Wings of the Ancients- An In-Depth Look at the Discovery of Human Flight of Brother Eilmer of Malmsbury and Leonardo Da' Vinci Before the Year 1600 A.D.

Honors Thesis

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Introduction

A father and a son met one morning at dawn over a thousand years ago and attempted to defy the gods. They leaped from the cliffs of Crete, spread wings of wax, feathers, and string and climbed towards the heavens. They made the most of their mortal imagination and became gods, forever immortalized by the legends that would follow. This story of early human flight has intoxicated people for centuries. Its origins date back to early Greek mythology.

A man named Daedalus and his son, Icarus, supposedly used wings made of bird feathers, wax, and string to escape the island of Crete. Daedalus was forced to devise an escape after being imprisoned by the legendary King Minos, keeper of the Minotaur. Daedalus makes the wings for himself and his son and prepared for the big day. Daedalus and his son prepared for their flight, he warned Icarus not to fly to close to the sun as it would melt the wax of his wings. Icarus got caught in the moment and flew too close to the sun, melting his wings and falling to his death. Legend says Daedalus flew on to Italy over the Icaria Sea in grief and never flew again.

This myth has long been a cautionary tale of the folly of human pride and the effects of challenging the laws of nature. It is considered a myth because it is hard to imagine a man gliding over a sea on wings made of mere bird feathers and wax. Yet, today historians know that there is a sea named for Icarus, and that the island of Crete was filled with labyrinths, and that worshiping of bull creatures happened there. Every myth originates from some form of the truth, and it is possible that a man could have constructed some sort of glider to at least get off the island. The interesting thing about the story is that similar stories exist around the globe in cultures that supposedly had no contact with each other. There are hundreds of stories that supposedly happened after the time of the Greeks, stories that had to be on the edge of the truth. Is it possible that early man was much closer at accomplishing flight than previously believed? I am almost positive they did. The question is, did man need to know what we know or have the tools we have today to accomplish flight? Or even what we had in December 17, 1903 when the Wright Brothers shocked the world (Howard, 1987)? This paper will attempt to answer this question by systematically breaking down two separate classical aviator's attempts at flight.

It is hard for modern society to believe that early man could have accomplished flying because it does seem impossible to think of people accomplishing flight without any grasp of the laws of motion and aeronautical design knowledge that we have today. Even today, flying is still a mystery to most, and it almost seems like an illusion every time a fully loaded Boeing 737-300 is able to take off at 131,000 pounds. However, magic is not the case. Flying itself works on very simple laws of physical science, but it is not so simple if one has never had the idea of lift explained to them. If you explained Bernoulli's principle that velocity and pressure have an inverse relationship, and the shape of the wing uses this relationship to create lift to someone who had never stepped in an airplane or heard of Bernoulli they would probably walk away thinking that flying is something for the smart people to do. Even though man has solved most of the mysteries of flight, it can still seem pretty out there for the common civilian who has never had flight training. The point is that flying is actually pretty simple and it is not anywhere near as complicated as people put it out to be.

But, understanding how things move through the air and how lift works is pretty handy when it comes to designing a successful aircraft. The Wright Brothers would never have been able to fly in 1903 without some of the work that was done by their predecessors. Today when an aircraft is designed, airfoil trials that N.A.C.A., the predecessor to NASA, made years ago can be easily referenced to find out things like critical angle of attack or lift to drag ratio without having to create unnecessary models or perform costly and lengthy trials (Suckow, 2009).

In contrast, ancient aviators usually had one shot at making the aircraft work. They did not have wind tunnels or thousands of files of complied data in their computers. In the middle ages, a craze known as tower jumping swept the land in Europe. King Bladud famously claimed he could fly and jumped off a tower in a glider only to immediately fall to his death. His test flight was his last flight (Biddlecombe, 1928). The ancients were at a severe disadvantage in terms of technology.

Yet, how much technology is needed for flight? One could argue that it depends on the type of aircraft which you are using. In aviation today, aircraft are categorized into four categories: airplane, rotorcraft, glider, and lighter-than-air. (FAA, Aircraft Categories Part 1.1, 2014).A glider, balloon, or kite would be a lot easier to stumble upon than an airplane or rotorcraft. As stated earlier, lift works on pretty simple physical laws of science. Man could have created a glider, balloon, or kite without much technology or knowhow. However, a rotorcraft or airplane would have taken a lot of ingenuity to create a propelling device worthy enough of carrying the aviator and the aircraft safely. An ancient aviator that wanted to build a self-powered airplane would have had to first try to invent some kind of engine. Steam and gasoline engines did not come until hundreds of years past their respective work. Thomas Savery invented the first steam engine in 1698 (Osbourne, 1922) and Alphonse Beau de Rochas patented the first plan for a four stroke gasoline engine in 1862 (Bryant, 1967). It would have taken a colossal amount of work for early aviators just to get started on an airplane, but they might be able to make a parachute or kite by simply jumping out a window while holding a bed sheet. It would be an enormous folly to underestimate the ancient aviator's abilities to create something simple enough to generate lift.

Much of what is known as basic physics today was also alien at that time. Kepler's Laws of planetary motion were published separately, but the first did not come out until 1609 (Russel, 1964). Francis Newton's laws of motion that were outlined in his Philosophiæ Naturalis Principia Mathematica was not published until 1687 (Newton, 1687). Not even Galileo, known by some as "the father of modern science, "had started coming out with some of his theories until 1615 (Hatch, 2002) The basic theories about how things moved in space or how things flew did not exist even in the most modern classical aviators' lifetime that we will examine.

Yet, these ancient astronauts came pretty close to accomplishing flight just the same. Ancient people discovered things and made creations without having a clue how they worked all the time. Early astronomers could accurately predict future constellations without having a clue at how the universe was shaped. It is highly doubtful that the inventor of the catapult had any knowledge of what parabolas were, but he did know that if he aimed it high enough it might toss a rock over the wall. The understanding of why things work was not always needed to make an invention be successful. It is feasible that early man could have flown through the air without understanding basic aerodynamic laws like what gravity was or how air pressure worked.

Thesis Statement

The question this paper is trying to answer is did man need to know what we know or have the tools we have today to accomplish flight? How much groundwork was necessary in aviation to get something off the ground? My argument is that they did not need to understand every aspect that we know today and that they did not need the technology that we hold as a standard today. Yet, I do think that they required a little bit of both and a significant amount of ingenuity, skill, and luck in order to be successful. I think it depended a lot on what kind of machine they were trying to use and what kind of flight they were going to accomplish. Glider flight would have been much more plausible than airplane flight just for the fact of not having to create an engine.

