

TORRES QUEVEDO'S TRILOBED AUTORIGID AIRSHIP. A CENTENNIAL CELEBRATION

Francisco A. González Redondo
Department of Algebra. Faculty of Education
Universidad Complutense de Madrid (Spain)

On June 14th 1908 the first flight of the “Torres Quevedo”, a trilobed autorigid airship, took place at the Spanish Army Aerostatic Service in Guadalajara (Spain). It was the culmination of several previous trials undertaken during the summer of 1907 with the most advanced aircraft in those days. Designed and patented by a Spanish civil engineer, Leonardo Torres Quevedo, his system soon spread throughout the world subsequent to the test at Sartrouville (Paris), during October 1909, under the supervision of French Astra Company. Around 30 airships were built in France between 1911 and 1936, along with more than 60 in the United Kingdom between 1916 and 1919; whilst several units were sold to Russian Army, and to the United States and Japanese Navies.

This centennial celebration is a milestone in lighter-than-air history that the *Dirigible Journal* cannot (and will not) ignore.

The problem of Flight

In 1901 Torres Quevedo embarked on the search for the solution to one of the biggest challenges that mankind faced at the beginning of XXth Century: Flight. In those days Aviation did not exist and it would not become a real solution to the problem until WWI. The only aircrafts were balloons and what would become known as ‘airships’: a kind of “dirigible balloon” which then lacked any in-depth scientific study.

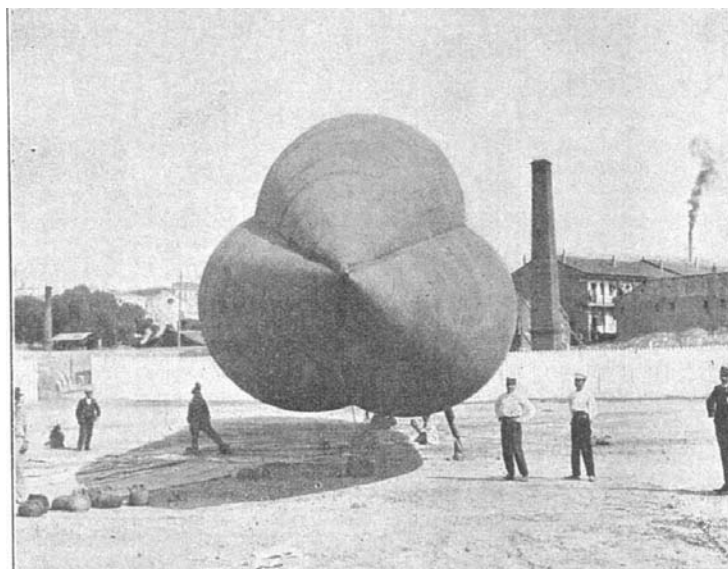
By that time there were basically two principal systems: *rigids*, built according to the designs of German Count Ferdinand von Zeppelin; and *non-rigids*, the best known being those tested in France by the Brazilian sportsman and millionaire Alberto Santos Dumont. The former had an internal rigid metal frame housing several hydrogen cells, and a fabric envelope which covered the whole structure. They had a stable form, but could not be folded when deflated, the volume of the exterior suspended elements resulted in considerable resistance and they also suffered transverse oscillations. The latter had an impermeable envelope without rigid elements which was inflated with hydrogen. They could be disassembled and were easily transportable when deflated, but they were dependent on internal overpressure in order to maintain their shape, and needed ridging along the whole envelope to prevent the gondola from bending the airship in the middle.

On 5th May 1902 Torres Quevedo’s technical scientific research came together when he applied for a patent in France for ‘Perfectionnements aux aerostats dirigibles’ (‘Improvements in dirigible aerostats’). In this patent Quevedo concentrated on the question of stability (of form and in-flight stability) while other scholars were still

principally concerned with that of *propulsion*. A few days later he would present some of his first reports on the general theoretical principals of aeronautics and technical plans to Madrid and Paris's Academies of Science.

