APPENDIX 1

Kites and the Wrights

Kites, early aviation, and what the Wright brothers actually did

1 Introduction

I know that I am not the only kiteflier with an interest in early manned flight. We kitefliers usually know about Cayley and his man carrying glider of 1853. We should also know that George Pocock lifted his daughter Martha 'to 100 yards' in 1826. Most of us know that Hargrave produced the cellular kite (or box kite) and can see one of those designs echoed in the Wright Flyer of 1903.

I visited Kitty Hawk in North Carolina in late 2005, got interested in the Wright Brothers, bought some books and did more reading. Originally I was looking at the influence of kites on manned flight but I gradually became fascinated with what the Wrights actually did and how they did it.

This article has six sections

1 Introduction
2 A chronology of the main events which advanced the development of manned flight up to 1903 – followed by some comments
3 An account of what the Wrights did and how they managed to do it
4 A brief look at events soon after 1903 from the Wrights' perspective
5 Some thoughts on Kitty Hawk today and a very brief conclusion
6 Reading

I don't claim to be an expert but hope that you find the subject worthwhile. However there are some big interesting questions which I have not considered e.g. why didn't the Chinese or Japanese develop manned or powered flight? The only exception I know is the Japanese Chuhachi Ninomiya who in 1891 had developed advanced rubber-band powered model aircraft after starting with kites. e.g. Why did the Europeans –particularly the French– fall behind America in the decade up to 1903?

My thanks to Ernest Barton for the drawings which transform the article.

2 The main events prior to 1903

2.1 Eastern

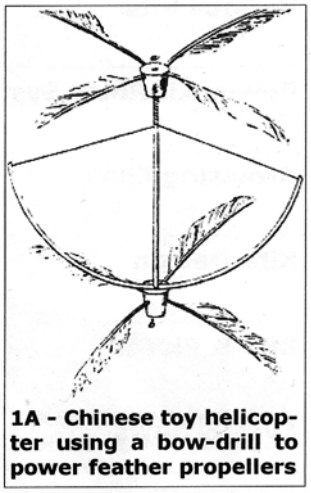
The Chinese developed man–carrying kites about 500AD. In 1285 AD Marco Polo in Guanzhou famously observed a man tied to a sail which was flown as a kite to predict the ship's fortunes on the next voyage. The quotation is very well known and appears in many books; I'm interested that although Polo travelled extensively in China this is his only mention of kites.

There are Japanese stories of man–carrying kites which must be rather later when kites had spread from China. The initial import was probably in the period late 7th century to 8th century AD. In 981 a Japanese dictionary mentions kites for the first time using a word which means paper hawks.

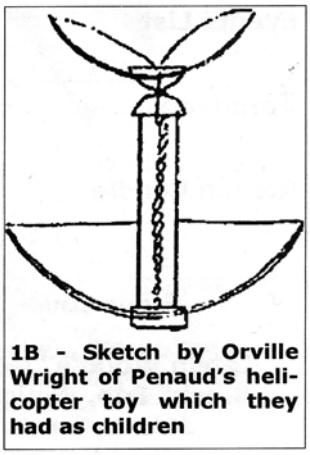
Note that these are accounts of man carrying where the person is attached to the frame of a large Edo-type kite rather than man lifting — the latter is considerably easier as the deadweight does not affect the balance of the kite.

In looking briefly at the 'Eastern' history of attempts to fly I have concentrated on kites, largely because I don't know of any other approaches in Japan apart from Ninomiya and the history of manned flight in China is unclear and contentious.

Certainly the Chinese developed at least one model flying machine known to Cayley.



1A - Chinese toy helicopter using a bow-drill to power feather propellers



1B - Sketch by Orville Wright of Penaud's helicopter toy which they had as children

In Illustration 1A a bamboo spring rotates two sets of feather propellers. It might well be that this influenced Penaud, whose toy helicopter was given to the young Wrights.

2.2 Western

1010 (or thereabouts William of Malmesbury in Wiltshire records a monk, Ellmer who tied wings to his arms and legs and glided for 200m. from the church roof. He broke both legs and was lame for the rest of his long life.

He asserted that the cause of his failure was that he hadn't provided himself with a tail. William is regarded as a very reliable historian.

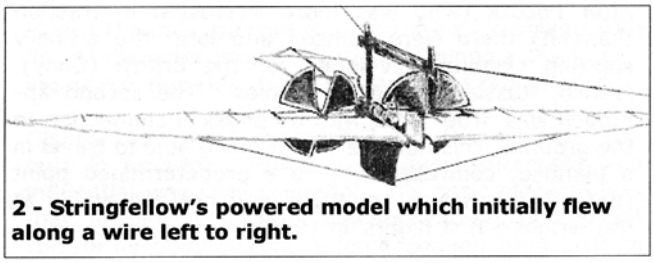
1783 In France the Montgolfier brothers ascended in a hot-air balloon and flew for 8 km.

1804 Sir George Cayley produced his model glider which clearly used a kite-shaped main wing.

1826 George Pocock lifted his daughter c.100 m. [1]

1839 A quotation from W.S.Henson of Chard, who worked with Stringfellow, "if any light and flat, or nearly flat, article be projected edgeways in a slightly inclined position, it will rise on the air till the force exerted is expanded (sic), when the article will descend" (*from an 1842 patent when he was working with John Stringfellow*).

1848 Stringfellow's powered model. Later designs were monoplanes with a tail and a 'modern' look— deceiving as they lacked the necessary complement of ailerons and rudder.



2 - Stringfellow's powered model which initially flew along a wire left to right.

1849 Sir George Cayley's experiments resulted in a 10 year old boy gliding.

1853 Sir George's famous gliding demonstration at Brompton, near Scarborough, leading to the coachman's "please Sir George I wish to give notice. I was hired to drive and not to fly."

1. It would seem that this doesn't often appear in a list of 'firsts' as she was a child. We don't know any details of how George Pocock (my nomination for the best kite flier in the West) did it. But just think about a child and 100m. Later he lifted his son up and down a 60m. cliff.

1857 Le Bris in France could be considered the first man lifted by a man-carrying kite in Europe. However it was meant to function as a glider, there was a bolting horse involved and a flying coachman. See Pelham[1][2].)

1858 Julliere's rubber powered model flew over 10m. Also Wenham, noticing that all birds have curved section wings, designed aircraft using high aspect ratio cambered wings.

1859 Cordner was lifted by a train of hexagonal kites designed for ship-to-shore rescue.

1866 The Aeronautical Society of Great Britain was formed. Cayley and Wenham were influential members.

1868 Stringfellow's steam-powered model won a prize for flying at a Crystal Palace Exhibition. His triplane configuration was influential on later designs. The Chard (Somerset) Museum has material to support the town's claim as 'Birthplace of Powered Flight.'

1870's Peneaud designed his rubber powered toy planoplane with a modern layout of monoplane wing, tail and propeller. In 1876 with Gaucht he designed, but never built, a large monoplane.

