

# Father Bartholomeu Lourenço de Gusmão: a Charlatan or the First Practical Pioneer of Aeronautics in History

Francisco Videira Louro<sup>1</sup>  
*francisco.videira.louro@ist.utl.pt*

*Instituto Superior Técnico, 1049-001 Lisbon, Portugal*

The credit for the first documented ascent of a model air-balloon belongs to the Portuguese Friar Bartholomeu Lourenço de Gusmão. On August 8<sup>th</sup>, 1709, in Lisbon, Gusmão presented before the Portuguese King John V, Cardinal Conti (future Pope Innocent XIII) and the remainder of the Portuguese Court, a prototype for a flying device he had patented earlier the same year. The machine was informally baptized as *Passarola* (big-ungracious-bird) as a consequence of the unrealistic and bizarre bird-like drawing that Gusmão presumably leaked out to avoid pernicious curiosity about his invention. There is contemporary hearsay concerning some sort of human flight in Lisbon on Gusmão's account. However, there is little credible evidence that he kept working on the subject after 1709 though he was kept under the King's protection. On September 26<sup>th</sup>, 1724, after being allegedly informed by an acquaintance that the Inquisition had the intention of questioning him, he escaped to Spain under a false name and died just a few weeks later. As a result of that, he may have destroyed or hidden all of his writings. In face of the absence of any autograph manuscript concerning the flying machine, most authors tend to overlook the importance of the efforts and achievements of Bartholomeu de Gusmão.

## I. Introduction

Father Bartholomeu Lourenço de Gusmão (1685-1724) is undoubtedly regarded as one of the most respected figures of the Portuguese 18<sup>th</sup> century for his crucial role in the development of Aerostation. As a son of Brazil (Gusmão was born in the village of Santos, São Paulo), by then a part of the Portuguese Empire, a number of both Brazilian and Portuguese academics have devoted their time to the mission of reinstating the good name of his fellow compatriot in face of a rather widespread international despidal and disregard. Although there is evidence of definite success in some of his experiments, he is either mocked or ignored on several bibliographic references in the History of Aviation. Consequently, the aim of this article is to highlight and extend previous efforts of some diligent Historians and Scientists in providing unequivocal historical and technical proof of the achievements of Father Gusmão in performing the first documented ascent of a model air-balloon before King John V of Portugal, Cardinal Conti (Vatican Ambassador to the Kingdom of Portugal; later Pope Innocent XIII) and the remaining Portuguese Court on the 8<sup>th</sup> of August of 1709 (74 years before the celebrated ascent by the Montgolfier brothers).

## II. Widespread International Skepticism and Misconceptions

One of the difficulties concerning the disclosure of the Works of Gusmão on Aerostation outside of Portugal, Brazil and other Portuguese-speaking countries is the language barrier, despite the fact that Portuguese is nowadays the 7<sup>th</sup> most spoken language in terms of native-speakers. Apart from a few exceptions, namely the acclaimed historian Charles Harvard Gibbs-Smith,<sup>1</sup> it is not uncommon to come across untruthful portraits of the 18<sup>th</sup> century naturalist, theologian and diplomat Bartholomeu Lourenço de Gusmão. For example, in two reference books<sup>2,3</sup> of the early 20<sup>th</sup> century, Gusmão is still accused of being somewhat idiotic and an impostor committed to the task of deceiving the Portuguese King John V (1689-1750) only to be rewarded with a monetary prize. Vivian<sup>2</sup> is adamant in stating that «he was a charlatan pure and simple, as far as actual flight was concerned, though he had some ideas

---

<sup>1</sup> AIAA Paper 2014-0282, presented in the 52<sup>nd</sup> Aerospace Sciences Meeting, 13<sup>th</sup> January 2014, National Harbor, Maryland, in co-authorship with João Melo de Sousa.

respecting the design of hot-air balloons». Further in the above-mentioned book, Vivian echoes another myth concerning Bartholomeu de Gusmão, recurrent in countless non-Portuguese bibliography: «there were two inventors or charlatans Lorenzo de Guzman (sic) and a monk Bartolomeo Laurenzo (sic), the former of whom constructed an unsuccessful airship out of wooden basket covered with paper». Moreover, since the end of the 18<sup>th</sup> century, roughly from the Montgolfier experiments onwards, most authors, when cautious enough to mention Gusmão, had been conveying the idea of him and his project being «childish»,<sup>4</sup> «absurd»<sup>5</sup> or a «childish absurdity».<sup>6</sup>

While the pragmatic skepticism towards the invention of Bartholomeu Lourenço de Gusmão can be easily explained (to be further discussed later in this article), the origin of the legend about the two hypothetical *Lourenços* has been really dazzling to some scholars. In the opinion of Affonso d'Escragnolle Taunay,<sup>7</sup> a celebrated Brazilian academic whose dedication to the feats of Bartholomeu Lourenço de Gusmão gave an undeniable contribution to the History of Aerostation, the bizarre myth was first introduced by David Bourgeois, during the year of 1784, in his work *Recherches sur l'art de voler*.<sup>8</sup> It is unclear where from Bourgeois got his information regarding a hypothetical *post mortem* experiment in 1736 (Bartholomeu de Gusmão actually died in 1724, in Toledo, Spain). He states that «un panier d'oiser recouvert de papier [basket covered with paper]» would have risen over the skies of Lisbon to the height of «200 pieds [feet]». It is rather obvious that the misinterpretation of this French author should not have been given much credit, given the dubious sources of the information brought forward. On October of the same year of the publication of the book by Bourgeois, the French periodical *Journal des Sçavans*<sup>9</sup> presents a different version of the facts, placing the experiment in 1720, with an aerostatic balloon in the form of a bird being tried out in the presence of the King of Portugal John V. The English Journal *The Daily Universal Register*<sup>10</sup> (it became *The Times* in 1788), echoed the French report on its issue of the 20<sup>th</sup> of October of 1786, number 560:

By accounts from Lisbon we are assured that in consequence of the experiments made there with the Montgolfier balloon, the *literati* of Portugal had been incited to make numerous researches on the subject; in consequence of which they pretend the honour of the invention is due to Portugal. They say, that in 1720, a Brazilian Jesuit, named Bartholomew Gusmao, possessed of abilities, imagination, and address, by permission of John V, fabricated a balloon in a place contiguous to the Royal Palace, and one day, in presence of their Majesties, and an immense croud (sic) of spectators, raised himself, by means of a fire lighted in the machine, as high as the cornice of the building; but through the negligence and want of experience of those who held the cords (sic), the machine took an oblique direction, and touched the cornice, burnt and fell.