The international resonance of the new developments had a huge effect on the aeronautical world, and by the end of 1902 the report at Paris's Academy of Science was included in the French journal *L'Aerophile* and the English translation was published in the British *Aeronautics*. Soon afterwards, on 27th January 1904, he presented a new paper to the Academy of Science in Madrid entitled "Globos atirantados" ('Stretched balloons') in which he suggested the possibility of eliminating all rigid elements in the interior structure (i.e. the beam), and of removing the keel in such a way that the interior pressure of the gas contained within the envelope would make the airship "self-rigidifying".

In March 1905, with the collaboration of the Army Engineer Captain Alfredo Kindelán Duany as Technical Assistant, the construction of the first airship began at Madrid's 'Beti-Jai' 'pelota' court. At the beginning of June 1906, the joining of the envelope to the funicular frame (made up of non-rigid elements) was complete, and the balloon was inflated to 640m³ in the Parque del Real Aero-Club in Madrid. With the shape of the aircraft proven to be stable, on 11th July he applied for a general patent for "Un nuevo sistema de globos fusiformes deformables" ('A new system of collapsible cylindrical balloons'). A few days later the balloon (at that time still just a balloon) was moved to the Parque Aerostático Militar in Guadalajara, 60 km east of Madrid.



26 June 1906 – Torres Quevedo No. 1. Madrid Aeroclub

By July 1907 the airship 'Torres Quevedo no. 1' had come into existence (fully equipped with gondola, engines, helm, rudders, etc.) and plans were made for the first piloted trials. The system brought together the advantages of preceding airships and eliminated their disadvantages: the airship was flexible (which meant that it allowed for any possible impacts), it was deflatable, transportable etc., and at the same time was rigid due to the interior pressure that stretched the interior frame to a stable form. Torres Quevedo had solved the problem of Flight by means of *auto-rigid* airships.

However, subsequent tests of in-flight stability were postponed in order to change the envelope for a more impermeable one, while keeping the original funicular frame. This required the volume to be increased to 960m³ in order to maintain lift. The result was too many delays, and the tests on the new airship 'Torres Quevedo no. 2', with the engine running and passengers in the gondola (the passengers being Kindelán, Pedro Vives and Torres Quevedo himself, along with other military aeronauts from Guadalajara) would not take place until June 1908.

Although six years had passed since 1902 (which was too long for any normal technological innovation to continue to be considered 'updated'), Torres Quevedo's creation continued to be a new discovery with extraordinary international relevance, and thus he seemed to have reached his goal. In Spain the public tests were meant to take place in September in the presence of King Alfonso XIII. Abroad the trials were anticipated with high expectations, given the lack of outstanding effective innovations in the rest of Europe (remember the 'Ville de Paris', 'Nulli Secundus', and not many more).



14 June 1908 – Torres Quevedo No. 2. Guadalajara

However, in August 1908 Torres Quevedo parted company with the Army and in September he found himself forced to leave the Park in Guadalajara. Despite this, on the 20th February 1909 he requested an additional certificate to the 1906 patent, for 'Improvements introduced in the main patent', but it would not be issued until 13th May 1909. Following various mishaps, he moved all the material to a rented hangar in Sartrouville (Paris) to the company *Astra*, a new Aeronautical Society integrated in the conglomerate of entrepreneur Henry Deutsch de la Meurthe, which was directed by Edouard Surcouf, who had been familiar with Torres Quevedo's work since 1901.

In October of 1909 the 'Torres Quevedo no.2' (having undergone several modifications) was inflated again for a flight around the outskirts of Paris. Despite some setbacks that took away from the expectations of the test, the advantages of the Torresquevedian system remained clear and France expressed its interest in the Spanish airship.

With earlier authorisation from the Spanish authorities on the 31st December 1909, the contract with the Astra society was signed on the 12th February 1910. The agreement included a *patriotic* clause which stipulated ‘the condition that the use of said system in Spain should be free’, which, unfortunately, would never be used. Torres Quevedo’s ideas continued to be the most relevant news in the aeronautical world at that time...and he would receive royalties of 3 francs for every m³ of each airship sold.

World Consecration of Torres Quevedo

In Issy-les Moulineaux (south-west of Paris) in February 1911, the successful trials of ‘Astra Torres no.1’ began. The airship was the first with the ‘Torres Quevedo’ to be built in France by Astra house and it had a capacity of 1600m³. The results were spectacular. It was faster, more stable and more manoeuvrable than all the systems before it. It won the ‘Deperdussin’ prize and the French army incorporated it into their operations.