1870's H.F. Phillips followed Wenham and developed cambered wings with a peak 1/3 back from the leading edge[3]. By 1884 he had patented several cambered double surface wings.

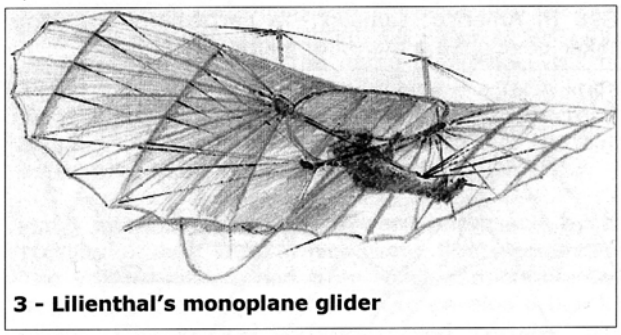
1886 In America, Herring started work on gliders.

1890 Working in Australia, Hargrave produced a radial rotary engined, propeller driven, model monoplane which flew nearly 25m. Even at this date he had been working on aeronautics for years and was one of the first to be aware of the importance of control in aircraft.

2. Kite fliers are always telling beginners not to run with kites — partly because of the problems caused by acceleration and high speed. Le Bris had a problem because his horse bolted — but he survived. However, Pilcher was being horse-towed in 1899 when the tail failed on his glider. Other aviators used cars. I am sure that any experienced kite flier looking at Langley's 1903 machine would guess (correctly) that it would not fly stably after being launched by sudden acceleration off the roof of a boat.

3. After a series of patents he had developed by 1893 a glider with 50 wings, each 6m. long and with 0.45m. chord, stacked 5 cm. apart. Referred to as the 'Venetian Blind', it prompts the thought 'would one of today's light plastic Venetian blinds fly?'

1891 Otto Lilienthal, a German engineer, started his gliding experiments using a range of bird-winged gliders; all controlled by moving his body. He was the most successful glider of his time but was killed in a flying accident in 1896.



3 - Lilienthal's monoplane glider

1892 Hargrave demonstrated the superiority of curved to flat flying surfaces[4].

1892 Chanute convened an important Chicago conference on aviation at which a paper by Hargrave was read.

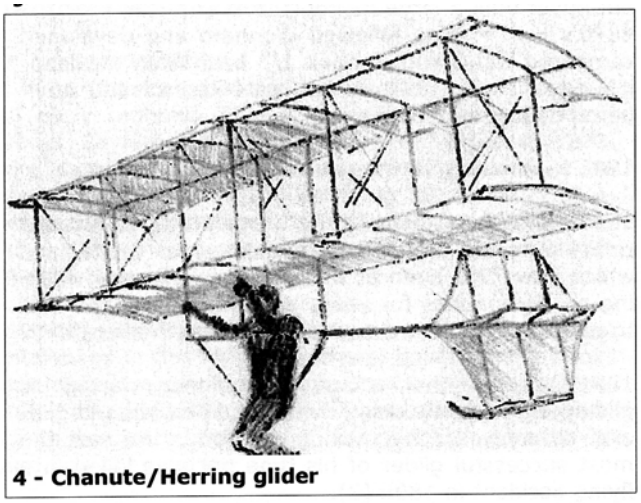
1894 Hargrave was lifted 5m. under a train of four box kites. Quite why this is so celebrated escapes me (and how Martha Pocock would have smiled). However it was influential as evidence of the box kite's stability.

1895 Baden-Powell, using two-lined flat kites, was lifting men to 30m.

1895 In America, S.P. Langley's steam-powered model flew for 1 min 45 secs and covered 1000m.

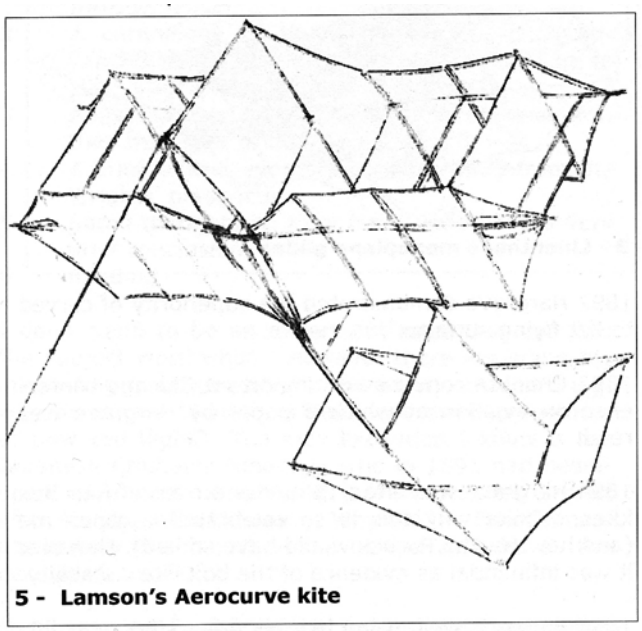
1895 Chanute's glider was developed with Herring. Its biplane wing plan and braced construction were a great influence on the Wrights.

4. Simple: on to an axle with four arms fit two (North and South) blades with curved surfaces and two (East and West) with flat surfaces, all of the same area and same 20 degree angle. So you have a four bladed windmill but with NS blades 'falling' one way and EW the other. Place in an air stream and see which way the blades revolve i.e. which produce more thrust. Result: the curved blades are superior.



4 - Chanute/Herring glider

1896 In America, Lamson – a particularly fine kitemaker– developed a man-lifting kite.



5 - Lamson's Aerocurve kite

1899 In the UK, Percy Pilcher –the leading British flier– was killed.

1903 In America, on 8th December, Langley's attempted first man-carrying flight ended in failure.

2.3 Some Comments

In the late 18th century the Montgolfiers had been the first Westerners recorded to have been lifted into the air. Although they could travel considerable distances, the lack of control (especially in the absence of an effective propulsion system) and the

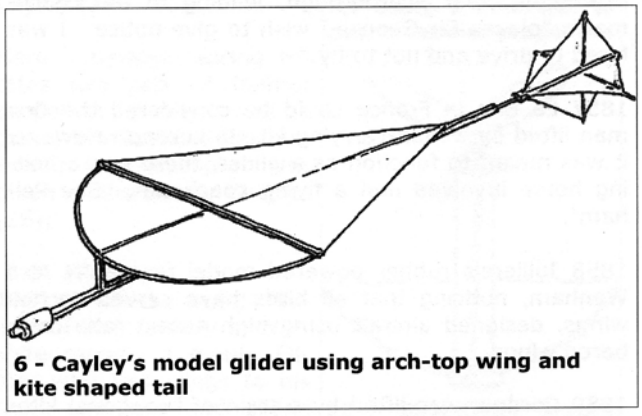
dangers of using hot air or hydrogen to produce lift, meant that alternative forms of flight (heavier than air machines) were being tried.