The balloon was in the form of a bird with tail and wings [...] They add that several learned men, French and English, who had been at Lisbon to verify the fact, had made inquires in the Carmelite monastery, where Gusmao had a brother, who had preserved some his manuscripts on the manner of constructing aerostatic machines. Various living persons they were present at the Jesuit's experiments, and that he received the surname of *Voador*, or the Flying-man.

Confronted with all these inaccuracies and contradictions, one is impelled to question oneself on whether or not Bartholomeu Lourenço de Gusmão really tried out some sort of aircraft. Irrespective of the impressive number of skeptics, as presented above, one should not be discouraged as the number of honest and capable investigators is equally as remarkable.

### III. The *Passarola*: three different concepts

#### A. Ornithopter?

In the first half of the 19<sup>th</sup> century, a manuscript was found in the Public Library of Évora, southern Portugal, with the title *Manifesto summario para os que ignoram poder-se navegar pelo elemento de ar*<sup>11-13</sup> [Brief Manifest for those who ignore the possibility of aerial navigation] attributed to Bartholomeu Lourenço de Gusmão himself.

*Três coisas são pois são necessárias à ave para voar, convém a saber: asas, vida e ar; asas para subir; vida para as mover; e ar para as sustentar. De sorte que faltando um destes três requisitos, ficam inúteis os dois; porque asas sem vida não podem ter movimento; vida sem asas não pode ter elevação; ar sem estes individuos não pode ser sulcado. [...] Entra agora o nosso invento com as mesmas três circunstâncias, em que infalivelmente devemos dar-lhe o voo por certo. O nosso invento tem asas, tem ar e tem vida.*

Three things are required for the bird to fly, you shall want to know what: wings, life and air; wings to ascend; life to move them; and air to sustain them. So that if one of these three requirements is missing, the other two are useless; because wings without life cannot be moved; life without wings cannot be lifted; air without those cannot be ploughed. Appears now our invention with the same three circumstances in which we should infallibly believe in the success of its flight. Our invention has wings, air and life.

The whole Manifest is much longer and the transcription above just delineates vaguely the intentions of Friar Gusmão. According to Carlos Fiolhais,<sup>12,13</sup> this is a document purported to discuss the idea of flight in a philosophical manner, pointing out the advantages of a hypothetical invention in this field. However, in a Petition to King John V,<sup>1</sup> sometime about March or April 1709 and in its subsequent Patent conceded in the name of Gusmão,<sup>14</sup> dated 19<sup>th</sup> of April 1709, the Friar claims more concretely that he has the knowledge to build a flying machine able

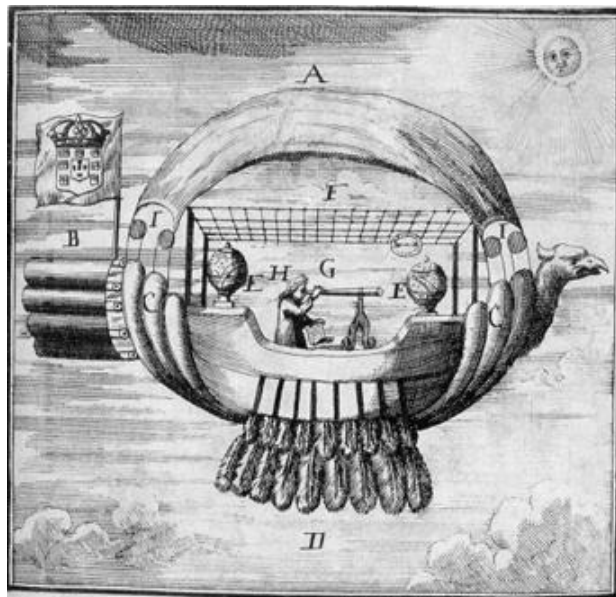
to travel 600 miles over a day. In addition, he lists the practical advantages to His Majesty's Empire impending from such a machine. The Petition original was transcribed by Francisco Freire de Carvalho from the State Archives of Portugal (Torre do Tombo, Lisbon).

*Eu ElRey faço saber, que o P. Bartholomeu Lourenço me representou por sua petição, que elle tinha descoberto hum instrumento para se andar pelo ar, da mesma sorte que pela terra e pelo mar, e com muito mais brevidade, fazendo-se muitas vezes duzentas e mais legoas de caminho por dia; no qual instrumento se poderião os avisos de mais importancia aos exercitos e a terras mui remotas [...], no que mais interessava Eu mais que todos os outros Príncipes pela maior distancia dos meus Dominios, evitando-se desta sorte os desgovernos das Conquistas.*<sup>14</sup>

I, The King, declare that Father Bartholomeu Lourenço presented to me in his petition that he had discovered a device to move through the air, the same sort as by land and sea, and with much more brevity, travelling often more than two hundred *legoas* [six hundred miles] a day; in which the instrument would allow warnings of the upmost importance to be sent to the armies and remote land [...]. To me, above all other Princes, it [the invention] matters as my domains are far in order to avoid its misgovernment.