My initial hypothesis is that Eilmer completed his glider flight without any correct concept of how lift works and with the technological capabilities of a glider made of wood and cloth. My initial hypothesis for Da' Vinci's concepts is that he was held back by both a lack of understanding and a lack of technology. The difference in the two is that Da'Vinci was trying to accomplish a much harder form of flight and it held him back from being successful.

Methodology

How will I answer an almost impossible question? I will examine two classical aviators separately through a systematic process and try to answer that question in the end. I will be looking intently at the attempt of Eilmer of Malmsbury and the concepts of

Leonardo Da' Vinci. I will do a small biography on each man and explain what each man was coming from, the challenges he faced, and the plausibility of success.

The creative aspect of this project is to attempt to recreate two machines from Eilmer and Da'Vinci's designs in the way that the aviator did. I will build two of the flying machines based on one of each of their designs and using primitive techniques and tools to do so. Eilmer used a simple glider, but I will have to decide which of Da'Vinci's designs seems the most plausible. He has a design for a glider that resembles a bat's wing, so I may focus on that one. I will either build a small scale model of each one, and then I will safely test each. I will record my building process, attempts, successes, failures by written document and possibly video. I will attempt to prove once and for all that both ancient aviators could have indeed flew their respective devices.

Definitions

1. Flight is the process at which an object moves through the atmosphere

2. Thrust is a force that moves an aircraft in the direction of the motion. It is created with a propeller, jet engine, or rocket. Air is pulled in and then pushed out in an opposite direction. (The Four Forces of Flight, 2003)

3. Drag is the force that acts opposite to the direction of motion. It tends to slow an object. Drag is caused by friction and variances in air pressure (The Four Forces of Flight, 2003).

4. Weight is the force caused by gravity (The Four Forces of Flight, 2003).

5. Lift is the force that holds an airplane in the air. The wings create most of the lift used by airplanes (The Four Forces of Flight, 2003).

6. An aircraft is any machine capable of atmospheric flight

7. An airplane is an aircraft that depends on some kind of engine for thrust

8. A glider relies completely on wings for lift, uses wind and pitch to control airspeed

9. Controlled flight- the aviator has positive control over the aerial craft and can make it follow his commands

10. Ancient aviators- people who attempted to discover flight before the Scientific Revolution (roughly 1550-1700) (Hatch, 2002).

11. Thematic analysis- examining the theme of the aviator's process in inventing and trying of their aircraft

12. Lighter than air aircraft- non-steerable balloons, such as hot air balloons and gas balloons, and steerable airships (better known as dirigibles) and blimps and rigid airships that have an internal frame

13. Heavier than air aircraft- there are two ways to produce lift: aerodynamic lift and engine lift In the case of aerodynamic lift, the aircraft is kept in the air by wings or rotors (see aerodynamics).With engine lift, the aircraft defeats gravity by use of vertical thrust. Examples of engine lift aircraft are rockets and helicopters.

14. Bernoulli's Principle- When velocity of a fluid increases, pressure in the fluid decreases, and inversely when velocity of a fluid decreases, the pressure of the fluid increases.

Mind behind the Machine Leonardo da Vinci

Every flight has to start somewhere. Leonardo da'Vinci was born in 1452 in Vinci, Italy not far from Florence (Capra, 2007). He was the illegitimate son of Ser Piero da Vinci and a peasant woman (Capra, 2007). He attended a school of basic knowledge as a child, but he was not allowed to go to a university because of the controversy surrounding his birth (Capra, 2007). With limited options, he went on to become an apprentice in the arts. Despite having almost no experience in Latin and not being able to read scholarly works during his lifetime, he may have come up with some of the most revolutionary designs and innovations that the world had ever seen (Capra, 2007). He had an insatiable hunger, an unstoppable drive to understand and study the world and how it worked.

Leonardo da' Vinci is perhaps most famously known for his art work, but his own records and designs show him to be an incredible innovator and master of design as well. He had a method of thinking that he used to break things down so that he could conceptualize what was going on. He used a combination of studying nature, mathematics, and logical reasoning to explore all aspects of the problem. He created a unique, heuristic method towards exploring scientific theories. He came up with his scientific method a hundred years prior to Galileo and Roger Bacon (Capra, 2007).

He was one of the earliest astronauts. He never walked the moon or heard of the Houston NASA Center, but he attempted heavier-than-air, self-propelled flight, a feat which until 1903 seemed insurmountable (Howard, 1987). He, like many, saw birds take flight and yearned for the ability to join them in their climb for the heavens. As a child, it is said that he was fascinated by the soaring birds in the hills around Tuscany, Italy (Mathe, 1980). It is hard to say what exactly he was thinking or had in mind when he began to study the flight of birds and bats and attempted to explain movement through the air. His project can be viewed as the combination of three phases. First, he had to start with the understanding of flying from his present time period. He had to either further that understanding of aeronautics, a term yet to even be defined, or radically challenge those theories and attempt to explain it in his own way. The next phase was his research. What did he observe and use for a references to figure out how birds flew and how man eventually could be able to fly? What was his understanding of motion through the air? Finally, the last phase was his trial phase. He drew many designs and plans for flying machines. What was the premise behind these vehicles? Is there a chance that if built they could have created lift, and lifted the early astronaut into the air?

The understanding of aeronautics at the time was very limited to say the least. Even with the Renaissance era of new technology and knowledge, none of the basics of aerodynamics such as aerostatics, aerodynamics, and aeronautics were known (Mathe, 1980). There has been talk of men soaring and weaving their way through atmospheric jungle of clouds since the beginning of time. Most of these stories are in the form of myths, passed down by word of mouth, generation to generation, until hardly any truth remained from the original tale. Regardless if any of the earliest stories are true, it is hard to ignore the possibility of truth when there are so many similar stories of early flight from around the globe. Even if mythical stories are dismissed as pure fantasy, man has always been interested in the science behind flight and has always felt the need to break the chains of natural design and make a machine that would challenge the heavens. Most attempts at flight during this time were unsuccessful and fatal to the astronaut, causing both an increase of public skepticism in the field and a loss of aeronautical knowledge that the pilot could have provided. It is hard to put oneself in Leonardo's shoes as he was starting out. To put it in perspective, heavier-than-air flight by man has been around in present times for over 100 years and airplanes have gone from a twelve horsepower engine that flew around the dunes of Kitty Hawk for eight seconds, to jet airplanes that can circumnavigate the globe (Hallion, 2003). When a teacher asks a high school or college student to make a paper airplane, the student immediately attempts to design a sleek fuselage and sturdy wings. It is not difficult to try to recreate something one has seen or experienced multiple times. Leonardo was attempting to fight gravity two hundred years before gravity was explained by Newton (Capra, 2007). Motion through the air of the 1400s was believed to work on the theory of impetus.