Kitefliers know of the late 19th century interest in raising meteorological instruments and cameras which were incentives for Eddy and Conyne. Both these designers used trains of kites and therefore wanted to do away with tails. Tail-less kites were innovative in the West and their designers faced some of the stability problems inherent in the development of the aeroplane.

My interest in this article is man lifting.

The first approach was to develop man-lifting kites. After Pocock (who was more interested in traction than lift) there were Lamson and later the artillery spotting systems developed for the British (Cody), French, Russian and other armies. The second approach was 'true' flight with no physical connection to the ground. This had the aim of being able to travel in a planned, controlled way to a predetermined point (note that this was ambitious and not achievable at the Wright's 'first flights' in 1903).

One line of development was to construct a model which, having flown as a glider or a powered craft, could be made bigger until it could support a man. To some extent this was the approach of Sir George Cayley in his long career in aeronautics.



6 - Cayley's model glider using arch-top wing and kite shaped tail

His 1804 'kite' plane glider also had a dart-flight shaped tail which was used by later designers. His full scale effort was in 1853. The absence of a power plant and propulsion system stopped his practical development of flight but his influence continued via his discussions with members of the Aeronautical Society of Great Britain and even to Hargrave. (He also founded Regent Street Polytechnic in London).

Stringfellow's models could fly using his unique light steam engines.

However the most influential model-maker who went on to attempt 'full-size' flight was the American S.P. Langley. He had been the Director of the Alleghany Observatory for 20 years with a national reputation as an experimental astronomer

and academic administrator[5]. There he had carried out tests on the lift from flat surfaces and was able to disprove the old Newtonian view that the weight of an engine powerful enough to move a wing fast enough to generate sufficient lift would always be too heavy. These results gave an impetus to work on flight as they came from one of the foremost American scientists who clearly felt that manned flight was achievable.

In fact his results turned out to be wrong — as the Wrights discovered. He moved to the famous Smithsonian Institute in 1887. This gave him additional resources and led to his very successful 1895 flying model. But it had no functioning control system and this was still true of the full scale 1903 machine.

Hiram Maxim's enormous steam driven machine with its 6m. diameter propellers rumbled along a track, giving an exciting ride, but never achieved real take off.

Gliders were more successful[6] e.g. Herring and Chanute in America. However the most successful and influential was Otto Lilienthal. His basic problem was that, despite being physically very strong, he couldn't control by body-shifting a large enough wing area to provide enough lift for easy gliding.[7]

His test results were well known — but inaccurate. When he died – his glider stalled at 50' – he had the world duration record – it was 15 secs. His 2000 + flights over 5 years involved just 5 hours of actual flying time.

However more important for the progress of flight than many individual's efforts was the development from 1890 onwards of an international network for the exchange of ideas. Not the internet, it comprised post and telegraph (and to some extent face-to-face meetings in America). Its chief architect was Octave Chanute. He was probably the most famous engineer in America with a high reputation for bridge and railway construction. He became interested in flight in later life when he could no longer participate personally but he believed that engineers had an important part to play in the process.

He communicated:

in person e.g. to the Wrights at home and at Kitty Hawk, and by travelling to Europe.

by correspondence e.g. to the Wrights and to Hargrave.

by organising and attending conferences. One in Buffalo in 1886 was badly received but did get Langley involved.

The 1893 conference in Chicago included most of those seriously interested in aviation.

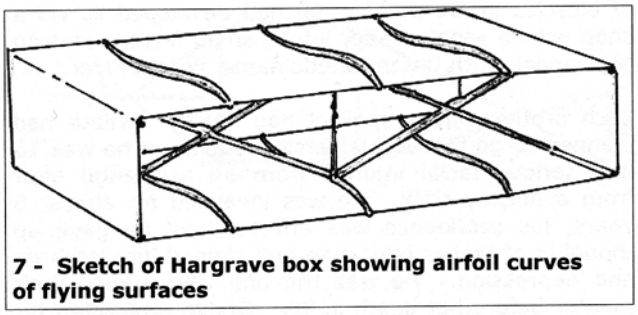
5. He had an original and successful method of providing funds for the Observatory — he sold time. Railways and others wanted accurate time, he obtained it by star sights taken from the Observatory and transmitted it to subscribers twice a day.

6. As George Faux of Wanstead said in the 1860's (he used to jump off his rooftop) "I'm a really good flier but I cannot alight very well". — source Jenkins [2].

7. The Science Museum at Wroughton has an almost mint Lilienthal glider, crated and not on public display.

He encouraged the publication of work on aviation e.g. Mean's 3 Volumes of Aeronautical Annual 1896/7.

At the 1893 conference a paper by Hargrave was read out which gave details of his experiments and in particular the performance of his box kites.



7 - Sketch of Hargrave box showing airfoil curves of flying surfaces

These had soon superseded Eddy trains for launching meteorological instruments at the Blue Hills Observatory near Boston. Interestingly his kite was soon marketed by others under the name Blue Hills. His box kite was not the basis of the biplane — a form known since Wenham's 1866 work and which came to the Wrights via Chanute. However his use of the cambered wing had a direct impact on the Wrights[8].

Many interested in aviation were impressed by the stability of box kites, which were flown square on. The Voisin brothers had been lifted accidentally by a large Hargrave box and went on to develop a box kite glider. The vertical surfaces, called 'curtains' were widely incorporated into European aircraft designs (e.g. A Santos-Dumont 1906), together with dihedral they gave great stability. It was one of the Wright brothers' insights that this hindered development and a different approach was needed.

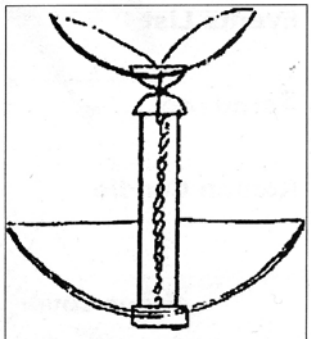
On the whole, European aviators were 'drivers'. They thought of aircraft as vehicles which went up into the sky and could then be controlled up/down by means of an 'elevator' (originally developed for torpedoes). Turning left/right would use a rudder as in a boat.

By contrast Lilienthal was a 'bird man' who saw how birds shifted weight to manoeuvre and the Wrights added to an aircraft the bird's ability to move wing tips by the development of 'wing warping'.

8. Getting the correct camber was a real problem for the Wrights. In 1900 they used a symmetrical 1:12 camber, reduced in the successful '03 Flyer to 1:20 with the high point $^1/_3$ back from the leading edge.

3 The Wright Brothers: what they did and how they did it

Wilbur (b.1867) and Orville (b. 1871) were two of the 5 children of Bishop Milton Wright and were brought up in Dayton, Ohio[9]. The first contact with flight was a Penaud rubber band driven 'helicopter' brought home by their father. *(See illustration 1B).* Although not a poor family, money was scarce and the brothers made kites for children as part of a range of money-making schemes.