At this stage one lacks a truthful, verisimilar idea of the invention attributed to Bartholomeu Lourenço de Gusmão, as he did not add (or it is no longer in the Archives<sup>1</sup>) any detailed description or drawing to the Petition. The most common illustration associated to it is somewhat fantastic and very far-off of the idea we now have of any aircraft (either heavier or lighter than air). There are two notorious illustrations and innumerable reproductions.

First of all, there is a Drawing of the Invention published on June of 1709, see Figure 1, after an article concerning *Passarola* was issued on the Austrian journal *Wienerisches Diarium*.<sup>15</sup> The wife of the Portuguese King, Queen Maria Ana of Austria, was a Habsburg and sister of the Holy Roman Emperor and Archduke of Austria Joseph I, hence the news concerning the intentions of Gusmão spread quickly to Wien. Apart from this, Bartholomeu Lourenço de Gusmão had become acquainted with and a *protégé* of Princess Elizabeth of Brunswick,<sup>16</sup> spouse of the Emperor Charles VI and sister-in-law of the aforementioned Queen.



**Figure 1: *Passarola* portrayed on the Wiener publication in 1709. Source: National Library of Vienna.**<sup>16</sup>

The other drawing is contained in a Publication from the end of the 18<sup>th</sup> century. The document *Petição do P. Bartholomeu Lourenço, sobre o instrumento que inventou para andar pelo ar*,<sup>17</sup> shows the year 1774 on its cover. Some academics claim it is a misprint for 1784, as the Publisher had not set shop until 1781.<sup>1</sup> Nevertheless, both figures are alike and their descriptions coincide in vague dreamy notions. For its notorious resemblance with a bird, the invention of the Flying-man was popularly baptized as *Passarola*, a Portuguese way of conveying the idea of a big and ungracious bird.

As a result of the Austrian Drawing and the news of a Petition for a flying machine coming from Lisbon, the English newspaper *The Evening Post*,<sup>18</sup> devoted it two pages of its issue number 84, dated 23<sup>rd</sup>-25<sup>th</sup> of February of 1710:

The Description of a FLYING SHIP, lately Invented, In which one may Travel Two Hundred Miles in Twenty Four Hours, carry Orders to Generals in remote Countries, as also Letters, Recruits, Provisions, Ammunition and Money; supply besieg'd Places with all Necessaries, and transport Merchandise through the AIR; As is to be seen by the

following Copy of the Original address presented to the King of PORTUGAL Invented by a Priest in BRASIL According to the COPY Printed at VIENNA 1709.

The remainder of the article consists in a translation of the Petition and a reproduction of the *Wienerische Diarium*'s picture of the *Passarola*, as well as the fantasist description.

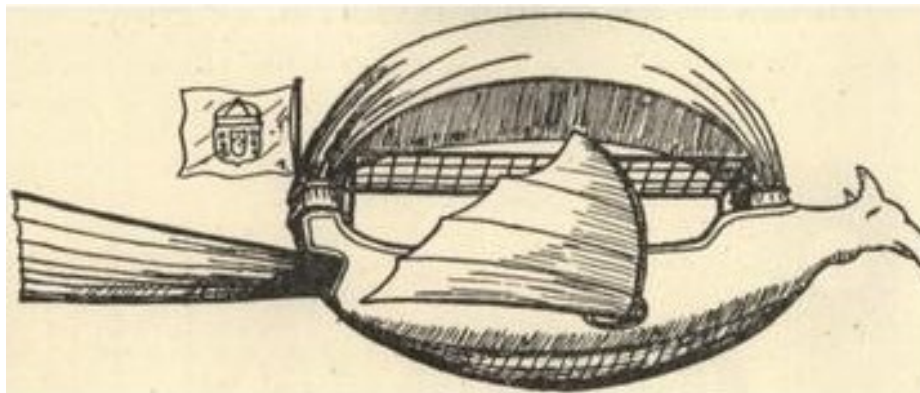
Since the very first moment, two *schools* of thought rose up over this subject: on one side, those who believed there was some technical insight behind the aforementioned drawings (e.g., Charles Gibbs-Smith); on the other side, those who inflexibly refused the viability of such a device as the portrayed. Gibbs-Smith<sup>1</sup> argues on page 824 of his monography:

The 1714 drawing published by Valentini [reproduction of the 1709 figure in Wien] must be almost contemporary, and may even date from 1709. It does not need much imagination to realize that the artist was rendering a vehicle which he did not fully understand, and was in any case producing a highly formalized drawing in which scientific proportions were beside the point. If we forget for a moment the description, and bear in mind the inevitable artistic idioms of the time, we see a perfectly logical design for an ornithopter conceived at a time when, despite Borelli's damping logic, some people still thought heavier-than-air could be achieved by muscular effort.

Giovanni Alphonso Borelli (1608-1679) was a renowned mathematician and a professor at the Universities of Florence and Pisa whose major achievement was his pioneering mathematical analysis of muscle performance and strength.<sup>16</sup> Published posthumously in 1680, *De Motu Animalium*<sup>19</sup> constitutes the first great treatise in Biomechanics. The conclusion of his work regarding flight is rather straightforward: «It is impossible that men should be able to fly artificially by their very own strength». Borelli was correctly convinced that the human musculature was far too weak to operate an ornithopter.

Following Charles Gibbs-Smith reasoning, Gusmão may have read *De Motu Animalium*, but looking «intelligently» at birds, still believed that human musculature could lift a man into the air. In fact, Gusmão might have envisioned that an eleven men crew would serve as the “power” to his hypothetical ornithopter. To corroborate this assumption, Gibbs-Smith reforms the known drawing of the *Passarola* in a more credible way (see Figure 2), suggesting that Bartholomeu Lourenço de Gusmão may have indeed been initially working on a man-powered flying machine. He states further:

The aircraft shown has fuselage, moveable wings, horizontal tail (the artist clearly got more confuse than usual here), a sustaining surface in the form of a sheet, together with a grid for keeping the collapsed material sufficiently high to catch the airflow beneath it once the aircraft was in flight.