Impetus was originally proposed by Aristotle himself, and it was expounded upon up until the Newton disproved it with his laws of motion that we hold true today. (McCloskey, 1983). Impetus theory revolves around the idea of cause and effect (McCloskey, 1983). However, instead of Newton's law where with every action there is an equal and opposite reaction, it works on the idea that every still object has a zero amount of impetus. Impetus is almost like gasoline in a car. As long as there is impetus, the object will move forward through space. When it runs out, the object will drop straight down. Keeping this theory in mind, inventers tried to create machines that would add enough impetus to objects so that they could travel farther and arrive with more power. Leonardo presumed impetus theory to be true, yet he approached it differently.

He believed, correctly, that air and water move in much the same way. He believed that birds flew through the air much the same way as fish swim in the seas. Da Vinci thought that the wings of the bird compressed the air underneath them on the down stroke, much like a fish turning its fins to maneuver through water. He also recognized a certain amount of resistance in the air from his studies in fluid motion with water (Hart, 1961). In a striking challenge to the impetus theory, he proposed that there may be multiple forces at play. In the Codex Atlanticus, one of his quotes roughly translates to "As much force is exerted by the object against the air as by the air against the object" (Capra, 2007). If this sounds familiar, it is the premise of Newton's third law, which was published around two hundred years later. It is interesting that Leonardo understood, at least in a general since that "lift" and "drag" forces existed. Another surprising aspect of Leonardo's notes is that it appears he knew of the importance of center of gravity and center of pressure in his machines. He may not have known what the term for each was, but he understood that the center of gravity was a fixed point, while the center of pressure (he referred to it as "center of resistance") moved in different circumstances (Hart, 1961). It appears that Da Vinci had at least a partial concept of four of the most important basics of aeronautics. He was on the right track, but he still believed the impetus theory held true when banking as he notes that "the bird will turn the movement behind the impetus of the wing which moves most" (Hart, 1961). Da Vinci perceived that the wing had to have a certain amount of lift and enough force to combat drag; however he held on to the theory that the wing had to "catch" enough air to keep it airborne.

Perhaps the cause for his greatest amount of confusion originated from the source of his fascination with flight. Most aeronautical aspirers of the time saw birds as the key to flight. Aviation enthusiasts the world over focused their attempts at trying to fully create the shape and motion of birds. Birds were seen as the basis of flight itself. People knew the wings were the behind the mystery of flight, yet they did not understand that it was more about the shape of the wings than the overall movement and use of feathers as a building material. So much effort over the years was devoted to pushing the air down with the wings in a flapping motion so that one could be lifted up. They understood that a force had to be harnessed that was pushing in the direction opposite of the direction towards the earth; they just lacked the how (Hallion, 2003) .

The anatomy of birds is substantially different than humans. Birds have much larger pectoral muscles and they have an extremely low bone density compared to humans (Capra, 2007). Birds have more power to flap wings in an up and down motion, and they have a lower body-weight ratio (Hart, 1961). Birds have a higher natural mechanical advantage to fly by flapping their wings than birds do. Leonardo had to recognize the pitiable muscle capacity of humans, which unfortunately was his only available means of engine (Mathe, 1980). Yet, his curiosity drove him on to attack this issue by adding multiple gears and levers to his machines. The amount of gears and levers eased the amount of work to move the wings, but it also added to the overall weight of the craft itself. Da Vinci designed his machines to lift a two hundred pound pilot, presumably himself, yet he failed to add in the overall weight of the device itself. It seemed like the more he dug into the problem of flight, the deeper the impossibility of the problem seemed to be.

Leonardo da Vinci started his quest to make a flying machine around 1490 (Capra, 2007). He started his understanding of aeronautics by watching the movements of birds, bats, and by studying the anatomical differences between humans and animals that could fly (Capra, 2007). He started off just focusing on making a device that could create lift. His first flying machine is extremely complicated. The only way to describe it is to that the pilot is supposed to crouch and pump his legs and arms up and down to move various pulleys and levers in order to go up. The device looks extremely impractical and weird by today's standards. There seems to be no way of steering or controlling the craft, and it seems like the pilot would have to be a perfect physical specimen to get it off the ground. It is a complete failure.

Leonardo da Vinci could have easily called it quits here, but his curiosity kept driving him forward. As Jean Mathe put it in *Leonardo's Inventions*, "He never lost heart, despite the repeated failures" (Mathe, 1980). This is greatly evidenced in the nature of which he researched the problem. Like his paintings, he would take breaks and come back to the problem every so often when he felt like he had something significant to add to his notes (Laurenza, 2006). He had the unique ability to see the forest through the trees. He could observe and conceptualize small minute details things that others could not.

He went on to develop much more practical machines, but he conceptualize the differences in man and birds and how flapping the wings for propulsion was not a very feasible approach. His trial and experiments led him to believe that although man could not flap like a bird, they may be able to soar or glide like one (Capra, 2007). He began to focus his attention on making a glider in his later years. Or at least he hinted at it. One of his most practical designs is that of a simple wing that is modeled after a bat. He utilized the idea of a membrane binding the joints of the wing, which would make the wing work much like a sail using the force of the air to lift the wing rather than a flapping motion (Hart, 1961). This "bat" wing is a foreshadowing of what is to come. It is eerily similar to present day aircraft wings. The original drawing can be found in *On the Flights of Birds*. It is presented in *Figure 1*.