1B - Sketch by Orville Wright of Penaud's helicopter toy which they had as children

Both Wilbur and Orville got interested in printing about 1885, inventing and building some of their equipment. By 1892 they had ended up with a print shop managed by a school friend and for a year they had published a newspaper. They became interested in the new craze of bicycles in 1892 and by 1896 had developed it, via a shop with a repair trade, into a small factory making two models with the prophetic name 'Wright Flyer.'

Each brother had a spell of bad health. Wilbur had planned to go to Yale University but when he was 18 had serious facial injuries from an accidental blow from a hockey stick. He was invalided for almost 5 years, his confidence was affected and he gave up thoughts of higher education and slipped into lethargy and depression. He was the one who nursed their mother before her death in 1889. Orville contracted typhoid in 1896. Wilbur spent a long time at his bedside and they read about Lilienthal and his gliders.

So all these events resulted in two of four brothers living in the same house who temperamentally were always ready to work together and who complemented each other[10]. Although their education finished with high school, both clearly had considerable engineering ability. They had shown this practically, linked with a business sense, in moving on from the very competitive business of cycle repair to the profitability of cycle manufacture. They were to be proved to be brilliant both at

9. The Bishop believed that since Wright was an ordinary surname they should have unusual first names. They had brothers Reuchlin and Lorin. But their sister was Katherine.

10. If one had married, or even got bored with flight then 1903 would have been different. To speculate; if the first flight hadn't been until say, 1907 (possibly in Europe) what would have been the development of aircraft in the First World War…?

applying theory and experimentation. Their business gave them experience of making cycle parts and they even designed a single cylinder internal combustion engine to drive their machinery.

Sometime in 1896 when the exploits of Chanute, Lamson and Langley were in American newspapers and Lilienthal's death in August was widely reported, the brothers became interested in flight and read all that was available in public libraries. Their business was seasonal so that from autumn on they had time to pursue their interests. On 30th May 1899 Wilbur wrote to the Smithsonian Institution stating his interest in human flight "since he was a boy"[11].

He mentions the performance of birds and goes on "I believe that simple flight at least is possible to man". By 'simple' he meant fixed wing soaring flight not the flapping wings of darting birds. He asked for all available information and the Smithsonian answered on 2nd July, sending research papers and the titles of books.

The most important available material was:

- the records of the Chanute/Herring gliders of 1896/1898. Their longest flight was 14 secs.
- the results of extensive testing of lift and drag by Langley in 1887-1891.
- Lilienthal's data.
- Mean's Aeronautical Annual.

The probable conclusions drawn by the Wrights from all that were:

- gliders (full size not models) were the way forward.
- Lilienthal had produced accurate tables of lift/drag. This turned out to be wrong.
- Chanute/Herring biplane gliders (which they called the Chanute Double Deck) solved the structural problem of thin wing sections. As mentioned earlier biplanes go back to Wenham in 1866.
- they were impressed by the stability of Hargrave's cellular kites.
- they valued, and used, the bracing system between the wings designed by Chanute and developed from his successful bridge structures[12].
- Langley's steam driven models showed a practical engine and propulsion system was possible.
- Hargrave, and others, had shown that cambered wings had superior lift performance.

The main problem which had not been tackled effectively, which they identified and solved brilliantly was <u>control</u>. Lilienthal had relied on his hang-glider type

11. The Smithsonian's reply was probably more influential in the development of flight than all the work of its head, J.P. Langley. There is a Wilbur touch at the end of his letter 'I do not know the terms on which you send out your publications but if you will inform me of the cost I will remit the price'.

12. Good basic design together with their practical engineering skills meant that up to the '03 flight the Wrights never suffered from structural failure i.e. no bits ever fell off. However their 'first flight' was delayed for days by their rough-running engine causing the propeller shafts to crack.

'thrashing around'. All Langley's machines were designed for straight flight i.e. no effective system of steering was installed (or a method of landing, see later).

Some, such as Hargrave, felt that control was a secondary problem and that, because airflow could change so dramatically, what was needed was an 'automatic' compensating system to provide stability, with steering to come later. This led to gliders with Cayley-type dart-flight tails on a flexible mounting so that they would move in response to wind changes. Similar flexible systems on wings (Chanute) were fitted and the use of 'curtains' or vertical surfaces was designed to provide stability.

Part of the problem was that aircraft move in one, or a combination, of three ways.

a) 'Nose-up, nose-down or pitch – this was well known as was the idea that it could be corrected by a horizontal rudder or elevator (though the Wright's design was unique). Such controls were used in torpedoes and submarines although there was little known on the different properties of water and air.

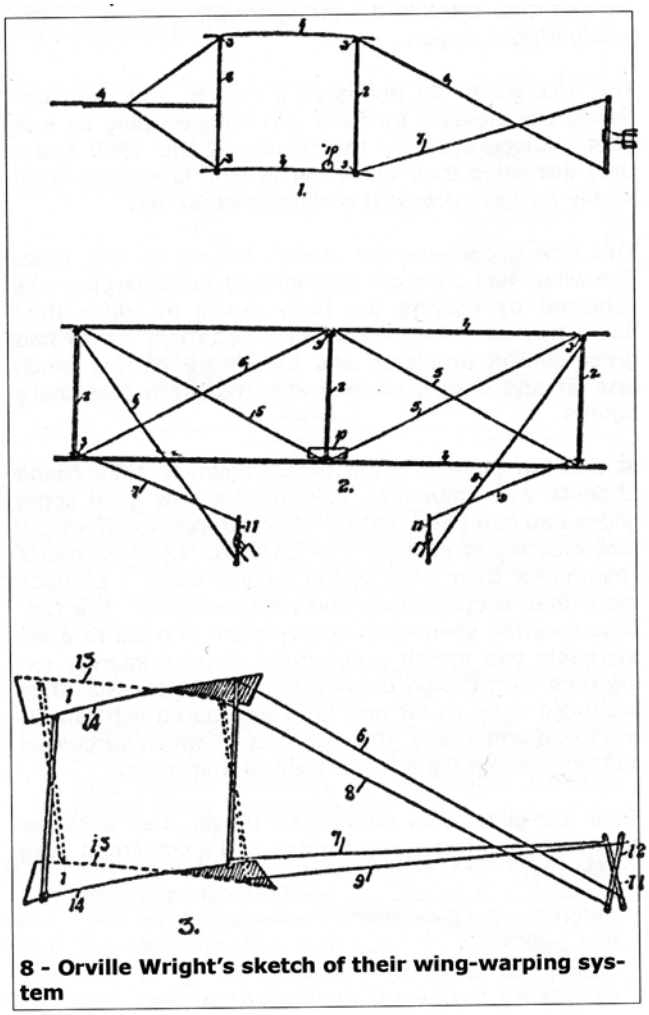
b) Yaw – nose moving from side to side. It would seem obvious that this could be corrected by a rudder as in a ship. Some saw this as all that was needed to change direction ('drivers'), rather as the steering wheel and the wheels of a car.

c) One wing up–one down or Roll. This was a new control problem and the only control system had been Lilienthal's body shifts.