In short, the system that the gifted inventor had thought up ten years earlier proved to be the best aircraft in the world in 1911, when the first –and it must be said ‘primitive’– aeroplanes were having continuous accidents. On a personal level, Torres Quevedo achieved great success and proved himself as one of the leading aeronautical engineers in the world at the beginning of the second decade of the twentieth century.



1911 - Leonardo Torres Quevedo in Issy-les-Moulineaux

In this respect, before he began the tests on ‘Astra-Torres no.1’, our talented engineer would again surprise the international community with another fantastic contribution. On the 2nd February 1911 in Belgium he applied for privilege of invention for ‘Moyens de campement pour Ballons dirigibles’ (‘Improvements in Mooring Arrangements for Airships’). The new creation consisted of a post with a superior

pivoting platform, designed especially in order to be able to moor Torres's airships outdoors. There were three cables placed respectively in the longitudinal intersections of the lobes which joined at the tip of the nose in order for it to be steered, thus evenly distributing the tension throughout the airship. What is more, the airship could turn around the axis of the post, orientating itself automatically with the direction of the wind, always with the least possible resistance. The new invention was a complete success and it became the mooring system used by every kind of airship. It is exactly the same that existing models still use now in the 21st Century.

However, at this time it was principally the start of the invention's commercial stage. So, in May 1911, petrol magnate Henry Deustch de la Meurthe took charge of the 3,400m³ 'Astra-Torres no.2', as if it were a private yacht and he used it in his travel business the *Compagnie Générale Transaérienne*, which ran trips between France and Switzerland. Shortly afterwards in 1912, Astra received an order from the English Admiralty for the 8000 m³ 'Astra-Torres XIV'. At the same time the French Army ordered the 23,000 m³ 'Astra-Torres XV' (later renamed the 'Pilatre de Rozier'), which had similar dimensions to those of the German 'Zeppelins' and could reach speeds of around 100 km/h.

The handing over of the 'Astra-Torres XIV' (the 'HMA no.3' to the Royal Navy Air Service) meant international recognition for the system with this ship beating the world speed record for an airship, registering 83.2 km/h during the reception trials, a speed which reached 124 km/h with the wind in its favour.

The orders kept coming, and after a few months the Royal Navy Air Service would receive the 11,327 m³ 'Astra Torres XVII' (HMA no.8) and the 3960 m³ 'Astra Torres XIX' (HMA no.10).

During those years Don Leonardo was even wanted by countries like Mexico and in June 1913 they requested that he work on an airship specifically adapted for flights at between 2000 and 4000m. The project led to a new patent, granted on the 2nd March 1914 for a system of 'cylindrical collapsible balloons', semi-rigid airships of variable volume for variable relationships between atmospheric pressure, density and temperature.

However, evidence of Quevedo Torres's genius did not stop here. On 30th July 1913, with World War I, and hence the new requirements of aggressive armies just around the corner, he had presented the Descriptive Report 'A new type of vessel named *camp vessel*' in application for a patent dated 12th December 1913. It was about a real aircraft carrier, conceived especially for the 'Astra-Torres' types, with mooring post and hold to house up to two inflated units, hydrogen cylinders etc. Yet again, Torres Quevedo was ahead of his time. Up until then no country, not even the United Kingdom, had even thought of the possibility of combining aeronautics with ships in this way, even though every nation was beginning to regard it as vital now that they were heading towards the outbreak of war.

Nevertheless (all be it ten years later!) the Spanish Armed Forces built what would be the first Spanish aircraft carrier based on this design, the first 'Dédalo'. A second one would be built several decades later. However, historians have never attributed this to Torres Quevedo, and in the end, the 'Dédalo' would never hold/carry 'Torres

Quevedo' airships, but 'SCA' and 'O' class Italian models which would play a part in the Alhucemas landings in 1925 during Spain's war against Morocco.

The International Success of the System

At the outbreak of the Great War, the French army's only two available 'Astra-Torres' were used at the trenches. But in this position they were extremely vulnerable, and turned out to be inefficient. In fact, 'L'Alsace' was destroyed in October 1915, as was 'Pilatre de Rozier II' in January 1917. France ended up without any 'Torres Quevedo' airships, like Belgium, as the same happened to 'La Flandre', a 14,700 m³ airship that they had acquired in 1916.