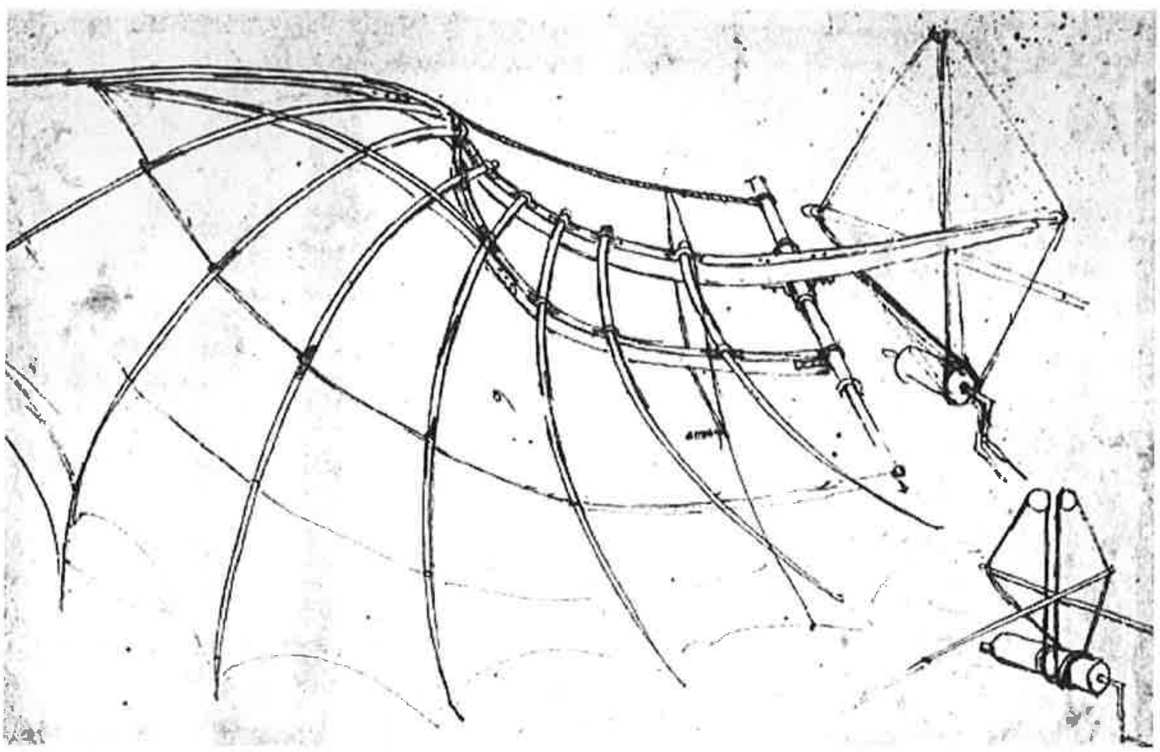


Figure 1- Leonardo's Glider modeled after a Bat wing. (Leonardo Da Vinci's Glider, 2015)

Figure 1 shows a curvature of the wings that is almost identical to a bats wings. The curvature suggests a large amount of camber to the wings, which also indicates a large coefficient of lift. The drawing on the bottom right seems to be some type of foot pedaling device that moves the wings.

A similar sketch by Da Vinci is found in *Figure 2.*

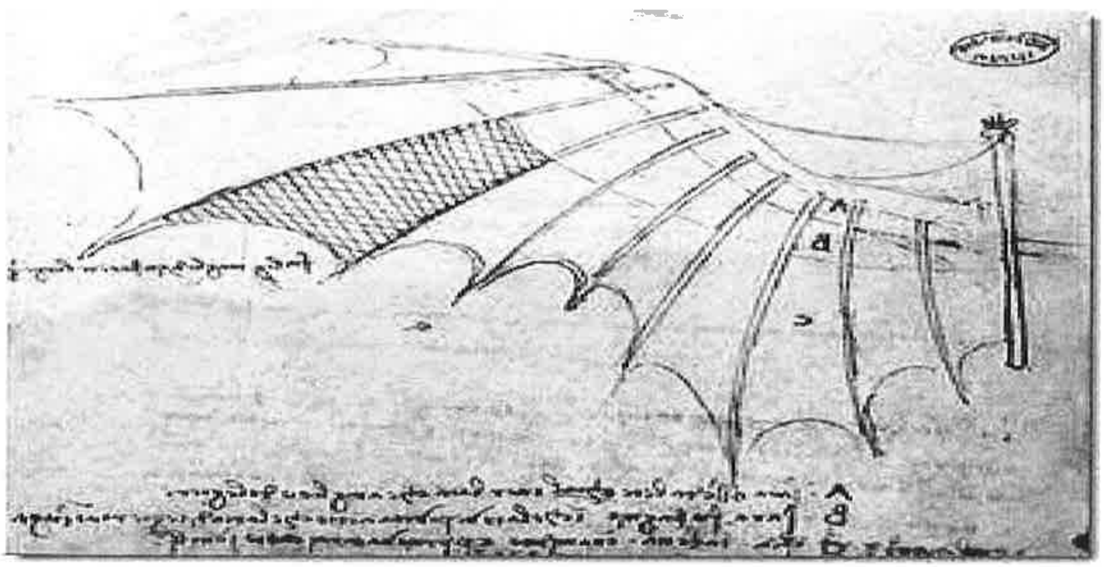


Figure 2- Similar Da Vinci drawing of a bat wing (Mathe, 1980)

Figure 2 suggests a long and wide wing design, similar to today's modern gliders. It is hard to estimate the length of the gliders wings from the drawing, but it appears to be at least 12-15 ft. in length and perhaps 6 ft. wide at its widest point. *Figure 3* is a bats wing for general reference.