The Wrights reasoned that manned flight was not practical until all three types of movement had been controlled and that 'automatic' stability was impossible. In fact they underestimated the amount of stability that needed to be 'built-in' and were partly reliant for their success on their great flying skills.

In my view their key idea was their realisation than an aircraft turned, not like a boat with a rudder, but by turning and rolling at the same time. A question is 'what might have caused them to have that insight?' A possible answer involves 'How do you turn on a bicycle?' You turn the wheel but you also lean over. To be fair the late Otto Lilienthal had commented on the relationship between balance when flying and when riding a bicycle. More generally, it would seem that whereas Bell, Hargrave etc. wanted a machine which would automatically find equilibrium, the Wrights reasoned that a bicycle by itself is not stable but a bike plus rider can be.Their observations showed that birds responded to gusts, and also turned, not by moving a rudder but by moving their wing tips. They also qualified the general aviator's belief in the virtues of dihedral by pointing out that a buzzard with a steep wing dihedral angle is less able to maintain equilibrium in strong winds than eagle with level wings (kite fliers please note). Their 1903 flyer had straight anhedral — why I don't know although it might have been to lock in the joints.

Their solution was wing warping, - said to have come to Wilbur when twisting a long box[13].



8 - Orville Wright's sketch of their wing-warping system

So to turn right the tip of the left hand wings twisted up at the front and down at the back. They developed this very quickly and by the end of 1899 had tested it by flying biplane glider as a four control line kite (1.5m span and 0.7m. chord). This is well written up in kite sources — see the articles by Dalto and Crouch in the Bibliography. Some years later when their patent claims were challenged they were able to find three of the kite flying boys who had witnessed its flight.

By early 1900 they had a glider which was potentially man-carrying but needed a suitable testing ground. By September they were making their first visit to Kitty Hawk, North Carolina — a site which promised good steady winds, sand dunes for launching and soft landings plus the absence of people. They built their own camp.

13. Unknown to the Wrights, wing warping had been developed by E.F. Gallaudet, an academic on the staff of Yale University. In 1898 he developed an 3.5m. span biplane kite which was launched from water. Control lines worked the warping and provision was made for this to be done by electric motor. However news was leaked to the University, who gave him the choice of leaving or giving up 'flying gimcracks'. He later regretted not having taken the idea further. However 'you can't keep a good man down' and he subsequently became an aircraft manufacturer with the Gallaudet Aircraft Co. This later became a major part of the General Dynamics Corporation, now in the current space industry.

Tests of the glider were encouraging. They controlled pitch and glide angle by their horizontal elevator which was fixed in front of the main wings. Though not a perfect design (on the 1903 flyer it was a biplane) it had three advantages:

a) It was in front and at the eye-line of the prone flier[14] thus acting as a horizon and giving quick information on pitching movement enabling the flying angle to be adjusted to preserve the glide.

b) It would tend to stall before the main planes and thus give early warning.

c) Mechanically it ensured that the flier would not hit the ground head first. This may well have saved a life and it is, I think, the only pure piece of luck in the whole Wright design.

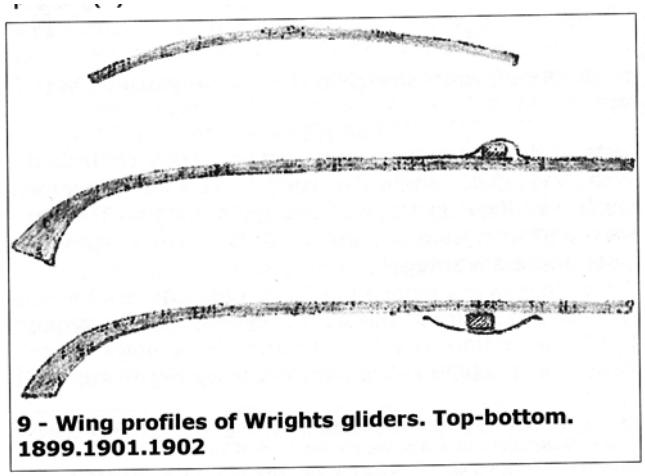
The first glider did not have a rudder, the flier controlled the elevator by hand and wing warping by foot bars. Encouraged by the results of the 1900 tests, they discarded their old machine (the fabric was used locally for girl's dresses) and planned for 1901.

This new glider was the world's largest to that time. The wings had a deeper camber and wing-warping was achieved by moving the body cradle in which they flew. Its results bitterly disappointed them — they had great control problems and they were getting much less lift and drag than they expected from Lilienthal's figures.

At this low point of great discouragement their friend Chanute was influential, pointing out how good some glides had been and getting Wilbur to talk to an important meeting of engineers in Chicago. Chanute was a channel for their work to the outside world — perhaps more than they realised and really wanted. The Chicago meeting seemed to steady them and led to a remarkable two month programme of experiments, using their own design of wind tunnel. As a result they produced data on lift and drag associated with angle, wing size and shape, thickness etc. which surpassed all the research done world-wide to that point.

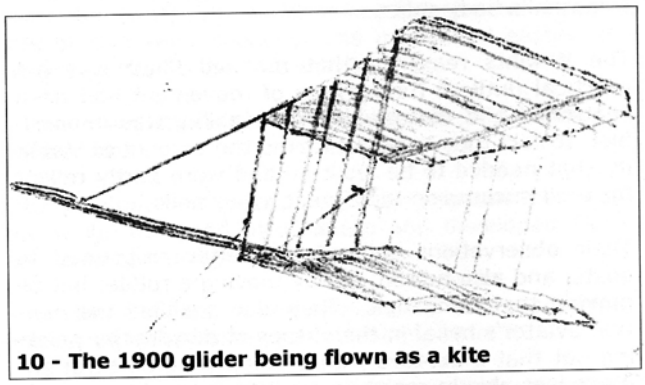
Their 1902 glider was once again bigger, had a higher aspect ratio, a less steep camber and a smoothed wing profile.

14. Wenham's biplane glider had a prone pilot.



9 - Wing profiles of Wrights gliders. Top-bottom. 1899.1901.1902

As before they relied on cradle-controlled wing-warping. Having at first placed two vertical fixed rudders behind the main planes, they later realised that they needed to be moveable and for a time had a single rudder with linked movement to wing-warping. As before, they tested as a kite before gliding.



10 - The 1900 glider being flown as a kite

The new arrangements worked well. By the end of the season they could control stall and side slip and had a controllable aircraft. The next steps were an engine and a propulsion system.

