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FROM FISH TO BICYCLING: The Role of Some Metaphors in the History of the European Aviation[1]

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Abstract

The aim of this article is to explain the development of some metaphors and their role in the history of European aviation. The description spreads from Aristotle's notion about the flight of living beings to the accepted theories of our century and so touches the supposed similarity between the birds and fish furthermore flying and swimming and rowing. Parallel with the rising of the metaphor of 'aircycling' the usage of those analogies forced back and so did the aspiration for planning flapping-winged aeroplanes nowadays.

Keywords: analogy, bicycling, flight, prebionics, swimming.

1. Fish and Birds

Clive Hart divides the early theories on the flying of birds in his book The Prehistory of Flight into seven categories from the supposition of the existence of the Empedoclean and Aristotelian 'inherent lightness' of upper elements, which are the reasons of rising, to the other end of the scale where are to be found the statement of the main importance of an 'interplay of muscles' (HART, 1985). These hypotheses were only destined to describe the flying of animals originally, but it seemed to be a logical step to expand their spheres of applications to the artificial flight. But it does not mean that the opportunity of human flight was generally accepted, obviously. To give an example: the leading physician and philosopher from the late Antiquity through the Middle Ages to the 18th century Aristotle rejected it:

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'It is ... evident ... that a bird cannot possibly be erected in the sense in which a man is. For as it holds its body now the wings, are naturally useful to it: but if it were erected they would be as useless as the wings of Cupids we see in pictures. It must have been clear as soon as we spoke that the form of no human nor any similar beings permits of wings ... because to have wings would be useless to it when moving naturally. And Nature makes nothing contrary to her own nature' (ARISTOTLE, 1949).

But a lot of experimenters, the so-called 'tower-jumpers', tried to make contrary to Aristotle's opinion in the Middle Ages, although not only the Philosopher, but the Church, too, stated more than once in the subsequent centuries that 'if man flies, he has wings' (HART, 1985). Neither the Stagírita's nor the Christian notion could deter them and the bud of one of the most successful explanation of the flight of all living beings involving men — irony of fate — originated not from any other author, but from Aristotle. The conception took as a basis the similarity of the main structures of all animals: he pointed out that wings were analogous to the forelegs of quadrupeds and going further the wings, their forms and functions resembled the fins' and vice versa (ARISTOTLE, 1949 b). Over the correspondence of the organization of those bodies some theologians e.g. Saint Ambrose brought to perfection that analogy by proclaiming the statement that

'Birds seem to be primarily related to the fish species, since each has a certain element in common, that of being able to swim. The second element which fishes and birds also share lies in the fact that the art of flying is an aspect of swimming. As a fin cuts through the water in the act of swimming, so a bird 'cuts the air' in his swift flight. Both species are provided in a similar way with tails and 'with the oarage of wings' ... Birds ... exercise their wings in the air as if they were floating on water, using them in the way one would use one's arms ... Not without reason, therefore, do both species have the innate faculty of swimming, since both have their origin in water.'

Saint Augustine supported Ambrose's arguments by 'showing out' that birds were not to be found in the upper regions of air as their abode were in the lower spheres solely, which may well have been considered merely very fine water. In other words: he taught that fish lived in water and so did birds and it is self-evident that the link between the two spheres was the same medium. The belief in the vital importance of the parallelism between those animals remained to the age of Chevalier de Viviens, who taught in the 18th century that the variable air-filled cavities in a

bird's body contained some 'elastic substances' and the animal was able to vary its 'specific gravity' by expanding or compressing that matter in those alveoluses on the analogy of air in the ballast sacs of the fish (HART, 1985). But not that Frenchman was the last representative of that view: in the early years of the 20th century the inventor of the machine gun Hiram Maxim wrote in his book some paragraphs on the birds 'swimming-bladders'. That strange organ (a production of his phantasy) should have served as a barometer to indicate whether the column of air under the gliding bird was rising of falling (MAXIM, 1908).

