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AEROTECNICA M&S 100 YEARS AGO

Aerotecnica M&S 100 Years Ago: Air Navigation and Debate Between Airship and Airplane

Aldo Frediani[1]

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The section "Aerotecnica M&S 100 years ago" of the 3rd issue of Aerotecnica Missili & Spazio Vol. 101 is dedicated to a famous paper relevant to the air navigation of airships by Gen. Giuseppe Valle, published 100 years ago, in 1922, and titled "On the air navigation of tomorrow".

Giuseppe Valle (1886–1975) became a balloon pilot in 1910; in 1911 he participated in the Italy–Ottoman war in Libya; in 1913, he participated in the Gordon Bennet Cup, a prestigious competition with spherical balloons departing from Paris and he also participated in 1921, 1922, 1924, and 1925; during the First World War he commanded several airships, he was awarded the silver medal for military valor and became head of the airships of northern Italy. In 1925 he made a cruise to France and Spain with the airship Esperia, the new name of the 22,000 mc Zeppelin Bodensee rigid airship, cited in the paper. In 1923, he was appointed deputy commander of the Air Force Academy and in 1926, he obtained the pilot license of the Macchi M.18 seaplane. He participated in the Italy–Brazil Atlantic cruise (December 1930–January 1931) in command of one of the fourteen Savoia-Marchetti S.55 seaplanes. In 1933, Mussolini promoted Valle undersecretary and chief of staff and it is general opinion that, even though he was in a position of great responsibility, his origin from the airships did not allow him to complete the technological innovations of structures and materials, aerodynamics and production processes that had made the biplane obsolete; the programs prepared in the 30 s until 1939 lacked the objective of modernizing the Italian aeronautical constructions and the air fleet, also because of the commitments of Italy in the wars of Ethiopia, Spain and Albania devoured large financial resources. He died in Rome in 1975.

These news about the figure of Gen. Valle are necessary as a premise to the reading of the article that the same Valle, Major at the time of the publication, published in Aerotecnica during the period of his participations to the Gordon Bennet cup and when he had a great responsibility in the production and management of the military airship industry; the description of the flight of the Zeppelin Bodensee airship from Germany to Italy is of great interest to understand how the aid to the navigation of airships was a priority theme and what enormous progress has been made in air navigation in this century. From reading the article, the reader will also understand the position gen. Valle in favor of the use of airships in air transport. The reader had been already the opportunity to take note of opposing opinions in favor of aircraft, such as that of prof. Pistolesi (in the preface to issue n. 4 vol. 100 of this journal); other authoritative opinions agreed with that of Pistolesi, such as, for example, that of Giulio Douhet who, 1921, claimed that "since the airplane was born we are affirming that the airship must disappear because the airship is and will always be inferior to the airplane" and again "the airplane has triumphed in all fields, it has imposed itself everywhere, it has perfected itself in every sense while the airship has prolonged its agony by striving to demonstrate its inability to render any service, both in peace and in war".

1 On the Air Navigation of Tomorrow

Translation of the conference paper "Sulla aeronavigazione di domani" by Gen. Giuseppe Valle, Italian Air Force (December 20th, 1922)

Great audacity is mine, in daring to deal with a topic already faced out recently with brilliant competence by Colonel Crocco and other illustrious technicians, who have

✉ Aldo Frediani
aldo.frediani@unipi.it

[1] Università di Pisa, Pisa, Italy

opened to the minds of the profane, and also of the non-profane, the new bright horizons that are going to be prepared for the air navigation of a very near tomorrow. But audacity, when conscious, is one of the main virtues of the pilot, and only as a pilot I speak, in the belief that the experience gained in the long hours of flight on board of the Italian airships can bring a modest contribution to the problem: first of all, to express an ardent cry of faith by a handful of survivors after the glories of our victorious war, confident that our cry will not be unheard.

In fact, no more than a small nucleus of pilots and no more than two glorious, but old aircraft, remain today, to represent the powerful team of men and vehicles that 4 years ago watched in arms le coasts of Italy against the pitfall of the underwater weapon or went to bring tons of destruction load into the most tight enemy defenses.

In the course of these 4 years, hibernation has descended to paralyze almost every civil activity, and our pilots and our technicians and our own best airships have migrated beyond the seas or will emigrate there shortly. Today, since a breath of new life has come to breathe on the latent energies of our race, we are sure that hibernation will be swept away as the fresh morning breeze sweeps the haze of the night: today, this very important among the nagging problems that arise to the new nation will be faced and resolved as well, and Italy will finally have the Air Force that is convenient to a great victorious people. And it is useful to recall an agenda that was solemnly voted a year ago by the Italian Association of Aerotechnics, in response to a question addressed to it by the Aeronautical Parliamentary Group: "The Assembly sees the definitive disposition and expansion of the Air Force in the establishment of a politically responsible autonomous body, preferably a Ministry of Air, which has all the aeronautical activities under its control, including those relating to the air defense of the homeland, and shall be provided with the necessary financial means.

The rebirth of our Air Force must be full and complete in its two branches of the lightest and heaviest of the air: both equally important, as they have the brightest future. I will deal here with the first of the two air vehicles, because on it, mainly, it was spread the veil of oblivion and also because today, according to me, it is at a decisive turning point in its history: the transition from small to large volumes. I state that none of my words should be interpreted in any way less than deferential and admiring for the heaviest of the air, in whose field I am honored to have firm and deep friendships; there can be no competition between them. Just as together, in fraternal agreement, the wings of Italy have fought and won the war of the air, so the lightest and the heaviest of the air will promote the peaceful conquests of tomorrow, to maintain that dominance conquered together and cemented at the price of common blood. The sky blue ocean that surrounds us is large enough for everyone, and the tasks of the two branches are now well delimited: (a) the speed for the airplane, which will find its explanation in inter-European communications especially postal, replacing not the mail (as superficially imagined) but the telegraph; (b) the safe domain of the seas for the medium and large distances for the airship to connect the distant continents in a comfortable flight through the ways of heaven. This is our profound conviction, based not on a brilliant dream of a visionary, but rather based on facts partly accomplished, partly close to completion, as we will see shortly.