Firstly they considered the engine. It had become clear by then that the future lay with the internal combustion engine. Not finding one which met their requirements, they designed one and their chief machinist made it. Interestingly this was the weakest part of their whole project – it was a four cylinder, weighed 63 kg., produced 16 hp. for 15 secs, then dropping to 12 hp. Langley's March1903 engine weighed 90 kg. but produced 45 hp.

While the Wright's achievements largely stemmed from their development of control, engine control was ignored. The engine was started on the ground and the only pilots' influence was an off switch. Speed control via the engine came much later, remarkable given the well-known effect of airspeed on lift.

Given their relatively inefficient engine, what probably preserved the success of their attempt, and was certainly their greatest single advantage over others, was in propulsion. Firstly they selected propellers[15] and secondly they saw propellers not as aeronautical equivalents of ship's propellers which screwed their way through the air, but rapidly rotating airfoils producing 'horizontal lift'. Furthermore, after the previous year's experiments they had the data to design the world's most efficient propulsion system by far, comprising two counter-rotating propellers mounted side-by-side behind the wings, driven by chains from the engine[16].

The engine was to the pilots' right and that wing was 10 cm. longer than the left to compensate for it. On the '03 model the wing-warping system moved only the trailing edge of each wingtip — even closer to the modern aileron.

By 1903 the Wrights felt that they were going to be the first to fly and they wanted recognition and economic reward for their success. As a result they sought to restrict the news of what they had achieved, were very cagey at a second Chicago meeting in June, and pointed out that they still had only 4 hours of airtime between them.

As autumn approached and they were ready to travel to Kill Devil Hills they had another problem. S.P. Langley, the famous scientist, was preparing to conclude years of work, funded by public money and also the resources of the Smithsonian Institution, by attempting the first flight of his Great Aerodrome (as he called his aircraft, there was a problem with his Greek!)[17].

The total failure led to savage press comment (public money wasted, should try a submarine etc) including the New York Times' view that man-carrying aircraft would take 1 to 10 million years.

It actually took 9 days.

Worried about the competition, the Wrights abandoned gliding tests and went straight to running the engine. That ran roughly and required them getting new

15. Early attempts at propulsion for balloons had involved oars and some clumsy paddles. Hargrave hankered after a strange system of flails. There were designs for rippling wings. The Wrights realised that rotation involved the tips of propellers travelling at much higher speeds than near the hub and this required a different angle on the blade — the twist which we see today. They also gained efficiency by gearing down their propeller speed, others had rotation at engine speed.

16. Early attempts at propulsion for balloons had involved oars and some clumsy paddles. Hargrave hankered after a strange system of flails. There were designs for rippling wings. The Wrights realised that rotation involved the tips of propellers travelling at much higher speeds than near the hub and this required a different angle on the blade – the twist which we see today. They also gained efficiency by gearing down their propeller speed, others had rotation at engine speed.

17. I find it remarkable that such an experienced experimenter as Langley should try for a first flight in a machine without effective up/down left/right steering and without any provision for landing so as to preserve the craft (let alone the risks to the pilot). Added to that the machine was large with tandem cambered wings (i.e. front-and-back and the same size) and, I would have thought, obviously a weak design for flight (Langley always wanted lightness).

    It was clearly unsuitable for a steam propelled launch from the top of a houseboat designed to achieve flying speed in 70 feet.. All this after 18 years and at least $73,000 of public funding.

    At the first trial in October it flopped into the water, according to a reporter 'like a handful of mortar'. It was agreed to go again in December in freezing conditions on the Potomac River. The pilot, C.M. Manly, had wisely decided not to be strapped in and simply hung on to the frame wearing warm underwear and a cork jacket. Again it seems to have stalled and failed. Manly's first attempt to surface after freeing himself from the wreck found him under the ice but he swam clear. His frozen clothing had to be cut from him, while his language (he was a Southern gentleman) confounded all those who heard him.

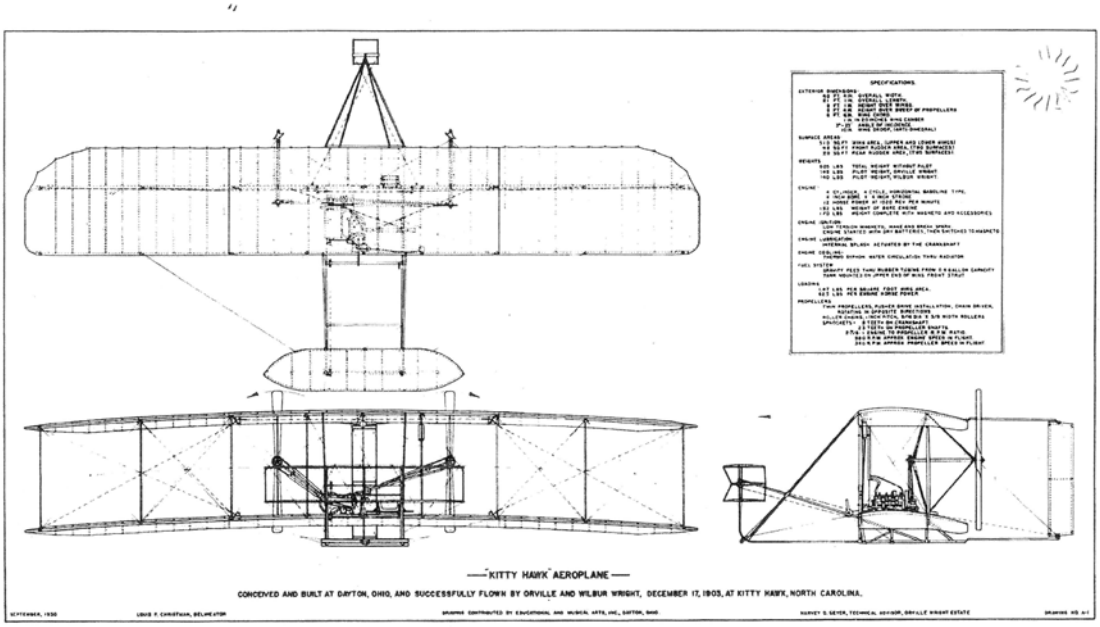
    Another journalistic comment; the "only thing he ever made fly was government money".

propeller shafts from home. They tried on 14th December but stalled at 15 feet resulting in minor damage. On 17th December, the day was icy with wind gusting to 27 knots. But they had promised to be home by Christmas and the weather was generally deteriorating so they collected their witnesses (four lifeboat men and a boy) laid out their track on level ground into the wind and set up their camera.

Orville was the pilot of the first flight — time 12 seconds, distance 40 m. To quote him "this flight lasted only 12 seconds, but it was nevertheless the first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in full flight, had sailed forward without reduction of speed, and had finally landed at a point as high as that from which it had started".

They made three more flights that day, the longest was the last and was piloted by Wilbur who flew for 59 secs., distance 279 m.

The wind then turned over and badly damaged the Wright Flyer – which never flew again.



11 The Wright Flier

Three months earlier as they left home, Bishop Wright had given them a dollar for the price of a telegram to announce success. This is what Orville sent (typo's corrected).