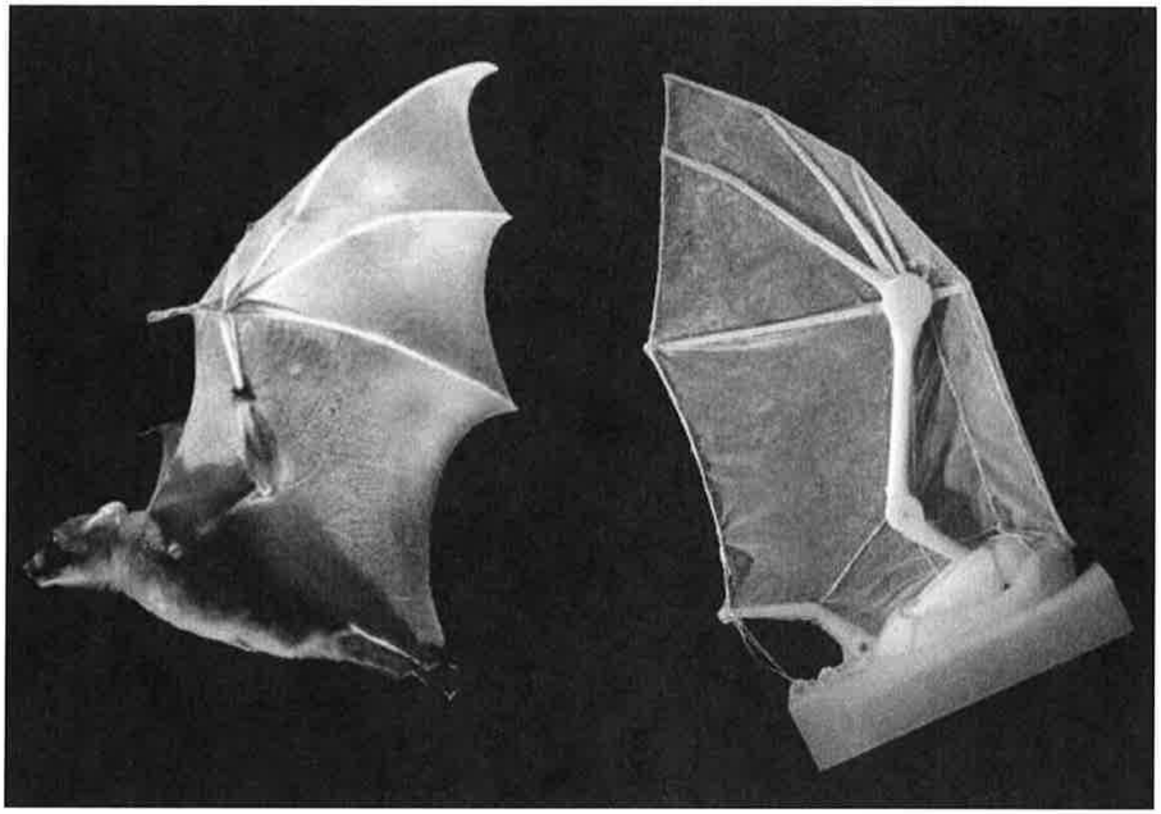


Figure 3- Wing profile of a bat and a modern 3-D model (Stacey, 2013)

If Leonardo was so close in his designs for flight, how did he fail? There are multiple probable reasons. First and foremost are lack of time and resources. He was recognized as a great artist of the period and still is today, the flying experiments were all done on the side and he rarely had an abundance of time to devote to the issue. He was a rare example of a man that was exceptionally bright in many different fields of interest. The advantages of such a brain are limitless, but the major drawback is not having enough time to pursue them all the things he was interested in.

His lack of resources include physical resources of materials for his aircraft, a lack of research on the topic itself, and a lack of manpower. In *The World of Leonardo da Vinci,* Hart mentions that Leonardo's devices were expected to be constructed with the following materials: cane, fustian, starched taffeta, well-greased ox hide, springs made from bands of iron or strips of cow's horn (Hart, 1961). Consider today that airplanes are made from everything from aluminum to steel to artificial composites.

Perhaps most importantly, he lacked an engine. The mere power of human muscle was not strong enough to make his contraptions go. There is no telling what he could have done if he were born in an era that had engines. As stated earlier, Leonardo did not know how to read Latin and did not have access to the research done in aviation prior to him. For one thing, most of the pilots that did research often died during their attempts and never lived to pass on tricks of the trade.

Secondly, there simply was no widely available research in flying even if he would have been able to read. How far would the Wright Brothers have gotten without contributions from Otto Lilienthal (Hallion, 2003)? Of course, Leonardo brought some of the weight of the project on himself by being extremely private with his notes. If he would have had a team of Renaissance innovators pooling ideas on the project, it is possible that they could have come up with more plausible machines. He chose to be private because he believed his ideas might lead to employment (Capra, 2007). Although this is rational, it also led to his findings not being found until years after his death. If his notes would have been published, technology of mankind may be much further than it is today. It is believed that over half of his notes have been lost over the past few centuries (Capra, 2007). However, all these reasons aside, there is a chance that he could have succeeded.

He roughly understood the basics of flight. He had lift, drag, center of gravity, and center of pressure down. Obviously, he understood weight as he designed most of his machines to carry a pilot that weighed as much as he did. Thrust was in his head as impetus, but at least he realized that something had to keep pushing it forward in order for it to move. His study of bats had the right basic design concepts for a glider. In one of his drawings, he designs a man using a large sheet to descend by using the force of the air to fly and glide safely down as gliders do. This drawing is said to be the first drawing of a parachute (Hart, 1961). There is no evidence that he ever tested his models, however there are suggestions in his notes that he did. From his notes he writes," On the second day of January 1496 I will make the thong (soatta) and the attempt" (Hart, 1961). He also describes the type of building one should construct the models in private in. He obviously did not try out every one of his designs, or he might not have lived to tale the tale as some of them are irrational to the point of dangerous if he had launched himself from the rooftops like his predecessors. His notes look continuous as if he made corrections or additions along the way that would seem to suggest he was constantly testing his ideas. Considering that this has been over five hundred years ago, it is highly doubtful that any of these models survived. This does not prove that they never existed.

Leonardo had one of the greatest minds the world has ever seen. He figured out more about basic aerodynamics than anyone for the next three hundred years or so. He most likely never flew full scale models of his aircraft, but it is highly possible that the glider could have worked. I will attempt to recreate his batwing glider and test it to see if it had a high enough lift/drag ratio. Some people have attempted and created this glider successfully, however none have made this particular and tried to find its lift/drag ratio.

One such model can be found in *Figure 4*.

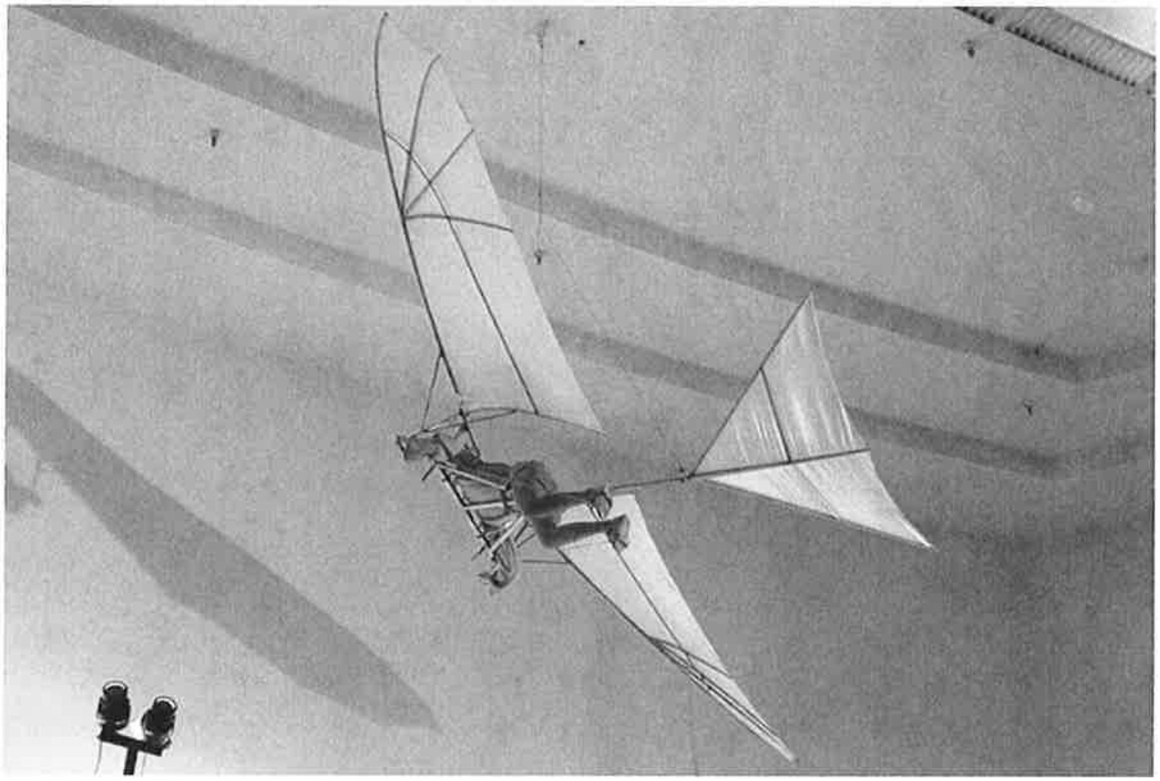


Figure 4 shows a model of Leonardo's batwing glider. (The Dawn of Flight, n.d.)