It is appropriate here to recall the conclusions of a recent study by Sabatier, technical director of the French Air Force Navy who, examining the most recent types of airships and airplanes for civil transport (the last creations of the civil airship technology are the Bodensee and Nordstern types, with a power of 1000 Hp, a speed of 120 km/h, a ratio between cargo payload and total lifting force of 40%; the last types of transport aircraft are the Farman-Goliath and the Handley Page, with an average power of 700 Hp, an average speed of 150 km/h, a unit ratio between payload and lifting, approximately) comes to the remarkable observation that, comparing the payload per Hp, an airship carries almost three times more than an airplane with the same power. If half of the total lift is attributed to the fuel and half to crew, passengers and cargo, the airplane can carry one ton of cargo about 1000 km away and the airship five tons, 2000 km away: thus, the efficiency in tons-km per unit Hp is ten times higher. These figures are the most interesting from a commercial point of view, since they relate the tons-km, the basis for the tariffs, with the power, the basis for the calculation of the operating costs.

It follows that the airship is the only air vehicle capable of carrying heavy loads over great distances and that its hegemony is and will be unrivaled for the crossing of oceans or regions where it is difficult to establish landing fields. It remains to establish whether it has the qualities necessary to carry out long-term routes in a regular and safe manner. So the Sabatier. Even the British Commander Sir Trevor Rawson in a conference held in England on the future of air vehicles for civil transport expresses himself as follows: "*Airplanes may fly above the ground at undefined distances, if airfields are located at intervals of no less than 500 miles from each other, provided with fuel and oil, and there are intermediate runways in the event of forced landings or engine failure. But for journeys that require a continuous flight of more than 1000 miles, the airship is the cheapest means of transport and, also, the only possible one. This means that the airship will have its useful use in transoceanic air services and will be as a supplement to the services of the ships from continent to continent. The airplane will instead maintain a service similar to that of the railway. If we consider the England-Australia journey and compare the airplane with the airship, we find that when*

the Vikers made its amazing journey from England, it had to land at 28 stations to refuel. If the airplane had been used to transport the passengers on this route, they would have had to go down and wait until the aircraft had refueled at each of these stations, or changed apparatus, which would have been very inconvenient. An airship, on the other hand, would require only two intermediate stops on such a journey. Considering the loss of time spent with an airplane at intermediate stations and the difficulties of flying day and night with the same speed, the higher speed of the airplane would be canceled, and total time difference would be between the two means of transport".

The history of our airships during war has already been largely presented in its pages of glory, in devout commemoration of the many heroes who sacrificed their young life in the fulfillment of their very noble mission. At that time, every flight was a risk: the same precious safety features of the airship made it a very fragile instrument of war, though deadly and feared. The airships departed from their hangars in the war area, with their ton of bombs inside, against the far enemy: the pilots, in the restricted constraint of a steel, an atom suspended in the dark immensity of space, exploited to the limit every potential of their means, to reach the target, to carry out, at any cost, the mission programmed. Today the problem is deeply different; that is: to make the most of the qualities of safety, stability and comfort of the airship to make necessary and indispensable this new factor of human progress, where the ordinary means of locomotion are insufficient or too slow compared to the rapid pulse of today's life: to connect two cities too far each other, and yet in need of rapid exchanges in the ordinary course of mutual relations, through the treacherous sea or flying over deserts and wild areas.

The problem of the use of airships as a means of transport is the subject of passionate controversy. Some people have already proclaimed the failure of the airship, based on the two disasters of the "R 38", broken in the air during its flight tests around London, and of our airship "Rome" destroyed in America during a speed test.

But they forget to add that the first was too light, built with an insufficient structural stiffness, and that the second, perhaps guided with too much lightness, was destroyed as a result of an impact against a high-voltage electric line. Instead, we forget to mention the flight of the "Zeppelin L 59" that left Jamboli in Bulgaria in 1917 to support the extreme defense of an equatorial German colony, loaded with 5 tons of medicines, 500,000 cartridges for machine guns, 3 tons of other war material and 21 tons of fuel, arrived at Karthum in upper Egypt where, after having received the radiotelegraph order to come back due to the ceased resistance of the colony, he turned back the bow reaching Jamboli again, after having traveled 7300 km in 4 days minus 6 h, without ever touching the ground, still having on board the fuel for over 30 h of navigation: they forget to talk about the double crossing of the Atlantic ocean made by the "R 84", and of the two war exploration flights, lasting more than 100 h, carried out by German airships over the North Seas and Russia.

These are the milestones well founded on the way of the solution of the problem, when you think that the raids mentioned before were extreme flights carried out by war airships while, for civil transport, we must use air vehicles that "absolutely guarantee the safety of the flight, both as a continuation of the service and as guarantee against any possible accident". This is the most important factor of a civil air navigation line: it is therefore worthwhile that we are particularly concerned with it, examining by a serene and positive criterion, the practical possibility of operating an airline, supporting our thesis not with words, but with facts, for the most part ignored.

The flight safety of the airships of the next tomorrow can be hindered for one of the following causes: pilot errors, malfunctions, bad weather, fire.

1.1 Pilot Errors

The pilot must never trust his luck and must carry out the careful preliminary study of his thousandth flight as of the first one. Navigation on board of an airship can now be said to be reduced to that of a common transatlantic. The crew is made up in a similar way to that of a ship: each man has his task well delimited, for a number of hours that do not strain his faculties of resistance. One of the legends to be debunked is that the pilot, like a carrier pigeon, possesses the instinct of orientation. Nothing could be more false: the faculty of heading into space above the deserts and seas is the result of an education and a methodical instruction completely similar to those of a sea captain: an education that today must be maximally cultivated and perfected, to make every long-flight pilot a superb air navigator.