Extending the correspondence between fish and birds almost every well-known natural scientist stated in an era spreading to the seventies of the 18th century the existence of footless birds. For example Buffon believed that the birds of paradise could remain 'suspended in the air as long a they breathed, just as fish sustained in the water', although it was contrary to Aristotle's doctrine on the impossibility of the surviving of footless feathered games.

The remaining of that analogy until Buffon's age shows the descriptiveness of it which more or less accounts for some theological 'deviations', e.g. the appearance of Eriugena's so radical theory on the relationship of fishes and birds in the 5th century. He announced the mutation of some creatures twice a year and that they spent six months in the water and the rest in the air proving their twofold nature by this way. Perhaps the Renaissance writer Andrew Marwell completed this direction of thinking by the creation of the symbolical meaning of the intermediate creatures, the kingfishers, which flew at twilight, 'betwixt the Day and Night', participated in the realms of good and evil, above and below, and light and dark (HART. 1985). But a more detailed explanation of the religious symbolism of the birds is beside the point.

2. Birds and Ships, Rowing and Swimming

In spite of the case of the footless birds and that above-mentioned problem of the winged men there is no doubt about the importance of Aristotle's role in the prehistory of flight whilst we are able to trace back the comparing of the ships with flying animals to his works. He said that the function of the tails of the flying animals and the rudders of the ships was one and same thing, and that the flying insects had no tails so their soarings were similar to a rudderness bark's drifting or to a row-propelled cargo boat's

movement. It also seemed to him that the breast-bone of a swift bird was as sharp as a clipper's prow and because of it is was able to cut the air and so was its beak (ARISTOTLE, 1949).

That idea became popular in a little while and a lot of thinkers echoed it through Leonardo, or the English naturalist John Ray at the end of the 17th century, or his contemporary Tito Livio Burattini to that ornithopter-builder Emiel Hartman in the sixties of 20th century.

That Briton doctor adopted Aristotle's notion about a beak and emphasized that 'the Trunk of their (i.e. the birds') body doth somewhat resemble the Hull of a Ship', furthermore their heads are similar to a prow 'for the most part small, that it may the more easily cut the Air' to make way for their bodies. Burattini's 'flying dragon' is said to be operated by a pair of levers arranged like oars (HART, 1985) and Hartman roughly three hundred years later wanted to pay respect under the planning process to 'the natural frequency of the human body when in the rowing attitude' (REAY, 1977). To cease the listing it is enough not to enumerate other names, but to mention that Leonardo had written that a turning bird in the air used wings as a man his oars in a boat rowing faster on the one, and remaining stock still on the other side of the vessel.

After the supposition the existence of the parallelism between flying and rowing there is an opportunity to demonstrate the similarity between swimming and rowing as both of them have connections with flying. As Leonardo formulated it:

'A bird makes the same use of wings and tail in the air as a swimmer does of his arms and legs in the water' (HART, 1985).

3. Flying Ships

It is understandable by taking into consideration those parallels that Etienne Montgolfier planned oars for propelling his balloon around 1783, but comment is needed to unfold that a lot of early airships had hull-form gondolas and were furnished with sails, anchors and rudders, too (GILLISPIE, 1983). These facts underline not only that the scientists and experimenters of the late 18th century were not able to renounce the supposition of the similarity of rowing and flying, but the other equipages over the oars show the conviction that a balloon was a german of a vessel and the basis of this belief was the Aristotelian theory of four elements which meant the division of the World under the Moon into the spheres of earth, water, air, and fire.

In consequence of the spatial arrangement of those layers the upper surface of the element of the air bordered upon the lower surface of the element of the fire and so a lightweight ship could float there as its position was analogous to a floating boat on the water (or more exactly on the boundary layer of water and air) (HART, 1985).