It is interesting to note that the wings are flappable and do not remain as one throughout the glide. Theoretically, Leonardo thought this would power the aircraft forward. However, it will most likely destroy the stability of the glider as one horizontal component of lift will likely always be greater than the other. The addition of a tail is also puzzling as it does not show up in the original drawing. Perhaps it is the creator's personal addition.

The Flying Monk- Brother Eilmer

A young Benedictine monk of Malmsbury Abbey sought to change history one day in around 1000- 1010 A.D. (White Jr., Eilmer of Malmesbury, an Eleventh Century Aviator: A Case Study of Technological Innovation, Its Context and Tradition, 1961).He was known as Brother Eilmer, and he was curious and determined like many before him. He had the courage to follow through with his dreams of flight, and built a crude a machine and launched himself from an Abbey Tower in Malmsbury. He did have a rough crash, but only after he made a stable glide of at least one whole furlong (approximately 660 feet) (White Jr., Medieval Engineering and the Sociology of Knowledge, 1975).

Historical records of this era do exist today. William of Malmsbury, a monk who worked in the Abbey about forty years after the estimated death of Eilmer, is the first to mention Eilmer's flight in his book *Gesta Regum Anglorum.* Roughly translated in 1998 as the History of the English Kings, William of Malmsbury is recognized by scholars as being the best "informed and most reliable historian in twelfth century" (White Jr., Eilmer of Malmesbury, an Eleventh Century Aviator: A Case Study of Technological Innovation, Its Context and Tradition, 1961). On Eilmer, he says "He had by some means, I scarcely know what, fastened wings to his hands and feet so that, mistaking fable for truth, he might fly like Daedalus, and, collecting the breeze upon the summit of a tower, flew for more than a furlong. But agitated by the violence of the wind and the swirling of air, as well as by the awareness of his rash attempt, he fell, broke both his legs and was lame ever after. He used to relate as the cause of his failure, his forgetting to provide himself a tail." (Malmsbury, 1998). He also states that Brother Eilmer prophesized the Norman invasion of England in 1066 when he saw Haley's Comet. Haley's Comet has been found to have flown before the Norman invasion of William the Conqueror so there seems to be validity to this statement.

In 1260, an English Friar, known as Roger Bacon claimed that " flying machines can be constructed so that a man sits in the midst of the machine re-volving some engine by which artificial wings are made to beat the air like a flying bird made, as well as in our own flying machine." He said he had never seen such a machine, but went on to claim that "I know a wise man who has designed one" (White Jr., Eilmer of Malmesbury, an Eleventh Century Aviator: A Case Study of Technological Innovation, Its Context and Tradition, 1961). This is the same Roger Bacon is one of the founding fathers of modern day science; it is doubtful that his records were intentionally false. It is extremely probable that Mr. Bacon knew of Eilmer's historic flight and perhaps records of his device still existed at this time.

Today no evidence of Brother Eilmer's original glider exists besides stain glass depictions in the church and local legends. This has caused historians argue the validity of his flight. However, if one looks closely, there seems to be a plethora of evidence that suggests that it is highly possible. There are four things that would have made such flight possible, a good environment, a decent design, intelligence, and courage.

Malmsbury is a small Catholic chapel found in an area known as Wiltshire, England. It is about 100 miles from London. However, at that time, it was a regional hub of the English Church (Hallion, 2003). Today it is roughly a third of the size it was at the time. Malmsbury impressed Athelstan the first King of England so much in 925 A.D. that he is reported to have had one of his palaces close by at Brokenborough and a villa at nearby Norton. He created a club for masons that may have brought forth Freemasonry in the England (Who was King Athelstan, n.d.). It was a budding environment of art, invention, and science. Creativity was encouraged by the church (Paz, 2014). Brother Eilmer was in the middle of group of intellectuals that motivated him to explore and push the boundaries of common knowledge. It is not known if he was trying to push the limits of his theological beliefs or if he was trying to copy the flight of the Jackdaws that constantly swoop around the Abbey. The interesting thing about Jackdaws is that they are noted for their gliding characteristics. Jackdaws have been tested in wind tunnels and it has been found that they have a maximum L/D ratio of 12:6 (Rosen & Hedenstrom, 2001). If Brother Eilmer based his glider on the wings of the Jackdaw, then he was using a pretty good model to start from.

Malmsbury is notorious for strong updrafts, gusty winds, and a damp, moisture-laden cold air, especially in late winter (Hallion, 2003). Strong winds would be essential to glider flight because wind itself is a major source of propulsion for the glider. Glider pilots that are shooting for best range will try to maximize their performance by using the winds to their advantage. Cold air is more conducive to flight because it is denser. An increase in density equates to more mass, and more mass in the airflow over the wings creates more lift for the aircraft (FAA, Glider Flying Handbook, 2013). Flight would be very favorable in such conditions.

The original tower and walls of Malmsbury Abbey do not stand today. They were rebuilt about two hundred years after, but most historians agree that the walls are close to the original height (Woosnam, Max Woosman, 1988). Today, the tower is exactly 150 ft. above ground level, and is very formidable from the top looking down. Assuming it was within even 50ft of the original height, he would have surely died if he did not have a decent glider. From William of Malmsbury's accounts, it is known that he covered a furlong (600) feet; so he would have had to maintain a relatively stable glide in order to survive. Richard Hallion took this a step further in *Taking Flight.* He calculated that the glide ratio would have had to have been around 4:1(four feet forward for every one feet of descent) (Hallion, 2003). He is said to have panicked towards the end of the glide as he tried to land. He over manipulated his wings and destroyed his lift. Perhaps it was not true soaring flight, but it was a stable descent up until that point. He crash landed, but he did live. His legs were crippled in the crash, but he was so determined to fly that he continued trying until the Bishop of the Abbey forced him to stop in interest of his safety. Eilmer gave some insight on his crash and acknowledged that the reason his flight failed was because he neglected to attach a tail to his craft for stability (Malmsbury, 1998). It is interesting to note that modern aviation forefather such as Otto Lilienthal and the Wright Brothers refrained from including tails in their initial attempts at creating gliders (White Jr., Eilmer of Malmesbury, an Eleventh Century Aviator: A Case Study of Technological Innovation, Its Context and Tradition, 1961).