Once, on board, an altimeter for altitude, a rev counter for the engine, a pressure gauge for the pressure of the gasoline tank were enough as instruments for short daring flights, precursors of other audacities. The pilot almost wanted to make people believe that he had confidence only in his own virtuosity and intuition. Generous audacity, but unconscious. This is no longer the case today. The cockpit of a modern airship is like a temple dedicated to the idols of an innumerable Olympus: and, never, idols were consulted with greater religion than that with which the aero-navigator consults the instruments on board. I will briefly mention the most important and modern instruments among those intended for navigation, confident to better show with how much confidence we can today rely on modern airship for a long flight. I will not talk about the instruments for the conduct of the engines: (speedometer, level indicators for gasoline, thermometers

for radiators, pressure gauges, etc.): about the instruments for the flight characteristics (absolute and relative altimeters, variometers for the measurement of ascent and diving speeds, of slope and curve, of absolute and relative speed): about, finally, the instruments for lighting, for signaling from ground and on board, for heating, for mechanical, acoustic, electrical communication between the various parts of the aircraft. Its stability must be as perfect as possible. A long practice and constant attention are necessary to keep the line of faith on the established angle: the helmsman cannot have any other task on board during his working hours, since his faculties can absolutely not be distracted; he don't need to know extensive knowledge on airworthiness; his activity is almost mechanical, typical of ordinary helmsmen of motorboats and ships.

The task of the route officer is very different from that of the helmsman, who is only a faithful executor of orders. After a period of training, his ability can become exceptional: even with very strong lateral winds, he can navigate with oscillations of a few degrees of amplitude (at most four or five on each side). In the flight from Friedrichshafen to Rome of the Bodensee airship, delivered by German to Italy, (the airship that today, under the new name of Esperia, lies in Ciampino airport waiting for the events), the lower Provence and the Gulf of Lion were crossed at a speeds of over 100 km/h, under the breath of the well-known Mistral (NW) with lateral gusts of over 50 km/h, fully controlled by the helmsman, who allowed steering of no more than 5 or 6 degrees. The fight against the wind storm lasted about four hours: three Italian officers were on board, and they can testify about the safety of navigation. The airship continued its flight quietly, regularly completing the 1300 km of route in 12 h.

The guidance of the airship by means of the compass becomes the only possible one, when there are no reference points, i.e.: in the middle of fog or on sea with clouds. With relative ease together with constant attention, it is possible to fly without the help of any point from the earth or of heaven, only keeping the eyes fixed to the line of faith, even for long routes. In the flight that the airship Ausonia (ex Zeppellin L Z 120) performed with our crew from Rome to Cagliari on the night of May 11 last year, having General De Siebert (Commander Superior of Air Force), and 34 other people on board, with a cloudy sky and a very difficult visibility for a dense fog, after having checked the position from the lighthouse of Fiumicino and chosen the most appropriate angle, the flight was governed exclusively with the compass for the whole crossing, meeting the Sardinian coast after about 400 km of navigation, only 1 km south of the previously fixed point, as the same General De Siebert declared. In the very recent transfer flight from Milan to Roma of airship F. 6, departing from Milano late at night with a dense fog, governing exclusively with the compass between two layers of clouds that never allowed the vision of the earth or the sky, arrived after six hours of flight in the blue sky of Lazio, flying over Orte, which was exactly along the prefixed route. And, apart from these, other infinite examples testify the absolute certainty for airships to sail even for long routes inside fog and clouds.

More recent instruments have perfected the use of the compass by amplifying, so to speak, its sensitivity. In an onboard compass, the oscillations of the moving rose must be rapidly dampened, the effects of vibrations must be canceled as much as possible and all the mechanical magnetic masses, which are the cause of frequent disturbances, are removed as far as possible. These drawbacks are diminished by the fern-compass, or remote compass. The real compass is fixed on the airship in the most appropriate position, where there are little vibrations and away from the moving magnetic masses; in front of the helmsman there is only the needle of the galvanometer of a circuit, in which selenium resistances are inserted on the compass that give variations very sensitive to the passage of the current; thus, instead of keeping the line of faith before the eyes, the pilot holds the needle of the circuit in the position of zero of an arbitrary graduation and correcting with the rudder any movement caused by changes of the route. In addition to the remote compass, other instruments of curve indicators are in use: they are based on the principle of the gyroscope, and by means of an index or a graduation, the indication of every minimum movement of the pre-established route is given with great sensitivity. But the compass, even if sensitized as said before, cannot be enough to achieve the goal in the long navigations of the future. I wish to mention the drift, which draws the air vehicle when the mass of air, in which it is immerged, moves in a direction different from that of the pre-established route. It obviously follows that the airship, while retaining a constant compass angle, moves parallel to itself with speed equal to the transversal component of the wind, of a space proportional to the intensity of the same component and inversely proportional to its own speed.

It is necessary to evaluate this drift, very sensitive even in air vehicles; however, fast and, consequently, to correct the compass of an angle called the "piloting angle", so that the airship can travel along the fixed route even with non-coaxial wind. Various instruments have been built for this purpose: in Italy we have the route indicator—"derivometer"—of Colonel Crocco, which quickly and easily gives the piloting angle and the relative speed of the airship with respect to the ground: it is an instrument used currently on board, to be used also at night by fixing bright, or otherwise visible, points, and also on the sea by throwing floating bodies and, if at night, bright. It was used in the first crossing of the Atlantic in 1919 (with a stop in the Azores) by two American officers aboard a *Navy Curtiss*.