**Figure 2: Reconstruction by Charles Gibbs-Smith of the *Passarola*. Source: Journal of The Royal Society of Arts, Vol. XCVII.<sup>1</sup>**

## B. Aerostation

As the news of the launching of the *Passarola* spread quickly through most of Europe, the plans of the young Friar Bartholomeu, who was under the protection of the Marquis of Fontes,<sup>7</sup> a Portuguese nobleman, were either mocked by some of his fellow countrymen or regarded with the upmost disbelief by the most cultivated minds of the Old Continent. On the other hand, steady, periodic publications of “journalistic” nature were not published in Portugal in the period between 1665 and 1715, when the *Gazeta de Lisboa* (Lisbon Gazette) finally started. During those times, news was conveyed to the people mostly via poetry.

Tomás Pinto Brandão,<sup>12</sup> a piercing, contemporary detractor of Gusmão, dedicated him and the invention some incredibly distasteful poetry. Brandão, alongside with the generality of the Portuguese baroque literature, is today virtually unknown in Portugal and Brazil, regardless of having been one of the most popular satirists of his time.<sup>20</sup> In his book *Pinto Renascido, Empennado, e Desempennado*,<sup>21</sup> published in 1732 (about 23 years after the Petition), the poet recollects some of his poetry, with various references to the *Passarola* and the *Voador* (Flying-man). Moreover,

he dedicates two poems exclusively to the subject. In one of them, written in *Décimas* (10 verses stanzas), he satirizes very harshly the invention (free translation from the Portuguese):

*Esta fera Passarola,  
que leva, porque mais brame,  
trezentos mil réis de arame,  
somente para a gayola;  
esta urdida paniola,  
ou este tecido enredo,  
esta das mulheres medo,  
e emfim dos homens espanto,  
assim eu fora cedo santo,  
como se hade acabar cedo.*

This *beast*, the *Passarola*,  
which takes, because it roars more,  
three hundred thousand *réis* of wires,  
only for the cage;  
this woven cloth,  
this plotted fabric,  
the fear of women,  
and astonishment of men,  
so as promptly was I made a saint,  
as it is going to end soon.

The verses above give a colorful idea of the atmosphere in Lisbon at the time. While Brandão is unmistakably mocking Bartholomeu de Lourenço de Gusmão, alongside other fellow compatriots, he also presents the utter amazement and growing excitement in the city in face of the invention. Another poem,<sup>11</sup> contemporary of the Luso-Brazilian, apocryphally attributed to Tomás Pinto Brandão is less subtle and even unkind:

*Mete esse invento onde tens o siso,  
Vê se no vento, que está nele, voas;  
Que outro voar, meu Lourencinho, é riso.*

Stick this invention where you have the wisdom,  
See if in the wind inside it, you can fly;  
That flying any other way, my *Lourencinho*, is laughter.

All the same, the excitement with the possibility of success of Bartholomeu Lourenço de Gusmão rose in Lisbon during 1709 and several learned men and women (namely Princess Elizabeth of Brunswick, the future Holy Roman Empress got the news through the Queen of Portugal, her sister-in-law, and was truly thrilled<sup>14</sup>), wrote letters and memoranda with respect to the Patent given to Bartholomeu de Gusmão and the suppositions over the fabrication of the *Passarola*. In his occasional newsletter, José Soares da Silva<sup>22</sup> reported some of the happenings prior to the experiment in August of 1709:

*O engenheiro volante já não gasta papéis, senão arames na fábrica do seu invento dizem ter gasto muito [...] Ele enfim vai com a sua teima adelante e El Rey lhe mandou dar as chaves da quinta do Duque de Aveiro a S. Sebastião da Pedreira, para nela haver de dispor o tal engenho, que só em arames ouço ter gasto 200 mil [réis].*

The Engineer of Flight no longer spends paper but wires, on the workshop of his invention, it has been said he spent a lot. [...] He is truly committed to his project and The King decided he should be given the keys to the property of the Duke of Aveiro in S. Sebastião da Pedreira [Lisbon], where the device should be set, on which I have heard he has spent 200 thousand [réis]/on wires.

The real configuration of the device remains unclear. Nonetheless, there are enough testimonies attesting the ascension of a model air balloon on the Sala das Embaixadas inside the Royal Palace, in Lisbon, before Their Majesties the King and Queen of Portugal, His Eminence the Apostolic Nuncio to Portugal Cardinal Conti and all of the remaining Portuguese Court. The experiment was set to happen on the 24<sup>th</sup> of June 1709 but, due to the King's illness, it was postponed to the 8<sup>th</sup> of August,<sup>22</sup> the occasion when Bartholomeu demonstrated to his audience that an aerostatic balloon was possible to build and fly.

Salvador António Ferreira, in his Book of Memoires of the period 1680-1719,<sup>14,23</sup> provides one of the most vivid contemporary reports of the various experiments:

*A 7 do mesmo mês (sic), veio o d<sup>o</sup> P.e com um meio globo de madeira delgada, e dentro trazia um globo de papel grosso, metendo-lhe no fundo uma tijela com fogo material, o qual subiu mais de 20 palmos e como o fogo ia bem aceso, começou a arder o papel, subindo, e o meio globo de madeira ficou no chão sem subir, porque ficou frustrado o invento. E, como o globo ia chegando ao tecto da casa, acudiram com paus dois criados da Casa Real, para evitar o pegar [fogo] e haver algum desastre; assistindo a tudo S.M. com toda a Casa Real e várias pessoas.*

On the 7<sup>th</sup> of the same month (sic), the Priest came with a thin wooden half-globe, with a globe of thick paper inside, placing a bowl in the bottom with the element fire, which rose more than 20 *palm*s and as the fire was well lit, the paper began to burn, rose, and the wooden globe continued on the ground not rising, so the invention became frustrated. As the globe reached the ceiling of the house, two servants of the Royal House came out with sticks, to avoid starting [a fire] and the occurrence of a disaster; all this watched by H.M. with the whole Royal House and several people.