There is considerable evidence that Brother Eilmer did indeed fly. There are just a few complications regarding the story. First, no one knows what his contraption looked like. It is unlikely that it had and engine because of lack of technology and means. It is also unlikely that it was a hot air balloon even though they were used at the time for military signaling because it is reported that his device had wings (Hallion, 2003). He most likely formed it after the Jackdaw bird that called the Abbey home. However, if his device flapped like the bird he would have failed like so many before him. Therefore, it can be concluded that the wings had to be long and rigid, stable enough to withstand the lift forces and maintain a steady glide. He might have originally intended for it to flap, but the wings had to have locked into place somehow.

The second problem with validity of the story is the original landing of Eilmer. Today there is a place in Malmsbury known as "Oliver's Lane" It is close to present-day High Street , about 200 meters (660 ft.) from the abbey. The late historian Max Woosnam has stated that it is a steep hill off to the southwest of the abbey is more probable (Woosnam, Eilmer, 11th century monk of Malmesbury: the flight and the comet: a recent investigation, 1986). Either way, when the distance (660ft) is calculated along with the height of the tower, the total flight time comes out to be around 15 seconds (Hallion, 2003).

Richard Hallion has surmised that device was most likely constructed of constructed of ash or willow-wand, covered with a light cloth, and somehow attached to pivots on either side of a back-brace, with hand-holds so he could attempt to flap them (Hallion, 2003). It is lucky for Eilmer that the wings locked, or else he would have most likely suffered a fatal crash. Ash is known to be a tough and durable hard wood, while willow wood is more known for its light weight properties and its stem flexibility (White Willow, 2015). It is reasonable to conclude that he used the Ash for his main support beams while using the Willow for the overall curvature and shape of the wings. As for light weight cloth, it can be guessed that he used that it was some type of wool, cotton or linen cloth. Silk might have been the best choice, but it was not manufactured in large quantities in Europe until around the 16th century (Cohen, 2015). Given the organic qualities of his materials, the remains of his crashed glider have most likely long since rotted away. Today historians have to guess at what the original craft looked like. The flight of Brother Eilmer has been a point of pride for the town of Malmsbury, and there have been several stage recreations of the flight over the years using a support cable. One such recreation is shown in *Figure 5*.

Figure 5 depicts a historical reenactment of Brother Eilmer's flight in 1962 with the use of cables.

There is a considerable amount of historical evidence that both Leonardo Da Vinci and Brother Eilmer were successful in discovering flight. They used light weight common materials, based their designs on flight in nature, and used their ingenuity to make machines that would be successful. Leonardo Da Vinci seems to have had a better grip on the overall aerodynamics of flight, while Brother Eilmer seems to have had that urge to live life on the edge that aviators today still carry. Modern historians recognize that both men existed. However, it does not seem to give credit where credit is due.

Considering all the previous information, it is highly plausible that Leonardo Da Vinci and Brother Eilmer could have achieved flight hundreds of years before the first historically acknowledged glider test pilots like Sir George Cayley and Otto Lilienthal. This project will attempt to prove that Leonardo and Brother Eilmer did indeed succeed.

Building Process

1. First develop a plan and draw a schematic of the design.

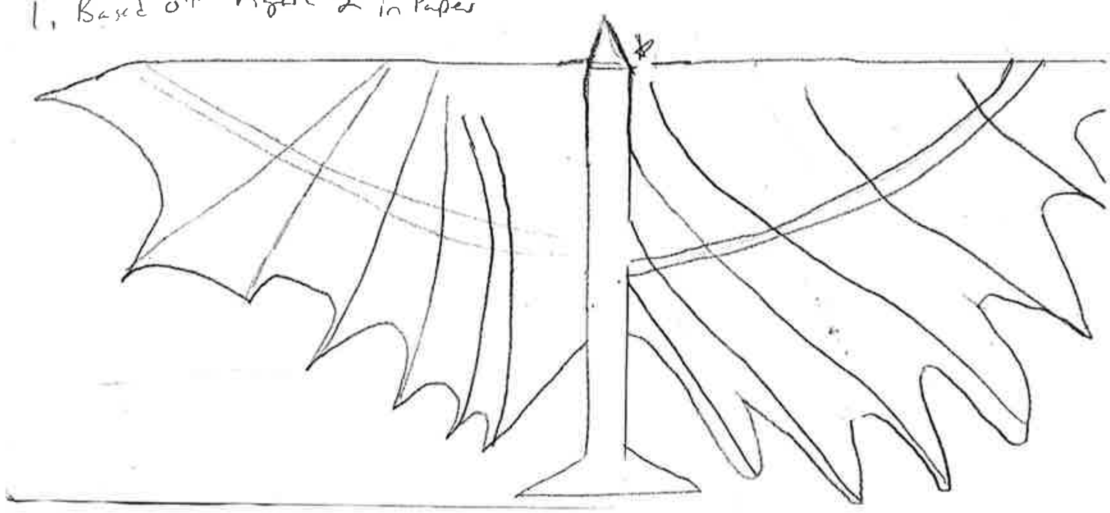
Plan A

1. Build glider with one 25" wing.
2. Fuselage at 8", divide into 2 wings, but don't seperate wings.
3. add ribs and spars - shape as needed w/ boiling water or acetone.
4. carefully build tail, use straight edge to put at 45° angle
5. glue cloth on last
6. cut excess cloth + sand wood where needed