However, it can happen to sail above large areas of fog or low clouds: the route indicator then becomes useless, because there are no reference points; then, the airship is directed on the basis of aerological observations performed before departure or for known information on the constant winds of the region (for example the trade winds and the counter-wings of the Atlantic Ocean) and, consequently, imparting the most convenient compass angle to the helmsman. It is evident that, especially for long navigations and if the space below remains hidden for a long time, the procedure is quite empirical: in this case we have the precious aid of the *astronomical determination of the point*. The problem of air route surveillance by means of astronomical observations falls within the scope of the general problem of determining the point aboard an aircraft. Every point found becomes the cornerstone of a new route. Among the various procedures used in Navy, it is adopted the one that requires less calculation and has a greater speed even with a lack of precision, since an approximation of 20 or 30 km will suffice for airships. As is known, the basis of each method is the determination of two heights observed on suitably chosen stars; it can be obtained on board a well stable airship by means of a dial with *maximum error from 3 to 5 primes*, that is, from 10 to 15 km of approximation. With the method of separate coordinates, applied by Dr. Brill to air navigation, frequent observations were made on our airship; I remember that on July 31, 1916, after an offensive action on Pola and after having been surprised by thick fog on the return above the whole northern Adriatic and the Po Valley, an airship or ours, which had on board as an observer Major Berardi, pure glory of our air force, immaturely dead in a tragic flight, regained the airport of Ferrara finding its way through the determination of the point performed with this system. Today we owe the genius of our Prof. Bianchi, a deep lover of aeronautical sciences, now director of the astronomical observatory of Brera, the discovery and practical application of a new simple and rapid method: that of the *globe*. We only need a geographic globe to plot on it the two minor circles corresponding to the two heights observed on two stars, to have the true point in their intersection on the hemisphere of navigation. Special devices facilitate the calculation and the plotting of the two circles on the aluminum globe which, for an approximation of 20 km, has a diameter of 66 cm: negligible dimensions and weight on board of an airship.

Finally, it may happen, and this is the most unfortunate hypothesis (but which can always occur and against which it is necessary to guard), that not even the determination of the astronomical point is possible because uniform layers of clouds cover the sky and, moreover, that it is not possible to determine the point with the aid of the ground because it is hidden by fog or low clouds. In this case we have the Radiotelegraphy. All modern airships are equipped with a perfect radiotelegraphic device, of higher or lower power, depending on volume and mission: usually, the airship communicates with ground stations and vice versa by means radiotelegraphy or radiotelephony; the antenna consists of a wire a hundred meters long, that hangs below the cabin and can be recovered with a slight winch. We can say that never an airship is left alone in the oceans of space, the same as never a steamer is left alone in the middle of the oceans. Well, with modern radio-goniometric devices we can get the position of the aircraft at any time: in this way the Germans succeeded to track down Paris many times and carry out their barbaric bombing enterprises, even with clouds and fog. It is known in fact that if the radiotelegraphic receiving aircraft is closed so as to form a triangle, a square, etc. it has the remarkable property of receiving only the waves coming from a transmitting station located on the plane of the square: so if this carries an index that moves in correspondence with an oriented circle with the compass, you can read the direction of the panel and then that of the transmitting station, even if located at a great distance. If two or more stations whose position is known on the ground, called "radio bacon", emit known signals at a certain interval of time, their relative positions with respect to the aircraft will be identified from the board and, therefore, the position of the aircraft is easily identified by intersection, so much more exact the closer to a right angle are the two directions. If the survey of the point is made at regular intervals, marking the data on the route map, the speed and direction of the aircraft with respect to the ground or the sea can be determined, even without seeing it and, according to the *known* proper speed, we can establish speed and direction of the wind. In this way we obtain all the data necessary for navigation, which can certainly be conducted even in poor visibility conditions. The problem thus summarily stated is, in practice, much more complex. Interesting experiments are being carried out in this regard to perfect the system with regard to the best shape and the best fitting on board.

Examined in this way all the possibilities of reaching the final destination, however, far away it is and, however, difficult the elements offer to the determination of the point, we come to talk of the other category of accidents that can hamper the navigation with the airships.

1.2 Malfunctions

They may depend on the engines and on the rest of the governing devices. As far as the first, with the perfection achieved today for the engines of aircraft, this accident is to be excluded at all. We do not need to skimp on the airship's weight to the detriment of the strength of the main operating organs; moreover, each engine is never stressed, it is continuously monitored by a technician who regulates the circulation of the lubricant, the temperature of the cooling water and listen with jealous care to the rhythmic pulse,

ready to intervene where necessary. The engines of Esperia have an average of 700 h of operation and, for now, they do not need to be changed, not showing signs of wear or fatigue.

In addition, each airship intended for long flights has a reserve of power that allows it to rotate the various engines, allowing us all the time necessary for checks and repairs of them. Nor should there be a fear of fuel deficiency, because there must be on board an endowment such as to allow twice the route to be carried out in normal time. As for the rest of the governing bodies, it should be borne in mind that the airship is accessible in all its parts, that it is technically built with very exuberant safety coefficients for any possible external loads, that all failures are repairable during flight including possible tearings on the gas compartments (as it occurred to our "Rome" airship in a flight in the United States of America on December 16 of last year). I mention an article in an American newspaper about it:

> "After two and a half hours of navigation, one of the doors that covers the engines and, precisely, the first left engine, broke off under the action of speed, and ended up between the blades of the propeller. This obviously broke, causing a great noise, a lot of damage and a general dismay in the passengers and crew. The noise was such that it sounded like the explosion of a bomb. Two large gaps in the ballonet and several tears in the diaphragms were immediately founded. Two pieces of the propeller passed completely through the gas compartment and came out of the bottom of the casing. One of them struck fully a beam of the box, but this showed no problem. Obviously, the leading engine was taken out of service and we began to remove gas from the broken compartment, to suck up the cloth and to allow two crewmen to work in the compartment. This action was successful and all the tears were repaired during the navigation. We flew another hour and a half after this accident and then made a perfect landing on the field. "

1.3 Bad Weather

Let's talk now about the bad weather during navigation. This is the greatest of the critics that the adversaries of the lightest of the air move us. It should be said that a real statistic in this regard has never been carried out; it is therefore a rather nebulous statement that is repeated only by hearsay, and that finds its origins in the low speed that, until yesterday, our airships possessed, and in the scarcity of the means with which they could cope with adversity. Yet, even with such scarce means, it occurred the fact, now forgotten, that a small airship, the P4 in the skies of Veneto in 1914, made 252 flights, without any other objective than the ardent will of the pilots to conquer the mastery of the air and to prepare worthily for the great war, expected imminent. A practical experiment in this regard has never been done in Italy, nor would it be possible to do so today with our antiquated airships; not so abroad, however, as we will see soon. Of course, no aircraft has a possibility to fly every day; and if the airship, like the sister of the sea, cannot today cope with the hurricane, but tries to get around it or to escape it, no longer fortunate in turn is the airplane in its struggle in the middle of dense clouds or fogs that cover the landing ground. I said today intentionally, because everything is legitimate to hope from the fervent geniality of human progress.

