing. [3]

IPT was highly involved in the development of Brazilian aeronautical industry one of the most significant example was the agreement with Companhia Paulista de Aviação CAP which first resulted was the construction of the IPT-4 Planalto. Also, through this agreement the Aeronautical Division of IPT worked in the redesign of the Ypiranga aircraft that became the

Paulistinha, a very important trainer aircraft which was produced more than 700 units most of them by the CAP and later by the NEIVA company which later became an EMBRAER subdivision. There are still many of them flying around Brazil. Figures 13 and 14 shows the IPT-4 Planalto and the CAP Paulistinha.

Fig. 13 The IPT-4 Planalto first aircraft produced by CAP 1942.[2]

Fig. 14 The CAP-4 Palistinha prototype donated the aeronautical museum in São Paulo, the first on the right is Romeu Corsini and the second on the left is Santos Dumont's nephew.

Fig. 15 Paulistinha flying today.

Also, designed and built more than 750 propellers. The IPT worked in aeronautical activities from 1930 until the end of 1950. In the aeronautical engineering sector, the works of the IPT were very important, first supporting the STA (Aeronautical Technical Service), then the CTA and ITA. It is not unfair to say that almost all the Brazilian projects of the 30s, 40s and 50s had somehow the help of the IPT [1].

When the activities in the IPT stopped in 1956 due to a combination of factors from a deactivation of the São Paulo aeronautical industries to the creation of the CTA and ITA, Romeu Corsini start to working in the São Paulo Air Transportation Department until 1970. After that he moved to São Carlos Engineering School of University of São Paulo (EESC-USP) as a professor where became director from 1974 to 1978. There, he created the Industrial Research and Improvement Center (IPAI) to support among others the aeronautical design. IPAI group designed various prototypes with a special emphasis on the TUCA IPAI-26 aircraft, a high-wing T-tail for basic flight instruction as a substitute for Paulistinha. The project was coordinated by a young faculty member of EESC-USP Eng. Dawilson Lucatto and also had the collaboration of Eng. Michael George Maunsell. He designed the "TUCA" with many influences from IPT Aeronautical division such wooden wings and empennage with IPT' plywood and, slots at the aileron section. The aircraft had a metal lattice type fuselage structure covered by fiber glass and a modern side by side cockpit. Also, innovate with an all composite fixed landing gear. Figures 16 to 18 shows the IPAI 26 TUCA.

Fig. 16 IPAI 26 TUCA first flight test in 1977.

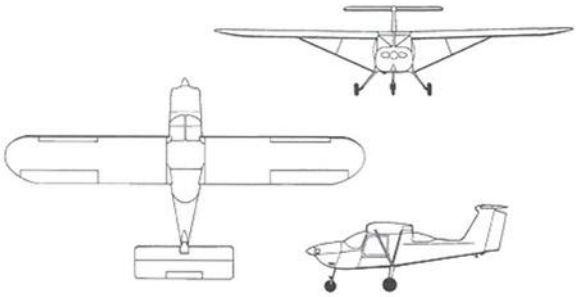


Fig. 17 The IPAI 26 TUCA three view.

Fig. 18 The TUCA in flight, note the boom for the calibrated pitot and the tail stop parachute for the spin tests.

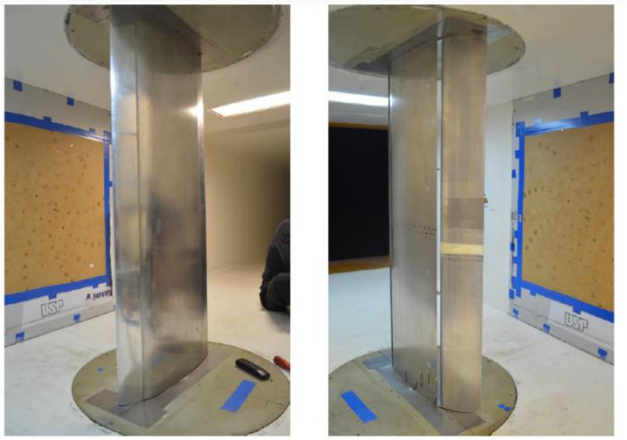
The group of teachers created with the actions of Romeo Corsini and Dawilson Lucato understanding that the formation of human resources was essential for the continuity of Brazilian aeronautical engineering, created a course for specialization in aircraft design within the course of mechanical engineering, Eventually, this specialization became an emphasis on aircraft engineering until 2002 when the course in aeronautical engineering was established. The creation of the first aeronautical engineering course of USP and the second besides ITA in Brazil was an answer to the Brazilian aerospace industry reborn after privation which demanded more and more high-level engineers. The University of Sao Paulo is the most important University in Brazil and stay within the 100th best universities in the world. The combination with all the heritage on aircraft design and aeronautical engineering from the its past at IPT transferred to EESC in Sao Carlos, became a perfect condition for high level education, research and development on aerospace engineering. The Sao Carlos region also became the second aerospace hub in the state of Sao Paulo as it can be seen in Fig. 19.

Fig. 19 São Carlos Aerospace hub.