It is probable that a similar train of thought motivated Roger Bacon to write that a vehicle linked up globes, which were filled with 'ethereal air' on 'fluid fire', could soar on the surface of the atmosphere like a sailing boat on the ocean (TOMLINSON, 1902). Roughly at the same time as Bacon explained his ideas the archetypal story of flying ships was given by Gervasius of Tilbury who noted down that an anchor of such a vehicle caught around a tombstone in London and a heavenly sailor trying to free it suffocated as if drowned in the sea. An other version told that that sailor diving through the air moved his feet and hands as if he swam. A hundred years later Albert of Saxony outlined the theoretical background of those stories:

'Fire is much subtler and more tenuous and lighter than is the air, for it is related to air as air is to water. Now air is much more tenuous and much subtler than is water; therefore the same is true of fire with respect to air ... the upper air, where it is contiguous with fire, is navigable, just as the water is where it is contiguous with the air. Hence if a ship is placed on the upper surface of the air, filled, however, not with air but with fire, it will not sink through the air, but as soon as it is filled with air it will sink. Just as, if a ship is filled with air rather than with water, it will float on the water, and not sink; but when it is filled with water, it sinks.'

This idea appears to have become a commonplace in the 14th century. Nicole Oresme believed that a ship loaded with several men could remain up on the outer surface of the sphere of air 'as naturally as a ship rests on the Seine' and touched the theological side of human flight asking whether it would harm the universal harmony of world. That question shows the importance of the cosmological context in his life (HART, 1985), but bishop John Wilkins in the 17th century respecting Albert of Saxony and Francis Medoca mentioned 'that the air is in some part of it navigable' if a brass or iron vessel is 'filled with the lighter air' (WILKINS, 1970) and his late successor the French Father Joseph Galien was not tormented by this kind of doubt. The latter in his treatise published in 1757 followed the old Aristotelian notion and stated that there were several distinct regions in the atmosphere and each region was different in density from each other on the analogy of the boundary layer between oil and water, but refused

the existence of the sphere of fire. He calculated the size of the flying ship supposing that the ratio of the density of the second and third sphere of air were two to one. He had very practical purposes: he wanted to engage a realm in the middle of Africa by an army carried on the board and sincerely trusted the possibility of building that gigantic vessel and the realization of that conquest (HART, 1985).

Galien's work was a zenith of the theory of flying boats and perhaps it was known by the Montgolfier brothers whose notions about the lifting power were influenced by it presumably when they were observing the rising of their first 'balloons' and it is almost sure that they did not suspect the role of the specific weight of hot air (GILLISPIE, 1983).

4. Flying Bicycles

Believing the similarity of birds and fish it was not difficult to suppose a resemblance of flying to swimming and to top that chain of ideas by stating the inherent sameness of the movement of wings and oars that is to say flying and rowing. That frame of notions completed with that Aristotelian theory about the qualities of elements was incarnated by the hypothesis of flying boats and the disappearance of those heavenly arks was a result of an interwoven effect of the virtually total decline of Aristotle's physics and partly the changes of the notions about the flight of birds (although some fragments of those supposed parallelisms between feathered games and fish survived to the 20th century) viz., the issuing a work on Animal Locomotion in 1873 whose author J. Bell Pettigrew explained that the way of walking of quadrupeds, the swimming of fishes, and the flight of birds are eight-figure movements (HART, 1963), but the elaboration of a new 'metaphor' on the basis of the 'mechanistic' natural sciences of the 19th century caused the rejection of that 'old-fashioned' comparison. So it is no wonder that the vanishing of the previous theory left a void in thought and scientists created a new analogy to fill it up. D. S. Brown pointed out in 1873 that

'It is ... not unreasonable to assume that a man who can propel himself so well upon a velocipede on the ground, will do so still better with a suitable machine in the air' (REAY, 1977).

That early form of the parallel where the fundamental idea was the supposed resemblance of the man-powered travel in air and on earth became step by step more sophisticated and detailed within some decades. The

Australian inventor Lawrence Hargrave declared the required rapidity of thought for steering airplanes would cause difficulties about in 1880, but he referred the one-man flying machines, as he believed that their piloting would be reduced 'to as simple act as ... riding a bicycle' (RUHEN, 1988). Following Otto Lilienthals paper James Means published a three-page study on Wheeling and Flying and arguing that the slow and early development of flying machines 'finds its analogue in that of the bicycle' (MEANS, 1964) and T. Baron Russel was sure after the turn of the century that as the effect of air-resistance could ever be devised

'a flying-machine must always be slow and cumbersome.