The climatic adversities to navigation that can occur during a long flight to an airship, are the rain, the wind, the snow, the storm. We have already examined the navigation inside fog and clouds, and we have seen how they can be faced with the help of the perfected tools available today. The rain brings nothing but a weigh increase by a fixed and well-defined quantity for each airship, to be compensated by means of the ballast, an indispensable equipment of each flight. Many times, our old airships have faced the rain without damage.

The wind, if until yesterday had a great importance because of the miserable speed of 60 km per hour of our airships, today has no other influence than that of the drift that is corrected on the compass, as seen before; with a speed of 100, 120 km per hour of the present airships, a wind of 40 or 50 km per hour has no other result than to delay the arrival and this is not worrying because, as said before, there is a reserve of fuel on board which can largely cope with it. Note that, at our latitudes, a wind around 40 km per hour at an altitude of 1000 m has a probability less than 10% and much less close to the ground. The passenger does not even have the impression of the fight against the wind: one does not "dance" with its disastrous consequences, as on board the most gigantic ocean liners; the larger the volume of the aircraft, the less it is affected by the wind which, although strong, is also significantly constant in direction and intensity as soon as we little rise from the earth. In this regard, I report an interesting passage from an American newspaper, the "World", that speaks of the maiden flight of our airship *Roma*, on the Langley-Field-Washington route:

«At the day of the ceremony, winds gusts, sometimes up to 60 km per hour, steadily blew on the Langley-Field-Washington route. The *Roma* managed to overcome all these headwinds and making the entire trip without inconveniences, despite the fact that three engines were out of service, because the radiators were not provided with screens to prevent the freezing of water, (a phenomenon due to not expected weather conditions). The value of this demonstration is enhanced by the fact that, during the baptism ceremony, the airship was temporarily moored on the ground and that, in these conditions, the airship was subjected to the gusts and supported repeated impacts on the ground. The

event will be remembered in the history of air navigation. When an airship of the size of a modern ocean liner can successfully approach and overcome the various obstacles encountered during an air route, when it can face a storm or overtake it with only half of its engines and, ended the journey, to come back intact to its destination, it can be said that this airship has passed the supreme test of practice. The test of *Roma* held for ten consecutive hours in gusts of 75 km per hour, will remain historic». The ceremony was attended by our Colonel Moizo, who confirmed these impressions to me, which may seem exaggerated.

Snow has the same importance as rain: it would be worrying if it adhered to the envelope, accumulating on it and weighing it down: but the snow, especially when it is dry, does not adhere and we need just to navigate a few hundred meters above sea level to find perfectly dry snow. The *Storm* can be avoided by overtaking it at altitude,—since it usually takes place in the lower layers of the atmosphere—and, if this is not possible, by circumventing it: the extension of it does not exceed 300 or 400 km in diameter, and given the total length of the journey, it is not a great drawback turning it over the wind. It should be added that from the airship you will constantly know the meteorological status of the entire journey by means of the on-board radiotelegraphic station, and that it will often be possible to avoid the center of the storm by quickly diverting the pre-established route in a few degrees. There is the example of airship that during the war were dragged adrift hurricane: but they were caught in the careless, obviously not having meteorological news from the enemy side, and not yet being able to fly by the same speed of today, nor with sufficiently robust structure, because the stiffness was sacrificed to lightness in order to reach a greater altitude with the maximum load of bombs; however, there is the positive situation of two Zeppelins that, hit by electric shocks, did not suffer thanks to the perfect connection of all parts of the structure and all the metal masses; there was no other damage than the fusion of an element in front of the airship and the metal counterweight of the radiotelegraphical antenna, that hung outside: the points of input and output of the current.

It is on one of these war Zeppelin, three times bomber of Paris and four times of London, that I witnessed the hardest struggle against the atmospheric elements that has ever occurred to me, who came out more and more confident on the safety of the airship: it is therefore worth describing it briefly. The airship was located in Staaken, 10 km from Berlin; its characteristics were: volume 55.000 mc, diameter 24 m, length 196 m, speed 90 km/h, 6 engines, 4 cabins. The airship had to move, with German civilian crew, from Berlin to Roma to be delivered to us as a prey of war. I represented the Italian Air Force and I had to take part in the transfer flight. The weather was decidedly adverse, as it was in the middle of the North winter, with snow and brown constantly present. Arrived at Staaken on 22 December 1920, the crew was warned that the journey would take place the next day: but, since the weather conditions had worsened, the German Commander on the morning of the 23rd asked to leave Staaken after Christmas, a solemnity particularly celebrated in Germany, in which nobody wanted to be at Rome. On the evening of the 23rd, I witnessed a stormy conversation between the Director of the Shipping Company and the Commander about this delay: the former gave the order to leave the next day 24th at any cost, so that it could be said that a *Zeppelin* had been won by bad weather. The weather conditions worsened even more; however, at 12 noon on December 24 we left, with the characteristic Nordic all overcast winter sky, with news of snowstorms on the Alps, and of quieter weather in Italy. The pre-established route was almost straight, with a slight deviation in the center towards Klagenfurt to avoid the highest peaks of the Alps. The 500 m of altitude was immediately reached: in Potsdam, the low fog impeded the visibility of the ground, after only six minutes of navigation. The helmsman kept his eye fixed on the compass. After about 4 h of navigation, we saw in the bow: the Mittel–Gebirge very close to us; we rose to 2000 m to cross them but, at this altitude, we entered the layer of clouds above and it began to rain.