Alongside the *supra* transcription, Francisco Leitão Ferreira (1),<sup>14,24</sup> José da Cunha Brochado (2),<sup>14</sup> José Soares da Silva (3),<sup>14,22</sup> and Cardinal Conti (4),<sup>14,25</sup>, future Pope Innocent XIII, accounted in their reports:

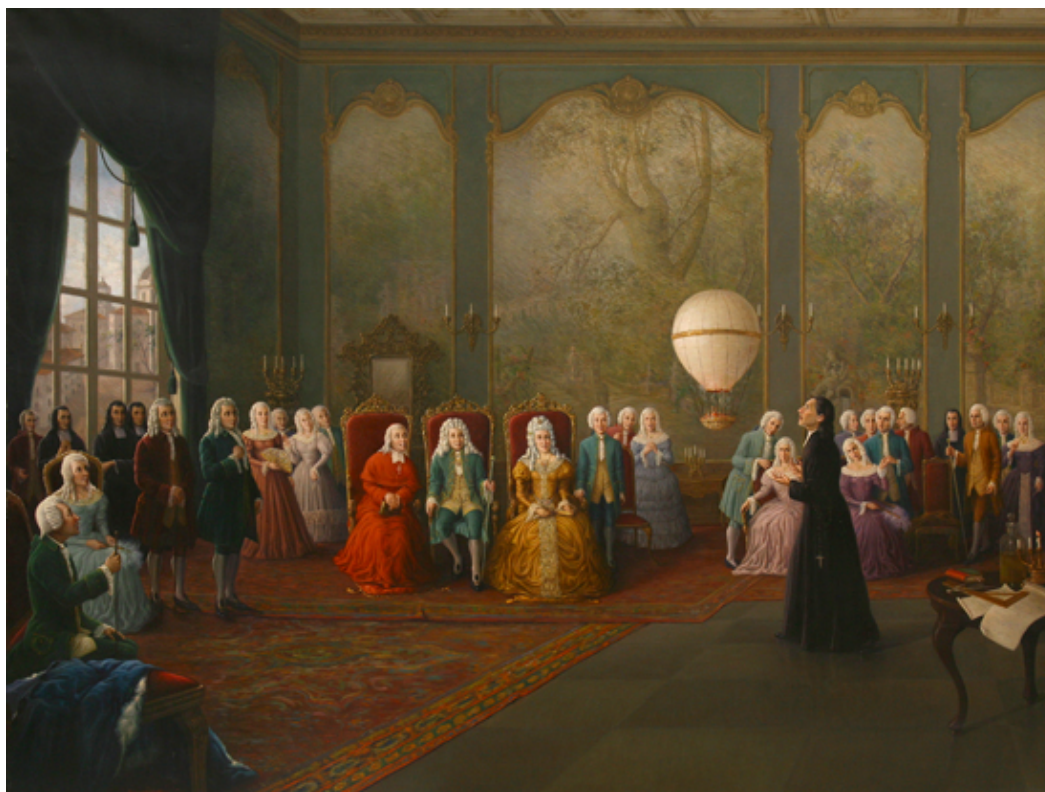
(1) He made the experiment on the 8th of August of the current year of 1709 in the yard of the *Casa da India* in front of His Majesty and much nobility with a globe which rose smoothly to the ceiling of the *Sala das Embaixadas*, and the same way it descended, elevated by the action of some sort of burning material to which the inventor applies fire. The experiment happened inside the *Sala das Embaixadas*.

(2) On *Casa do Forte* the device or paper ship got burnt before starting its flight.

(3) One of these days, the Flying-man, in the presence of the King in the *Caza do Forte* [...] experimented his device for the first time, taking a paper globe which would, in his words, rise to the air, when lit by a candle below [...] It got burnt. The next day, the globe he took didn't get burnt like the first one [...] and rose to the top of the House.

(4) He experimented his device, in the presence of the King, having built a light sphere [...] that got burnt the first time, without moving; the second time, although it rose two *canes*, and it got burnt as well.

In face with these consistent accounts on Bartholomeu Lourenço de Gusmão having succeeded in experimenting a small globe lit by a candle or a “bowl” of fire, inside de Royal Palace, one is left wondering about the origin of the drawing of the *Passarola* and its lack of realism. Providing a definite answer to this question has been difficult, though not impossible. A clue that definitely may contribute to sort out the truth comes from Italy in the literary work of Pier Jacopo Martello,<sup>7,26</sup> first published in 1710, revised in 1720 and re-published in 1723.



**Figure 3: Painting by the Brazilian painter Bernardino de Souza Pereira, recreating the experience inside the Sala das Embaixadas before the Portuguese Court in August of 1709. Source: Museu Paulista.<sup>15</sup>**

In Dialogue *Del Volo* Martello had originally divided this work in four *mattinas* [mornings], devoting the last one to Gusmão and his *Passarola*, including its illustration and covering it of ridicule as well as predicting its obvious failure. However, in the ten years that followed the first printing of *Del Volo*, Martello got in touch with people close to Cardinal Conti (by the time Martello secondly published his book, he was already Pope Innocent XIII) and with the Marquis of Fontes (or Abrantes, the protector of Gusmão, Ambassador of Portugal to Rome from 1712 to 1718). These contacts made him realize that he had been fooled by the picture he had seen from the Wiener publication<sup>7</sup> (from 1709). Somewhat ashamed, Martello decided to cut out the last *mattina* from his original *Dialoghi* and included a note concerning Bartholomeu Lourenço de Gusmão on its 1720's preface. As it can be read in the 1723 edition (free translation directly from the Italian<sup>26</sup> and also from a Portuguese translation by Taunay<sup>7</sup>):

Already under the Printing Press of Gonzaga, alive at the time, were these Dialogues of mine: behold, in the Court of the Lord Envoy of Portugal, now a worthy ambassador of that Crown, a Print in the German language appeared, which contained an experiment of a flying ship by an *Indian* (sic) friar, named Bartolomeo Laurenzio (sic), in Lisbon invented, which may have been experimented, in that great capital, in the presence of the whole Court, on the Twenty-four of June of the year 1709. The Drawing was from Vienna, printed by Giambattista Schottner (sic), Printer *Cesareo Aulico*, and of the University [...], and contained the Figure with other peculiarities of the device, which I found not practicable, according to my reasoning, so I let myself fiercely contest the Invention, and to prognosticate its unfortunate outcome on the Fourth *Mattina* [...].