"SUCCESS FOUR FLIGHTS THURSDAY MORNING ALL AGAINST TWENTY ONE MILE WIND STARTED FROM LEVEL WITH ENGINE POWER ALONE AVERAGE SPEED THROUGH AIR THIRTY ONE MILES LONGEST 59 SECONDS INFORM PRESS HOME CHRISTMAS". [18]

4 After the First Flight; briefly and from the Wrightís perspective

When they went home for Christmas ’03 the Wrights knew that although they ‘had done it’, there was still some way to go to develop a practical aeroplane. They were anxious that others should not be able to take over their inventions freely. They were looking for an economic return via patents and/or contracts to build and develop aircraft.

Their first thought was the US Government. However the Langley fiasco meant their achievements were treated with great caution. Officials were often slow to see the implications of flight. Back in 1783 when Franklin was asked to comment on the value of an early balloon ascent, he replied “And of what use is a new born baby?”

In January 1904 they started to use Huffman Prairie as their flying site. This is 13 km. from Dayton and, unlike Kill Devil Hills, was fairly level rough surfaced ground with variable winds. Launching into wind on a track was no longer feasible so they developed a launcher which essentially towed the machine by the fall of a weight from a wooden tower.

For various reasons it was not until the end of that year that they were making reasonable flights but in December Orville flew for 5 min. 8 sec. covering in more than 2 circuits, 4515 m. at 26 knots[19].

They continued to learn and in 1905 produced the world’s first practical aeroplane with a more powerful engine, longer tail, better leading edge to the wings, re-rigged propellers and separated warping and rudder controls. On 4th October, Orville covered over 38 km. in 34 min. 23 sec. (more than their total airtime in 1903 and 1904).

What follows was, I think, the saddest part of the whole Wright Brothers story. Still without a contract and insulted by the misleading press reports of their progress (some seemed to think that they had flown a balloon) they didn’t fly between November 1905 and May 1908.

However, flying started in Europe with A. Santos-Dumont’s *iv bis* hopping 236 m. in October 1906 (it really did look like a cluster of box kites).

Others flew in Europe in 1907 and 1908 — not as well as the Wrights but there were flights which started at 22 sec.. and grew to Delagrange with 6.5 min. in April

18. I am happy to accept this as the ‘first flight’. The quotation from Orville shows they knew precisely what they had achieved and, as the text mentions, for the next two years they relied on a headwind or catapult mechanism to launch. Not until 1907 could they sit up, take a passenger, follow a reasonable course and land on skids then wheels. But no-one beat them to the first ‘practical aircraft’ either.

    There are of course other claimants, chief of which is Gustav Whitehead. There is a supportive website, which claims he flew near Bridgeport, Connecticut on 14/8/01. Crouch [3] dismisses the claim but undoubtedly Whitehead had great talent, designed interesting engines and a copy of his airframe flew under modern power in 1997.

19. It was at this point, when flying was first being made a practical method of transport, that the first journalist to witness a circle being flown had his report published. He was Amos I. Root and the article was in ‘Gleanings in Bee Culture’ 1/1/1905.

1908. This led to enormous popular acclaim in France together with some scepticism about what the Wrights had done — were they fliers or liars? In America Glenn Curtis became the third American to fly in March 1908.

However in February 1908 the Wrights started to get what they wanted — a contract from the Signal Corps to produce an aeroplane which had to meet certain performance specifications. Also they were able to set up a company in France. Their response to these two developments was typical — Orville stayed in America to fulfil the performance requirements and Wilbur crossed to France. It was to become what has been called 'The Year of the Wrights'.

In France, Wilbur after great problems in assembling a badly damaged kit, got flying in August. Although it was late September before he flew for over 1.5 hr. and 63 km., right from the start his control was clearly superior to French aviators. High society came to see him and to be impressed. This aircraft had two upright seats and his passenger, Mrs Berg, was the first lady to fly. [20]

In America, Orville drew crowds in September as he tested his aircraft at Fort Myer Virginia. In the 3rd week, while flying with Lt. T. Selfridge as passenger, a propeller hit a bracing wire, cracked and the plane dived. Selfridge was killed and Orville severely injured[21].

After recuperating and joining brother and sister in Europe they returned and in May 1909 Orville fulfilled the requirements of the Air Corps contract — a two-man flight of 1 hour plus and a 10 mile flight at a minimum of 40 mph.

The Wrights set up a manufacturing company – their aircraft now had landing wheels and the elevator was moved to the back (so at last we see what we expect in an aircraft, front wing, rear tail).

Flying in Europe was starting to develop. In 1909 Bleriot crossed the Channel in a Wright influenced monoplane which used wing warping. By 1910 it could be argued that European monoplanes were leaving American biplanes behind.

Did the brothers ever fly together? I think just once in 1910.

In 1911 Orville and some of their family went back to Kill Devil Hills to test a new glider. It flew beautifully and at 9 min. 45 sec. set an endurance record which stood for 10 years.

I'd quite like to leave them at that point with Wilbur looking after their business and Orville happily gliding. However, a few more things have to be said to finish their story.

Wilbur died of typhoid in 1912, worn out it is said by litigation to defend their claims.

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20. Her skirts were tied round her ankles to preserve modesty, leading to a new fashionable look — the hobble skirt.

21. Selfridge had been the passenger in the Cygnet, a 3,393 tetrahedral celled kite on floats which had flown when towed behind a boat in December 1907. He designed the aircraft flown by Baldwin in 1908 – this was the second flier after the Wrights.

In 1914 what was claimed to be a replica of Langley's 1903 craft flew. In fact it was modified in the light of the Wright's experience, but this did not stop the claim (shamefully supported by the Smithsonian) that its non-flight in 1903 was due to the launching system and that Langley had really invented the first manned flier. This affected the Wright's patent position and took years to defeat. Orville was so upset that he lent the 1903 flyer to the Science Museum, London in 1928 where it stayed until 1948.

Orville died in 1948, a wealthy man. Back in 1915 they had relinquished their interest in the Wright manufacturing company. Perhaps the final influence of kite designers on aircraft was the support that A.G. Bell (he of the tetrahedral and triangular box kites, as well as the telephone) gave to Langley and Glenn Curtiss. When the two firms joined in 1929 it became Curtiss–Wright and not the other way round.

Anyway the Wrights succeeded far beyond their ambition. In that letter to the Smithsonian in 1899 asking for all available information, Wilbur added "I wish to avail myself of all that is already known and then if possible add my mite to help on the future worker who will attain final successes."

5 Kitty Hawk and the Kill Devil Hills today

Kitty Hawk is on the outer banks of North Carolina. This is essentially a long line of islands off the East coast of the USA Kitty Hawk is part of a long thin strip of sand dunes, usually less than 1.5 km. wide, accessible by a series of road bridges and stretching down to Cape Hatteras and further South via bridges and ferries.