The clouds were so thick that the stern of the airship was no longer visible from the cockpit but disappeared into the fog. After climbed through the corridor to the upper platform, the spectacle of the mysterious cluster of clouds against which the bow of airship headed safely was truly fantastic: it seemed to live in the heavy atmosphere of a nightmare: neither above, nor on the sides, nor below there was a glimpse of reassuring clarity. In front of us, the Alps had to be close by now, in a not very nice proximity. At 7 pm, after seven hours of flight, the rain turns into snow and the wind blows hard from the right: the snowy dust penetrates through invisible cracks into the poorly closed cabin; a pine branch that, in memory of Christmas' Eve, the Commander had placed on his table is covered with a thin snowy embroidery. We climb to 3000 m to avoid encountering the invisible peaks of the Vorarlberg Alps: but, due to the increasing intensity of the snow that has now become a torment, and apart from considering unwise to venture blindly among the alpine gorges, the Commander decided to circumvent the obstacle, fleeing with the tailwind to the East, until he was sure of not having the highest and wildest Alpine ridges on the South. With teutonic tranquility, in a short and meticulous war council in which I was invited to participate, the General Staff of the airship opened the map of Europe on the table of the command cabin, while the helmsman sailed impassively through the storm. Short calculations, measurements, compass, choice of the most convenient angle for the new line: the helmsman performed the approach to East; from 9 h, we were not seeing neither earth nor sky. After an

hour of navigation in the new conditions, in the certainty of being out of the dangerous area by now, we pitched down until 2000, 1500 m; at this altitude, we came out of the clouds, we got rid of the frozen sleet and we glimpsed under us a wide river: the Danube. After a short time, we were on Vienna, from which we turned the route towards Ljubljana in increasingly favorable conditions: at midnight, between Ljubljana and Trieste, the radiotelegrapher on board, an Italian officer, distinctly perceived the first friend voice: it was the radiotelegraphic station of S. Paul in Rome, 500 km away, who transmitted a radiotelegram to one of our ships located in who knows what sea. At two in the morning, crossing the Adriatic sea, we cut the coast at Ravenna; at eight o'clock on Christmas day under the warmth of the rays of the good Italian sun, we were on Rome, having traveled 1800 km in 20 h. *My faith in the future of large-volume airships became unshakable after that flight.*

1.4 Fire

And now let's move on to consider the last factor, the most dangerous able to generate a great terror in the crowd of the public: *the fire*. I wish to note that no civil transport airship ever had a fire during navigation; fires on board were only caused by incendiary projectiles during war time. In the navigation of peace this danger is the same we could have on board of a common steamer, because it is the constant concern of the manufacturer to eliminate any possibility of fire caused by construction defects, bringing the gas valves away from the engines, protecting these from any probability of flame returns or sparks; it is the constant concern of navigators, whether pilots or passengers, to use all precautions to avoid fires. The discovery of helium in recent times has totally eliminated any possibility of accident; it a precious light and incombustible gas, which can substitute hydrogen in the case of large airships; in the United States of America alone, 10 million cubic meters of Helium are produced per year, only partially utilized so that there is exuberance for the operation of a large world air fleet. Helium airships have already been inflated in America with excellent results. Its higher cost is compensated by the much lower power of diffusion and by the greater purity that can be achieved in its production.

So, we have quickly examined the possibilities of navigating safely through the skies by means of the airships: but to navigate is not enough, you must leave and land. The air power of a country is not only made up of pilots and air vehicles, but also of its station facilities. It can even be said that these elements are the most necessary, because if an aerial fleet can be prepared with relative ease, we need much more time, and it is more expensive to create the skeleton to gives it the necessary stability. Let us confess it frankly: we have much to learn by the Germans in this field. Visiting their facilities, examining the positions of 73 airports which they possessed at the time of the armistice in Germany, Poland, Bulgaria, Hungary and Belgium, one cannot conceal a sense of admiration for their powerful organization. Each center was expertly arranged in every detail; it had a double maneuvering field, a perfect underground system of power lines, telegraphs, pipes for water, gas, gasoline; each hangar was equipped with special ventilation systems, lighting, heating, special rails for the mechanical exit and maneuver even with strong winds, and could give shelter to at least one *Zeppelin* of 60,000 cubic meters; many centers were equipped with several hangars arranged in a star or a cross, some even swivel. Each center had a repair shop and a hydrogen production plant; it has been connected to the nearest railway and it had special provisions for landing at night, or in case of fog or strong wind. With an airport prepared in this way, it is possible to perform the entry and exit maneuvers even with a little staff. On the other hand, the needs of shelter on the future long routes will be reduced to two terminals, because safe mechanical systems have been already designed (and partly experienced) for the rest and mooring stations; these systems, the result of the skill of our technicians, allow the airship to wait safely for the events: I mean to talk about the rotating mooring platforms. I will say more: the large future airships will be equipped with strong fabrics to face the insults of atmospheric agents even for a long time. As for the landing hands, Colonel Crocco demonstrated in his well-known conference that the ease of maneuvering grows with the volume because, while the mechanical force of maneuver and mooring increases proportionally to the volume, the force of the wind on landing grows proportionally to the surfaces, and the ratio between the two antagonist terms varies directly due to the size, in favor of the ease of maneuvering. The perfection achieved by the present instruments and the thrust reversal of the propellers, allow us to carry out slowly, but with the maximum safety, the delicate landing maneuver in a pre-established point.