Afterwards, having returned from that *Nunciatura Apostolica* [Lisbon], His Eminence the Cardinal Conti, now the Holy Father in Christ, and our beloved Sovereign Innocent XIII, *Pontifex Optimus Maximus*, I made some inquires over the experiment of the man of Brazil, to the Ministers of His Eminence, since he [the Cardinal] had fame of having attended [to the experiment], and I realized that nothing of what was read to me in the German Print happened there.



A globe of Paper was mentioned, which by dint of *Quintessences* therein closed and heated, and drawn to the Sun to some height rose, so then, bursting into tiny pieces fell, something of no use, and no expectation deserving.

First of all, it must be noted that Martello refers to one of the experiments as described in those five reports previously quoted here; Cardinal Conti maintained his version of having seen a globe of paper rise through the action of fire. Nevertheless, this Preface to *Del Volo* is exceptionally important because it provides a reasonable explanation to the widespread illustration of the *Passarola*. It had been Bartholomeu Lourenço de Gusmão himself, through the son of his protector, who had leaked voluntarily an unrealistic drawing of his invention, in order to avoid further inquiries and questioning. Martello, referring to words of Marquis of Fontes, by then the Ambassador of Portugal in Rome, concludes that the inventor and his pupil were completely astonished with the success of their hoax:

[...] a day with His Excellence the Ambassador of Portugal of that time, Lord of various high sciences, and owner of all the fine and naive Arts, amiably smiled, and revealed to me, that his studious Firstborn, whose talent had been raised on the Education of the Brazilian Mathematician, committed himself, since he was the only one who was admitted by the Religious man inside the perimeter, in which the long-awaited device was being constructed, not to reveal the secret deposited in his faith, and so to get rid of the curious insistence of inquiries, he leaked a manuscript that passed from hand to hand, and that came out uncritically from the presses of Germany, France, and Holland, to which success, the Young Knight and the Indian (sic), *laughed their heads off*.

From 1709 onwards, reliable records of any aerostatic experiments by Bartholomeu de Gusmão cannot be found. Quoting Gibbs-Smith,<sup>1</sup> «when the balloon became a practical proposition in 1783, and writers naturally turned to forerunners and history to embellish the achievement, the claim of Gusmão was immediately maintained by David Bourgeois». <sup>8</sup> As already presented in section II, this is not the sole report of a manned ascent by Gusmão, but since most of these reports lack both credibility and likelihood, they were excluded from this text.

### C. The Apocryphal Figure

In the year of 1868, Augusto Felipe de Simões published one of the most important books about Gusmão. In his *A Invenção dos Aerostatos Reivindicada* [Claimed Invention of Aerostats]<sup>27</sup> he presents a description of a device with a strong resemblance to a hot-air balloon, accompanied by an illustration (see Figure 4), undated, whose author is unknown (the original may have disappeared in the 1940s according to Fiolhais;<sup>12</sup> other authors claim Simões to be the *drawer*, vide Pinheiro Correia in Taunay<sup>28</sup>). These documents were found in the Portuguese Library of the University of Coimbra (Gusmão studied there later in his life; in 1709 he was just 23 years old), referenced as Codex 342. The origin of the manuscript with the description of a «pyramid» is attributed to a friend or a good acquaintance of the Friar. Despite references on the first part of the document to «magnetism», «amber», «spirits» and «air tenacity» concerning operation of the device, and since the manuscript shall not be imputed directly to Gusmão himself (but a second-hand reproduction of his explanation instead), one may carefully read the description translated here.

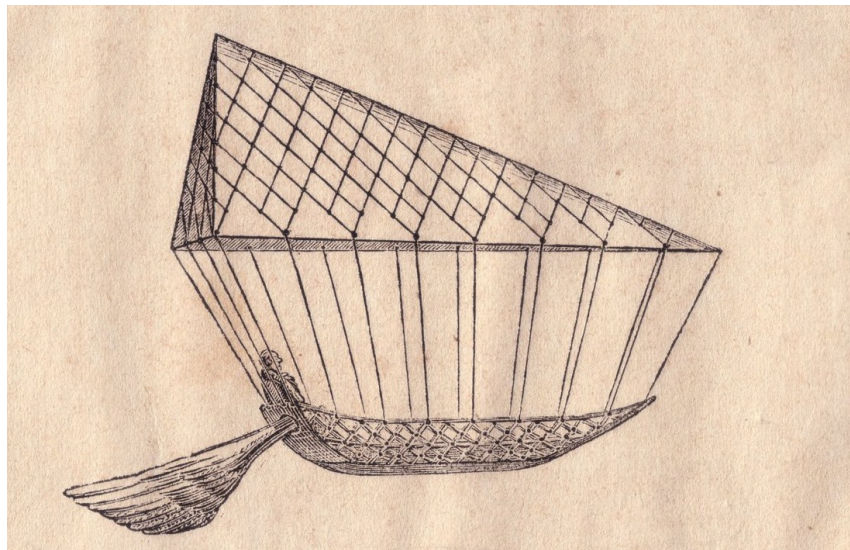


Figure 4: The illustration that may have stood along other documents on Codex 342 of the Library of the University of Coimbra. Source: Augusto Felipe Simões.<sup>23</sup>

The figure of this flying machine is a triangular pyramid composed of a solid matter such as iron or copper laminae, joined together as to prevent the magnetic spirits sealed inside to evaporate. This pyramid will be attached with strong chords to a wooden pavement, where the passengers will be carried, along the cargo you may want to carry; the sides of the pyramid will be six *Rhinlandic* [as in relation to the river Rhin<sup>7</sup>] feet long, and fifteen to the top; these are the measures to carry one man.