... But as a meant of amusement, the idea of aerial travel has great promise. Small one-man flying machines or the aerial counterpart of tandem bicycles, will no doubt be common enough. We shall fly for pleasure' (LANGFORD, 1981).

So that analogy became more and more 'tangible' gradually assuming the form of a very machine and it influenced the definition and the structure of the early aeroplanes, both the muscle-powered and the motor-propelled ones.

When Peugeot donated 10000 francs for a competition to develop the man-powered flight in 1912 and Gabriel Poulain by a flight over only 3.3 m into each direction succeeded in winning a prize, that event was proclaimed to be the first true success of a 'flying bicycle'. There were some other attempts to overcome a longer distance, but it is more remarkable to us that except of some simple constructions without wings, aided only by propellers to increase the ground speed those muscle-powered aircrafts fell into two categories: those which were built for only pure momentum for their flight and the more advanced flying bicycles were furnished with a propeller or flapping wings to sustain flight after take-off. The basic form of both of them was a normal bicycle with fixed wings and the frame of that third, wiggles type was a bike, too. Then Gabriel Poulain polished that metaphor saying in 1912 that

'The aerocycle below and the aeroplane above; thus both will fly without interfering with one another. There is a plenty of space in the sky and there is room for both. Room even for three, because between these two a third will be introduced, just as the motor-cycle has taken up a position between the bicycle and the car.' And that motor-cycle will be a 'motor–powered aerocycle' (REAY, 1977).

5. Bicycles and Early Aeroplanes

Poulain's final words expressed one of possible points of view in connection with airplane construction and stability. The other school consisting of almost all early aeronautical engineers (except the Wright brothers and some of their adherents) espoused the conception of inherent stability: the Europeans' model was the steering the crafts 'in the manner of automobile drivers or mariners' and opposite of them the Wrights (who were owners of a bicycle repairing workshop) followed the ideal of the three-dimensional control and a method similar to the driving of an inherently unstable bicycle. Partly the refusing of this latter notion (over the nationalist approach) was the cause of the Continental and Briton disclaiming of the Wrights' results (FERGUSON, 1993).

The differences between the conceptions about the independence of an airplane from the airport and from other technical conditions contributed to the sharpening of those divergences as the earliest American machines' separation from a pair of rails (which substituted for a runway) and the take-off was aided by falling weights and that technical solution resulted that an airplane was not able to continue its route after landing unless it arrived at an airport. On the contrary the Continental engineers preferred a wheeled undercarriage which made the continuing to travel after the touching a tillage possible and the wheels came from bicycles. Ironically, they wanted to imitate by their 'flying wire entanglements' a bicycle's mobility, lightness and applicability for roam 'on the road of air', so when they denied the existence of early American flights it took its origin from the consideration of the other features of 'steel steeds'.

6. Man-Powered Flight and Metaphors

The motor-propelled aeroplanes' fuselages became too heavy for carrying on bicycle-wheels after the termination of the heroic age of flight, but the idea of the pedal-propelled, biking-like flight remained to today and it has got some remarkable results for example that 120-km-flight from Crete in 1987. As the Annual published by James Means stated about a hundred years ago:

'It is not uncommon for the cyclist ... to remark, "Wheeling is just like flying" .... Both modes of travel are riding upon the air' (MEANS, 1964).

Parallel with the rising of the metaphor of 'aircycling' the usage of the flying-swimming or flying-rowing analogies were forced back and so did the aspiration for planning flapping-winged aeroplanes. It is more than probable that there was an interaction between the birth, growth, and disappearance of those images and the changes of the airplane building tendencies from the ornithopter-botching furore to favouring the 'flying bikes' and those descriptions not only mirrored the naturalists' or engineers' accepted opinions, but reacted upon the common notions and more or less influenced the theoretical frameworks of the rising aviation.

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