It now remains to debunk a last legend that the commercial exploitation of airships is not economically profitable. In a recent study by General Maitland, Director of Air Services of England, it has been calculated a price of about three lire per ton kilometer, which is equivalent to the ticket price of about 2000 lire per passenger with light baggage, for the operation of the London-Bombay line (7000 km) with four 77,000 mc airships, taking all the costs for mobile and fixed material and staff into account. For larger volumes, Colonel Crocco calculated the price of an air trip from Rome to New-York in lire 1500, at the current cost of the lira. Ing. Nobile, in his detailed studies on air transport, concludes that the passenger-km maximum cost on large airships would be 20 cents at current prices, that is, less than railways and steamers. The skeptics say that in such calculations, despite the authoritativeness of those who performed them, it is easy

to fall into error on the exact placement of commas; and indeed, one cannot help but be perplexed reading that, in the first eight months of operation of the French aviation lines in 1922, each passenger costs by 2. 000 to 17. 000 francs to the State, according to the lines, in the form of a grant to the Company; therefore, for the use of skeptics, I wish to report here not calculations on the future (susceptible to optimism and subject to criticism), but precise data extracted from an unpublished document, namely the advisory budget of the last activity actually accomplished with the airship *Bodensee* by the "Deutsch Luftschift Action Gesellschaft", for the *Hamburg America Linie.*

Built by the Germans after the armistice, the *Bodensee* was used to operate the Swiss line (Lake Constance)-Berlin: about 600 km, just under the Turin-Naples route. Its characteristics are the following: length m 136—diameter m 18—volume mc 22,500—maximum speed 124 km/h—economic speed 100 km/h, 4 engines of 250 HP. As evidenced by the high ratio between the dead weight (14 tons) and the total lifting fore (25 tons), the airship allows the greatest robustness to the whole, the main factor to guarantee a safe service. To this end, the passenger's comfort has been taken care of to the maximum, by means of a cabin closed to that of the commander, furnished with comfortable deck chairs and well equipped in every detail up with an electric kitchenette and due toilets. The passenger has a small removable table at his disposal; he can easily maneuver the side doors, is away from the annoying noise of the engines that are positioned over 50 m behind the cabin. The experiment lasted only three months, since the airship stopped its flights to be delivered to us as a prey of war and it was no longer allowed to the Germans to build airships on their own: but even from this short period we can draw very interesting data.

One hundred flights were made in 90 days, including seven short ascents to Berlin and its surroundings and 15 stopovers to Munich; in total 38 outward and 38 return trips, with a single airship, plus two trips from Berlin to Stockholm. The passengers transported were 2380 over the crew, 5000 kg of mail and 30,000 kg of luggage, for a total of 533 flight hours and 52,000 km travelled. The longest duration of the journey between Friedricshafen and Berlin was of 1 h and 20 min, covering the 600 km with violent thunderstorms of S–W: the longest of 9 h 23 min, with strong wind in the bow. By train it takes 16 h with the direct one. The only accident of the whole period was a violent landing in Stockholm during a thunderstorm, for which the lower part of the cockpit suffered a failure as a result of a collision on the ground: with his own means, since there are no hangars in Stockholm, the damage was repaired, and Bodensee returned to Berlin without further incidents. In almost all the journeys established by the time table the airship carried full load. The average load (passengers, mail and cargo) was 2.5 tons which, for a total route of 52,000 km and for a cost of about 1,300,000 marks, gives about 10 marks per ton-km; one mark was worth 50 cents at the time. Expenditure is divided into 1,000,000 (one million) marks for operating expenses (maintenance, gas, consumption, flight personnel, maintenance and maneuvering, repair, salaries, management, claims); 70,000 for station expenses (salaries for office staff, telephone, telegraph, energy, workshops, ground transport, order service), 50,000 marks for insurance, 90,000 for taxes and duties, 130,000 for depreciation. The calculations mentioned on the cost of a line with large airships are therefore correct, since they are slightly lower than those exposed on the operation with a single medium-sized aircraft, a very unfavorable exercise from the economic point of view, as all the general and administrative expenses and maintenance and claims would have been slightly higher if there had been more devices. The short duration of the period also acted unfavorably, since only after a certain time would it be possible to improve the organization and conduct of the exercise, even more so since it takes place in a climatologically unfavorable period, that is, in the late Northern autumn (September, October and November). The enterprise closed to balance, that is, it was profitable looking at any subsidy was given to the company, which nothing asked to the State; contrary, the intervention of the State was negative, for taxes and duties! The reservation was always double the availability, which would have allowed to increase considerably the price of the journey, if they had not deliberately kept the prices as low as possible for propaganda purposes and to ensure the future of the line. The Zeppelin house (Delag) was not in its infancy because, in the years before the war, it had already transported 17,000 passengers in 800 flights: a single airship, the *Victoria Luise*, had made 200 flights with passengers on board in 250 consecutive days. We too have successfully made numerous flights for tourist purposes after the war, adapting spacious cabinets for short excursions. But these are airships by now, not be able to be used in a regular remote service; they are already 4 or 5 years old, with speeds that do not exceed 60 and 70 km/h. Today, it is a question of something else: the speeds must be at least 100 km/h with 10,000 km of autonomy and with 100,000 cubic meters of volume; without this we cannot think to overcome the obstacles of deserts and oceans.

There are very interesting projects here that unfortunately remain in the state of study, while abroad similar projects are in full development. I mean the London–New York line with 150,000 mc airships that America is building; the test condition one of which, like Zeppelin is the execution of the route of over 20,000 km in three stages (three ocean crossings from Berlin to New York); I mean the line New York–San Francisco–Yokohama and, above all, I mean the Spanish line in full course of development between Seville

and Buenos Aires, which is a lot of regret for us, because we had and could have been the first to join by air with our hard-working masses overseas.