To run this machine, there is a rudder on the stern of the pavement that controlled by the passenger inside, will allow the navigation to happen, the ship to raise, descend, turn over and to stop, if necessary. The position of the pyramid will be helpful, as the angular part (sic) may point upwards when ascending, the plane one pointing downwards when descending. The [front] tip of the pyramid may point on the direction of the movement, as to face the opposing wind.

The description above and the drawing are too simple and vague, probably to preserve its secret<sup>1</sup> and it is unclear what would be the “fuel” of this airship. Nonetheless, it is impressively interesting to observe the effort in explaining some of the “aerodynamic” questions a ship such as this could rise.

It is obvious to the modern reader (or even to the layman) that a concept as this is utterly impractical as the dimensions are far too unrealistic. Disregarding a minor difference between the *Rhinlandic* feet and the Imperial Standard, the volume of such a triangular pyramid, 15 feet high, whose 3 sides measure 6 feet each, would be 78 cubic feet (roughly 2.2 m<sup>3</sup>). Optimistically considering that one could heat up the air inside the pyramid, while on the ground, in the beginning of the 18<sup>th</sup> century, to the temperature of 200 degrees Celsius, from the Perfect Gas relation we get that the density of the air therein would be 0.74 kg/m<sup>3</sup>. Because the balloon is open below, the pressure is the same both inside and outside.<sup>29</sup> The condition assuring a balloon to float stably at a given altitude can be stated as,

$$M + \rho'V = \rho V. \quad (1)$$

Recurring to the above balloon equation,<sup>29</sup> Eq. (1), where  $M$  is the mass of the balloon (gondola + skin + payload) at a given altitude, assuming a density of atmospheric air of approximately 1.20 kg/m<sup>3</sup> at near room temperature and  $\rho' = 0.74 \text{ kg/m}^3$  as the density of the air inside, one may find the necessary volume to lift a given mass. As the description refers that the invention could lift a man, let us assume that one wanted to lift 100 kg. In these conditions, the volume required would have to be about 220 m<sup>3</sup>. This means that to lift a man and the gondola, the volume enclosed by the pyramid would have to be 100 times larger than that set in the design.

As a curiosity, *La Montgolfière*, the balloon of the Montgolfier brothers, is reported as allegedly enclosing a volume of 1700 m<sup>3</sup> of air, allowing the ascent of two persons to the height of 1000 meters. It is said that the machine weighed 725 kg, so the total mass would be about 900 kg. In this case the displaced air mass would have been  $\rho V = 2040 \text{ kg}$ . With respect to air temperature and resorting again to the Perfect Gas relation, from Eq. (1) we get:

$$T/T' = 1 - M/(\rho V). \quad (2)$$

At the mentioned altitude, the temperature of the atmospheric air may well have been not far from  $T = 0^\circ\text{C}$ . Based on Eq. (2), such temperature would imply that the enclosed air must have been heated up to a temperature close to  $T' = 216^\circ\text{C}$ .

#### IV. Conclusion

From 1709 onwards there is no evidence that Bartholomeu Lourenço de Gusmão kept working on his projects in Aerostation. He continued his academic life, carrying on his studies at the University of Coimbra. Apart from that, he travelled around Europe, namely The Netherlands, where he lived for a few years. Returning to Portugal, he devoted himself to other subjects and apparently lost the interest in his flying machine. He was made a full member of the Royal Academy of History of Portugal in 1720 and the King's Chaplain in 1722.<sup>25</sup>

Gusmão became very close to a number of New Christians, a term given to Jewish people forced to conversion in Portugal, Spain and their colonies. The most influential of Gusmão's “unconventional” friends was Miguel de Castro Lara, a wealthy personality in Lisbon, who may have influenced him to have a crisis of Faith, which ultimately may explain subsequent events. There is some hearsay that he may have even converted secretly to Judaism, while this is unlikely.<sup>15</sup>

In September 1724, as soon as Bartholomeu Lourenço de Gusmão received the information that he could be the target of accusation of apostasy by the Portuguese Inquisition, he fled from Lisbon accompanied by his brother João Álvares de Santa Maria, friar of the Carmelite Order. They tried to escape to England by boat but failed and had to cross the land border to Spain. During their journey, Bartholomeu died of sickness in Toledo at the age of 38, on November 28<sup>th</sup> of 1724.<sup>16</sup> Unfortunately, due to the fact the Inquisition may have indeed intended to question and eventually convict Gusmão, he is likely to have destroyed all of his manuscripts, making immensely more arduous the task of writing the History of Aerostation since its inception.



Although it may be difficult to explain why Bartholomeu Lourenço de Gusmão apparently abandoned his works in the field of Aerostation, as he was kept in the King's good grace almost until his death, «it is surely not too much to claim for Father Gusmão the place of the first practical pioneer in aeronautics, and the first *successful* pioneer of aerostation», as Gibbs-Smith<sup>1</sup> wisely points out.