Today, the course forms 40 aeronautical engineers per year. The Aeronautical Engineering course at EESC-USP is a 5-year course divided in three phases: basic, general professional engineering and specific engineering. Each phase has a main stream of disciplines although some preparatory and introductory disciplines in aeronautics are distributed through the first two years. There are three main directives for the all the disciplines: learn to learn, team work and addressing open problems. These directives, despite the fact that is not always ease to implement in every discipline taught, are essential for the multidisciplinary aspect of aeronautical engineering. In fact, the majority of disciplines are centered to develop student skills for aircraft design and to work at an aerospace engineering environment. However, engineering is not practiced in a vacuum nor the engineers live in a world made up their own creations. Consequently, the educational program in engineering also provides an appreciation of the world in which the graduate will act. This requires notions of cultural forces, political, ethical and aesthetic that affects the world.

The Aeronautical Engineering Department of EESC-USP coordinates research and development projects with the Brazilian and foreign aeronautical industry. The infrastructure is more than 3600m^2 and the department has 9 laboratories for research in aerodynamics, aeroacoustics, flight dynamics and control, maintenance, smart materials and aeronautical structures. One of the highlights of these projects

is the coordination of the Silent Aircraft program which involves EMBRAER and FINEP. The 5-year project aims to the development of the capacity of testing and simulating airframe aeroacoustics. The wind tunnel of the Aerodynamic Laboratory can carry-out aeroacosutic experiments with microphone array in two-dimensional high lift wing in order to develop noise reduction technologies (NRT) in TRL (technological redness level) up to 3. Within the project is possible to carry -out experiments in large wind tunnel to increase the TRL of the NRTs. Figures 20 and 21 show the 2-D wing testing at EESC-USP and half model at DNW wind tunnel in Holland and fan noise at NASA Gleen USA.



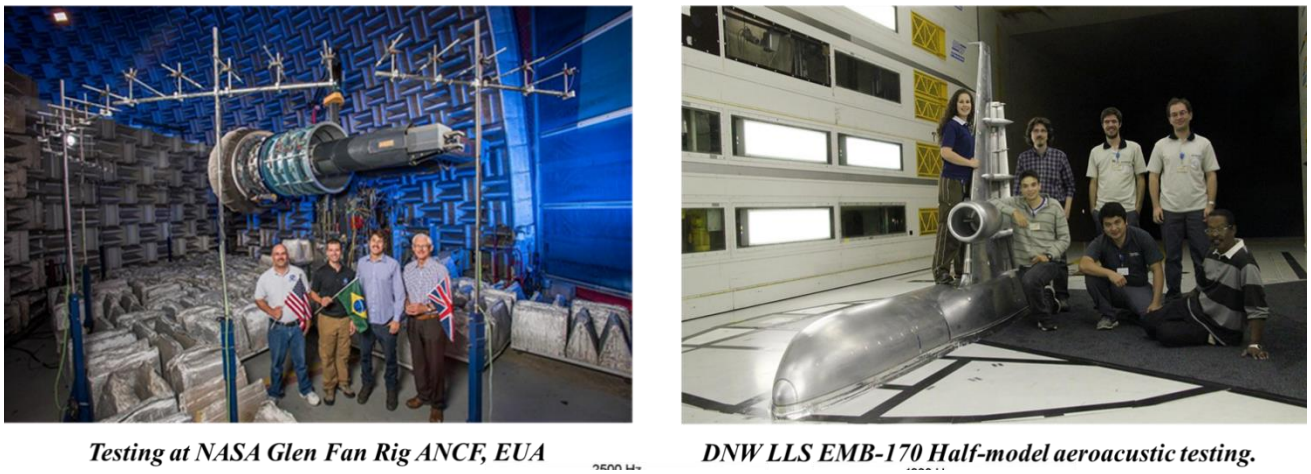
(a) Flap Retraído (b) Flap Full

Fig. 20 2-D aeroacoustics testes at SAA wind tunnel.

Figure 22 shows the recent testing carried out with a full model at DNW wind tunnel in Holland.

Recent project with the Boeing BR&T the wind tunnel at the Aerodynamics Laboratory of the Aeronautical Department of EESC-USP aimed to the development of NRTs for nose landing gear. Figure 23 shows the nose landing gear at the test section of LAE-1. The importance of the aeronautical engineering activities at EESC-USP today in formation of high quality engineers and international level research and technological development reveals also the importance of the perseverance and good work in the past.

Fig. 212 Full model aeroacoustic testing at DNW ND. source author.



Testing at NASA Glen Fan Rig ANCF, EUA *DNW LLS EMB-170 Half-model aeroacustic testing.*

Fig. 201 Large aeroacoustics testing NASA Langley (left) DNW half model testing.

Fig. 23 Nose landing gear model tested at LAE-1 wind tunnel from Boeing BR&T project.

2 Conclusions

This brief work describes some of the historical details of the aeronautical engineering development at University of Sao Paulo which lead to an important center of aerospace development at Sao Carlos School of Engineering. The effort of many pioneers and abnegate persons from the past together with the knowledge transfer through the years, was the key for the success of today.

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