Two years ago, H. M. the King of Spain expressed the idea of establishing an air link between Spain and the Spanish-American countries, so that reducing the distances could produce mutual benefits for the two regions. The study of the practical realization of the idea was entrusted to a commission of technicians headed by Eng. Errera and it was soon recognized that the project was fully executable with airships; therefore, a company was established under the high royal patronage, which asked for the cooperation of the Zeppelin company, granting it the exclusive right to use this type of airships for the Spanish-American line, on a route of 10,000 km. The total route can be divided by climatology into five parts: two temperate zones and three tropical zones from the Canaries to Cape Frio; the two temperate zones have a weak possibility of storms and snow, little rain and regular trade winds from N E to S W; in these zones, the possibility of storms is small (almost zero), the possibility of rains is somewhat higher, but almost never there are strong winds and, finally, the presence of fogs is insignificant. Above 2000 m, the counter-trade winds blow constant in intensity and direction (SW–NE).

Accurate meteorological studies show that Andalusia and the west of Buenos Ayres are particularly privileged regions, suitable for positioning the two terminal airports there, with the certainty of always finding areas of calm air that make landing easy and safe. During the outward journey, the trade winds, of constant intensity around 20 km/h, help the march of the airship; on the way back, it is enough to lift to 2000 m to find the counter-trade wings, which facilitate in the same way the journey to Europe. The planned line is now under construction; it consists of the two terminal stations in Seville and Buenos Ayres, equipped with hangars, H generators, fuel depots and workshops. Each airport has an extension of 200 ha; in that of Seville there are 3 large hangars under construction: two of them of m $300 \times 90 \times 50$ for operating airships, one of $150 \times 50 \times 50$ m for a school airship. Two reserve stopovers with devices for outdoor mooring and deposits of hydrogen, fuel and spare parts, are arranged in the Canary Islands and Cordoba, 600 km W of Buenos Ayres, where the climate has the same calm characteristics as in Seville. There will be 4 airships: three for the transatlantic flight, with 135,000 cubic meters, 250 m in length and 34 m in maximum diameter and one airship school to train the Spanish pilots who will later replace the German pilots in the operation of the line; this airship that will be operated on the Seville-Canary route, is similar to the Bodensee but somewhat larger. These airships have nine 400 HP Maybach engines in 9 independent nacelles of the usual eggshell type, brilliant Italian conception adopted by the Germans during the war. In addition to the crew, they will transport 40 passengers and 10 tons of commercial cargo and mail. The economic speed is set at 110 km/h, and the maximum is 132 km/h in case of headwind. The expected frequency is two simultaneous weekly direct trips in both directions, taking 3 days on the outward journey and 4 on the return, as an average. Passengers will have the comfort of modern ocean liners, comfortable berths, dining room, smoking room, sinks, etc. with the enormous advantage of saving 15 days of time and without being disturbed by the noise of the engines which are in separate spacecraft at a convenient distance. These airships represent an intermediate grade between the existing ones and the already planned future airships of 180,000 cubic meters with maximum speeds of 144 km/h and 75 passengers in independent cabins, similar to those of the transatlantic liners. During the flights, the airships, provided with powerful radiotelegraphic stations, will always be in communication with some of the 45 radiotelegraphic stations currently located on the coasts of the Ocean, along the route. In this technical and financial project, the price is fixed in 5000 pesetas per passenger (by and large, as a luxury seat on board a modern ocean liner), in 2 pesetas and 25 centavos for a letter (the price of a word of cable). The project was enthusiastically received in Spain, Argentina and Brazil; numerous and important French and English companies have submitted offers to contribute to the execution of the project the most important insurance companies—this is the most significant—have offered their services. I will report here some very interesting and well-thought-out remarks, contained in the Spanish preliminary report annexed to the draft:

> "The inexhaustible riches of South America, for the most part untapped, would only require to be placed in easy contact with the centers of European industrial activity to easily become a source of prosperity and well-being, which would also spread to the rest of the world. Currently, it takes twenty days for a letter to arrive from Europe to America and this certainly does not facilitate the rapprochement of the two continents. A letter that arrives after twenty days has very little interest given the intense activity of today's era; a message by cable obliges us to take decisions in a few words and costs a lot and, therefore, is used only in cases of great need. A line of communication which would allow a letter to be transported four times a month in three or four days and whose cost would be equal to that of a single word of cable, would not only favor the industrial and commercial exchange of the countries connected, but would considerably increase intercontinental activities: transatlantic traffic would be increased to the same extent, increasing existing lines for maritime transport, the scope of which cannot be replaced by airlines. This benefit would extend

to the whole of South America and especially to the Argentine Republic, the terminal station of the planned line, which would become the center of communications with Europe, where the streams of commercial and industrial activities of South America should flow. At the same time, the advantages of this project would be extended to all European nations in varying proportions: however, the importance that this line would have for Spain would be extraordinary, not only because of the greatness of the enterprise that would be an unexpected manifestation of the great scientific potential of Spain compared to foreigners, but also because it would channel commercial activity between Europe and South America into our territory. The Seville air station would be the port of entry into Europe for all airlines from the Atlantic and West Africa".

We feel a regret in reading these conclusions which could have been realized by us for some time, because we have technicians and pilots and workers and projects in nothing inferior to the foreign ones; it must be a training and a spur for us. Our privileged position in the middle of the Mediterranean, in the area where nature has lavished most the clemency of its smile, the bridge that the divine will has created as a symbol by extending our sweet country towards the riches of the East, must not remain a field of sterile indolence. Already today, in the dense aerial network that surrounds our globe, Italy represents the frightening spot in a desert; already rapacious hands stretch out from beyond the Alps to violate the pure blue of our skies with foreign wings. We have already been preceded in the exploitation of western air traffic; at least, let us be present in the air traffic of the East by means of lines that connect our colonies, and beyond staring from them to bring the triumphant sign of our colors throughout the Mediterranean, in Asia, in the Indies, in Australia and preceding England and Holland who want to join their fertile and industrious colonies and their domains by air. If my mind fails, we need the energy of a government to go on. We will thus renew the glory of the ancient maritime republics of St. George and St. Mark, which gave us the hegemony of commercial traffic up to the farthest sea and made the name of Genoa and Venice imperishable in the world.