The beaches are beautiful and by European standards empty, the inland water side often devoted to nature reserves. Kitty Hawk is the biggest centre of population. Accommodation is plentiful but can be difficult to book in season. Food is the usual American cheap 'junk' with a few good exceptions (Dirty Dicks for seafood).

For me it is worth visiting really because of the Wright Brothers National Memorial (it is run by the National Parks Service and the USA does great National Parks). You won't see the 1903 Flyer which is now in the Smithsonian. You will see, on Big Hill about 30 m. above the flying site, the Memorial. More to the point, their launch spot with a rail is there and stretching in a line are the markers of their four flights on that day so that you can pace them off.

Nearby are replicas of their living hut and their hangar – which we found useful in a rainstorm. The Museum is rather disappointing even though it has a full sized replica of the 1903 Flyer which was produced (I am told for $1m) for the centenary and refused to fly. Wrong wind — I've seen film somewhere. There is a model glider and a good bookstore — with a book on kites. Also built for the centenary is

a temporary-looking space with some hands-on exhibits and good recreations of their workshop equipment and their camps.

I find the site fascinating. The area is covered in sandy seaside grass which didn't exist in their day but was necessary to stabilise the dunes. There are no high buildings near and it is just sandy enough to allow you to imagine what it must have been like.

Just down the road is a kite store with some interesting Wright centred goods. There is a wide range of kites — but all are 'packets' i.e. made in China or Taiwan. Almost opposite is a huge (more than 25m.) dune in a local park where kite fliers go on Sundays.

I wonder if anyone has flown a four line biplane kite there recently?

5.1 My conclusions on the impact of kite flying on the Wrights

It seems to me that there were two ways in which kites were important. Firstly they tested and refined wing-warping on a four line biplane kite. Secondly, for all except their 1903 machine, they regarded flight as a kite as an important stage of development.

There were other less direct connections. The group of American fliers which included Lamson had helped the development of aviation in the USA in the 1880s.

Hargrave's work on flight was very influential e.g. the lift from curved airfoil shapes and the stability of his box kites.

Pioneers of flight had great problems in settling on an efficient wing plan shape. Though others before Hargrave, e.g. Wenham had used the broadly rectangular plan used by Chanute and the Wrights this was not settled at that point. Cayley had used very low aspect ratios (derived from arch-top kites). Henson and Stringfellow had both used a high aspect ratio pointed plan. In contrast Lilienthal, Penaud and Pilcher had all used a bird wing shape close to a sparrow with all feathers extended. Hargrave experimented with a range of odd-looking kite shapes (to our eyes); perhaps it was the box plan shape which was the greatest contribution.

6 Reading

The list is limited by my own reading from the large number of books dealing with early flight. Pelham [1] has a good historical section obviously from the kite perspective. See also the book by Hart [4]. A more general history by Hart is [5].

Individual histories include those by Gibbs-Smith [6], Penrose [7], Hudson-Shaw and Ruhren [8], Combs [9] (a good technical book), Friedman [10] (brief with good illustrations) and Crouch [3] (deals with American fliers in the 30 years before the Wrights).

[1] Pelham, D. (1976*) Kites.*
[2] Jenkins, G. (1999*) Colonel Cody and the Flying Cathedral.*
[3] Crouch, T. D. (2002*) A Dream of Wings.*
[4] Hart, C. (1982*) Kites: an Historical Survey.*
[5] Hart, C. (1972*) The Dream of Flight.*
[6] Gibbs-Smith, C. H. (1962*) Sir George Cayley's Aeronautics 1796-1855.*
[7] Penrose, H. (1988*) An Ancient Air.*
[8] Hudson-Shaw, W. and Ruhren, O. (1977*) Lawrence Hargrave.*
[9] Combs, H. (1979*) Kill Devil Hill.*
[10] Friedman, R. (1991*) The Wright Brothers.*

See also the following kite magazine sources:
D.Alto *Stunting with the Wright Brothers* American Kite. Winter 1990
T.D.Crouch *Wilbur & Orville Wright Fly a Kite* Drachen Foundation Kite, Fall 1999

7 Postscript to ì Kites and the Wrightsî

This is a follow up to the chapter on "Kites and the Wrights". In November 2007 we returned to the Outer Banks of North Carolina (seemed a good place to take the grandchildren) and I got the chance to add to my knowledge of the 'first flight'.

An attendant at the museum showed me how the Wrights lay on the wing to the left of the engine. He emphasised that they were right handed and had a good hard hold on the leading edge close to the engine and that this was their only firm attachment to the aircraft. The left hand worked the elevator and they simply rested on the cradle which they shifted sideways to control the wing warping/rudder arrangement.

The museum now has some short films of the 'centennial flights'. The first one on 20 November 1903 is recorded as 8 seconds and 32m. — looked like pilot error as the aircraft left the rail. On 25 November they managed 12 seconds and 38m. — very close to the Wrights first flight of 12 seconds and 40 m. The 'official' attempt was an abject failure, blamed on low winds not giving enough airspeed and the wet weather affecting engine efficiency.

An unexpected bonus was the soundtrack which was presumably very close to 1903 — it was a loud steady Wop-Wop-Wop beat which probably came from the propellers (or pistons?) being amplified by the tightly covered wings.

A commemorative edition of the Outer Banks Sentinel records the first flight with the well known photo under the headline 'Man Shall Never Fly debunked!'. The start of the article is: -

"Excitement is abounding today as word travels across the country that Man has achieved the impossible through the exploits of two cyclists from Dayton, Ohio who broke the bonds with the Earth when one of them flew for 12 seconds in the world's first powered flight.

"In Norfolk and other points of commerce there is much rumour and speculation about the event."

Reading the paper gave me a clearer impression of just how isolated Kitty Hawk was.

One article records interviews with the Kill Devil Hills Life Saving Station personnel — who look a desperate lot but were the equivalent of the Life Boat Service (the Outer Banks being well known for wrecks). The Life Savers has a saying "you have to go out but you don't have to come back". With other locals they had helped the Wrights build their camp and move materials about. Their comment was "each one have one oar out of the water". Orville Wright, when talking about weather conditions on the morning of the 17th December said that "the wind had a velocity of 10 or 12 metres per second". I am very surprised he used a metric measurement —which is the equivalent of 22-27 mph. (19-23 knots).

Anything about kites? Well the 21st KDH Sport Kite Festival was on when we were there — but standards didn't seem remarkable. The Sunday fliers on the big dune opposite the kite store seemed into fairly large soft kites. We flew on the sea beach in generally excellent conditions. But beaches are different in North Carolina. Would you see more than one local sunbathing in a chair with a kite tethered behind them? And how often do you see a full formal wedding on a British beach?

And I did manage to buy a Star Bird kite designed by Buteo Huang, a heavily promoted designer for New Tech.

(Available from a number of American sellers — approx. $50 plus shipping + VAT.)