In fact it was the British Navy (and not the Army) that saw most clearly the advantages of using airships in antisubmarine war as a way to guarantee protection of naval convoys which were vital for supplies, a task which the aeroplanes of the time were unable to carry out. They began to make their own trilobed 'autorigid' aircraft, 4,180 m³ 'Coastals', taking advantage of Airship Ltd's (an English affiliate of Astra) constitution and the experience they had gained in building Astra-Torres. All in all they built 34 units, four of which were sold to Zarist Russia in July 1916, although Torres Quevedo did not get a penny for them as the English patent had expired some years earlier for not having satisfied the appropriate annuals.



1916 – A British-built tri-lobe of the “Coastal” class

Throughout 1917 the first nine units of a new model of airship were developed, with more than double the capacity. The 10,190 m³ 'North Sea' ships were completed along with another 9 airships in 1918, only one of which would be sold in the USA in November of that year, the 'NS-13'. Between the two series, 10 new and improved 'Coastals' were built, as were the 5950 m³ 'Coastal Stars', which were dedicated to vigilance and the antisubmarine war in the North Sea, the English Channel and the Western Approaches. Next to Britain's impressive panorama of construction and use of Torresquevedian airships, the French Navy paled in comparison. So, before

ordering new airships of the 'Torres Quevedo' system from Astra (and that only happened once our inventor reduced his commission to 1.5francs per m³), they had to buy a British 'Coastal', the 'C-4' that, renamed as the 'AT-0', became a starting point for the new 'Astra-Torres' ships.

So now, at the beginning of 1917 all four units, from the 'AT-1' to the 'AT-4' of 6,500 m³, would be delivered. This would be the case for the following five 'Astra-Torres'(from the 'AT-5' to the 'AT-9' of 7,600 m³) in the summer of that year and later, in 1918,for the remaining eight airships (from the 'AT-10' to the 'AT-17' of 8,300 m³). All of them were used for continued vigilance of the coast and for tracking German submarines at the Bay of Biscay, the English Channel and the Mediterranean Sea (from bases at Marseille, but also in Tunisia and Algeria).

When the USA entered the First World War in 1917, their airship pilots trained in England with the 'NS-7' and in France with the 'AT-1' and the 'AT-13'. What is more, the US Navy took charge of the new 'AT-18' (10,700 m³), at Astra, that would be delivered once the conflict had ended to be used for the development of the North American aeronautical programme of the interwar period. On the other hand, in 1922 it was the Imperial Japanese Navy that bought the latest unit built by Astra, the 'AT-20', also 10,700m³, marking their expansion across the Pacific, leading them into conflict with the USA during World War II.



1920 – Astra Stand at the Paris Aeronautical Fair

A decade later, and in an international context dominated by rigid models based on the Zeppelin' system, another French company, now the Société Zodiac (better known later for their rubber dinghies) again took on the construction of 'Torres Quevedo' airships. It started in 1930 with the small **bilobed** 1,100 m³ 'Vedette' 'V-10'; followed by two semi-rigid models in 1931 which were also **bilobed**, the 10,170 m³ Eclairieurs 'E-8' and 'E-9'; and culminated in 1935 with two units with a trilobed 'autorigid' envelope identical to those of the 'Astra Torres, the 3,400 m³ 'V-11 ' and the 4,100m³ 'V-12', sold to the French Navy ten years after they removed the final models constructed by Astra.

These Zodiac airships marked the end of Torres Quevedo's impressive contribution to the history of Aeronautics. Ahead of his time, Don Leonardo began his 'conquest of the skies' in 1901 and his designs were considered to be 'up to date' for more than thirty years at the beginning of the 20th century.

In Conclusion

In 1908 the 'Torres Quevedo no.2' became the first Spanish airship to take flight. It was designed by a Spaniard; it was built in Spain by Spanish people; and was the starting point for his impressive international success. I am delighted and grateful that *Dirigible* has chosen to join Spain in its celebration of the centenary of such an important event by publishing this article in 2008.