## References

- <sup>1</sup>Gibbs-Smith, C. H., "Father Gusmão: The First Practical Pioneer in Aeronautics", *Journal of the Royal Society of Arts*, Volume XCVII, 9<sup>th</sup> September 1949, pp. 822-830.
- <sup>2</sup>Vivian, E. C., *A History of Aeronautics*, Harcourt, Brace and Company, New York, 1921, pp. 37, 317.
- <sup>3</sup>Hodgins, E., Magoun, F. A., *Sky high: The History of Aviation*, Little, Brown, and Company, Boston, 1920, p. 10.
- <sup>4</sup>"Aerostation", *Encyclopaedia Britannica*, Volume I, 3<sup>rd</sup> Edition, A. Bell and C. Macfarquhar, Edinburgh, 1797, p. 198.
- <sup>5</sup>"Aerostation", *Encyclopaedia Perthensis*, Volume I, 2<sup>nd</sup> Edition, John Brown Anchor Close, Edinburgh, 1816, pp. 254-255.
- <sup>6</sup>Tiberius Cavallo, F.S., *The History and Practice of Aerostation*, C. Dilly, P. Elmsly, and J. Stockdale, London, 1785, p. 23.
- <sup>7</sup>d'Escragnolle Taunay, A., *Bartolomeu de Gusmão, Inventor do Aeróstato: A Vida e a Obra do Primeiro Inventor Americano*, Edições Leia, São Paulo, 1942, pp. 185-190, 271-289.
- <sup>8</sup>Bourgeois, D., *Recherches sur l'art de voler, depuis la plus haute antiquité jusq'á ce jour*, Cuchet, Paris, 1784, pp. 59-63.
- <sup>9</sup>*Journal des Sçavans*, October 1784, pp. 673-674.
- <sup>10</sup>*The Daily Universal Register*, 20<sup>th</sup> October 1786, number 560, p. 2.
- <sup>11</sup>Carvalho, F. F., "Aditamento a Memoria que tem por objecto reivindicar para a nação portuguesa a glória da invenção das machinas aerostáticas", *Actas das Sessões da Academia Real das Ciências de Lisboa*, tomo I, Academia Real das Ciências, Lisbon, 1849, pp. 193-219.
- <sup>12</sup>Fiolhais, C., et al., *Bartolomeu de Gusmão: O Padre Inventor*, Andrea Jakobsson Estúdio, Rio de Janeiro, 2011.
- <sup>13</sup>Fiolhais, C., "A história de um padre e de um rei que quiseram voar", *Jornal Público*, Caderno P2, 6<sup>th</sup> September 2011, pp. 4-6.
- <sup>14</sup>Gaspar de Freitas, D., *A vida e as obras de Bartolomeu Lourenço de Gusmão*, Secretaria de Economia e Planejamento, São Paulo, 1967, pp. 125-132, 176, 183.
- <sup>15</sup>Visioni R. M., Canalle, J. G., "Bartolomeu Lourenço de Gusmão: o primeiro cientista brasileiro", *Revista Brasileira de Ensino de Física*, volume 31, number 3, 2009, pp. 7-9.
- <sup>16</sup>Hallion, Richard P., *Taking Flight: Inventing the Aerial Age from Antiquity through the First World War*, Oxford University Press, New York, 2003, pp. 27-29, 32-34.
- <sup>17</sup>*Petição sobre o instrumento que inventou para andar pelo ar, e suas utilidades*, Officina de Simão Thadeo Ferreira, Lisboa, 1774.
- <sup>18</sup>*The Evening Post*, 23<sup>rd</sup>-25<sup>th</sup> February 1710, number 84, London.
- <sup>19</sup>Borelli, G. A., *De Motu Animalium*, pars prima et secunda, Editio altera, Correctior & emendatior, Lugduni in Batavis apud Johannem de Vivie, Cornelium Boutesteyn, Danielelem a Gaesbeeck, & Petrum vander Aa, 1685.
- <sup>20</sup>Topa F., Amaral A., "Um Tomás contumaz: A prisão de Pinto Brandão na Baía e um inédito de Gregório Matos sobre o tema", *Revista da Faculdade de Letras- Línguas e Literaturas*, II Série, vol. XXII, Porto, 2005, pp. 591-608.
- <sup>21</sup>Pinto Brandam, Thomaz, *Pinto Renascido, Empennado, e Desempennado: O Primeiro Voo*, Lisboa Occidental na Officina da Música, Lisboa, 1732, pp. 237, pp. 509-511.
- <sup>22</sup>Soares da Silva, J., *Gazeta em forma de Carta*, volume I, Costa Veiga, A. B., Biblioteca Nacional de Lisboa, Lisbon, 1933, pp. 208-209.
- <sup>23</sup>Ferreira, S. A., *Várias notícias de Cazos acontecidos em Portugal*, Manuscript 15 Colecção Conde de Azevedo, Biblioteca Municipal do Porto, Oporto, pp.78-81.
- <sup>24</sup>Leitão Ferreira, F., *Ephemeride historial, chronologica lusitana, na qual por dias e annos se referem varios successo historicos e memoraveis acontecidos em Portugal e nas suas conquistas, com outras memorias notáveis a este glorioso dominio pertencentes*, 2 volumes in 4, Biblioteca de Évora, Portugal.
- <sup>25</sup>Faria, A., *Académie aéronautique Bartholomeu de Gusmão*, Imprimeries Réunies S.A., Lausanne, 1917.
- <sup>26</sup>Martello, P. J., *Opere de Pier Jacopo Martello tomo quinto: Seguito del Teatro Italiano*, Bologna, 1723, pp. 375-377.
- <sup>27</sup>Simões, A.F., *A Invenção dos Aerostatos Reivindicada: Exame Critico das Noticias e Documentos Concernentes às Tentativas Aeronáuticas de Bartholomeu Lourenço de Gusmão*, Typographia do Sul, Évora, Portugal, 1868.
- <sup>28</sup>d'Escragnolle Taunay, A., *Bartolomeu de Gusmão e a Sua prioridade Aeroestatica*, Escolas Profissionais Salesianas, São Paulo, 1934.
- <sup>29</sup>Lautrup, B., *Physics of Continuous Matter*, 2<sup>nd</sup> Edition, CRC Press, Boca Raton, FL, 2011, pp. 44-45.