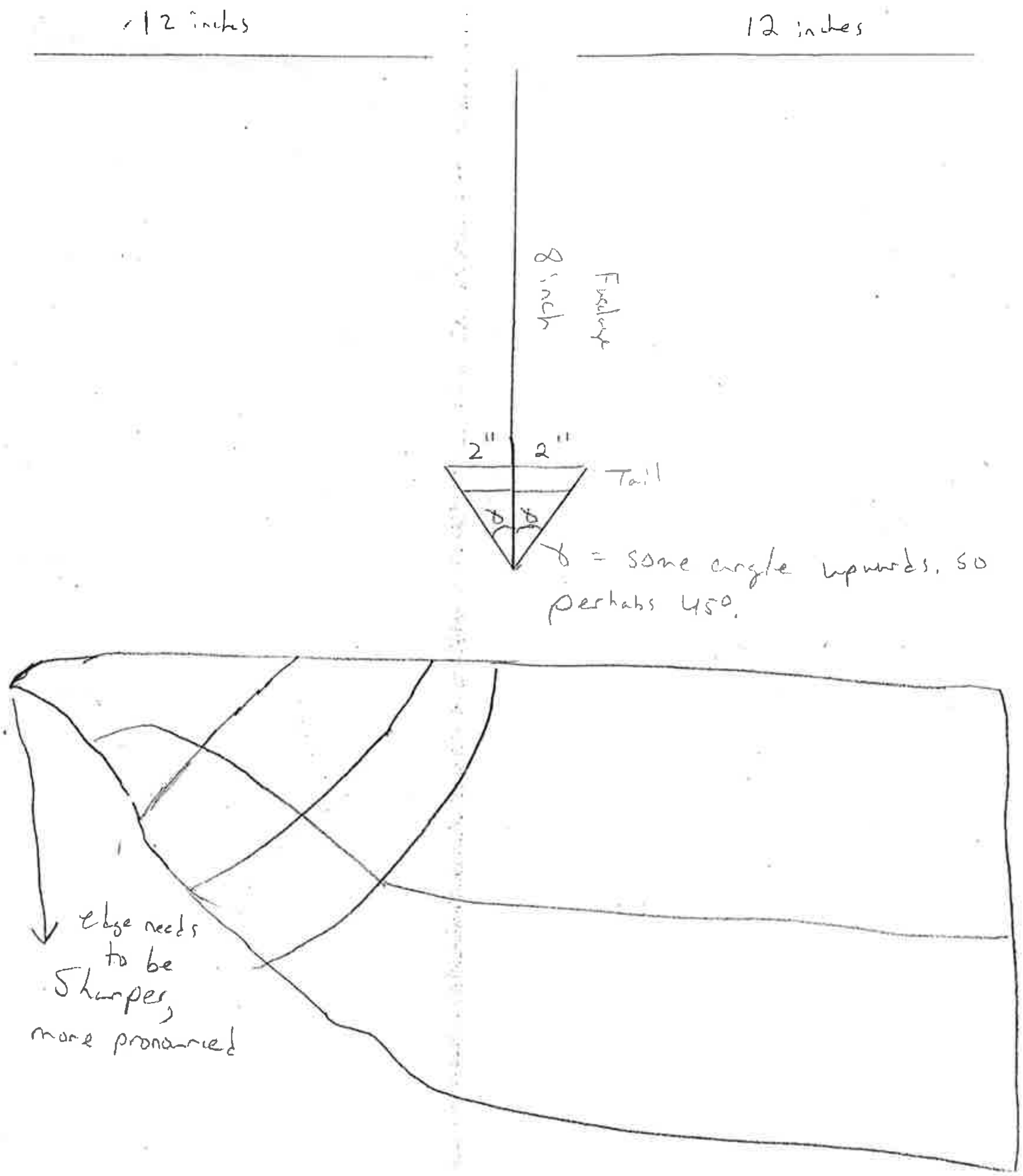
Plan B

★ - in most of the drawings, the wings are not attached, as Leonardo h the intention of flapping forward rather than gliding. In all the recreations I have se the wings have been attached in the interest of gliding so we will attach t.

1. Based of figure 2 in Paper



2. Make a schematic that has the measurements you are planning on using. It is easier to understand what you are going to do if you can see it first.



3. Go and get materials. I chose Hobby Lobby and Walmart as my suppliers. I bought some of the materials, but I was also able to find a few tools out of my own storage. the following: 1. 1 exacto precision cutting knife for cutting and car-9.99

2. 2 ¼ inch wide, 3 ft wooden Dowel rods-2.00

3. One bag of Balsa wood assorted pieces-8.99

4. 1 16oz bottle of acetone (nail polish remover)-3.99

5. 24 clothespins- 3.99

6. 4 white handkerchiefs- 4.15

7. Sanding paper(fine grade) -1.67

8. 1 bottle of Gorilla Wood Glue-4.99

9. 2 bag of 12 inch long, 1/8 inch wide dowell rods-3.99

10. 1 unit of Scotch Tape

11. Cloth cutting Scissors- found in roommates first aid kit

12. Wood Cutting scissors- borrowed from neighbor, can be found at Walmart

13. 1 level- borrowed from neighbor, can also be found at walmart

14. 1 hair dryer

15. 1 empty wine bottle

16. 1 empty coke bottle

17. Rubber bands

18. multiple Q tips and cotton balls

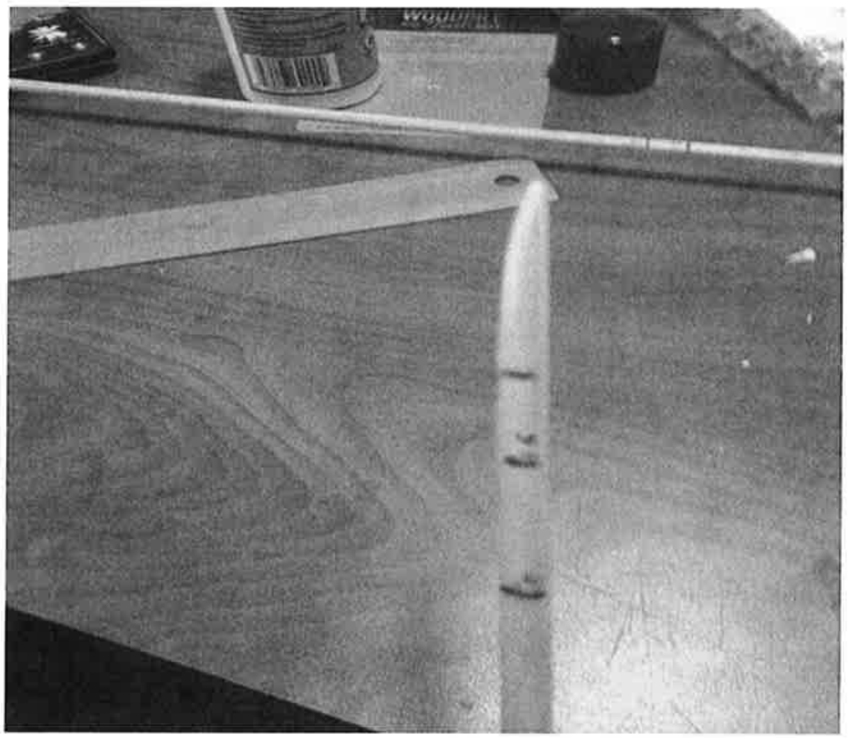
19. 1 towel

20. 1 pot

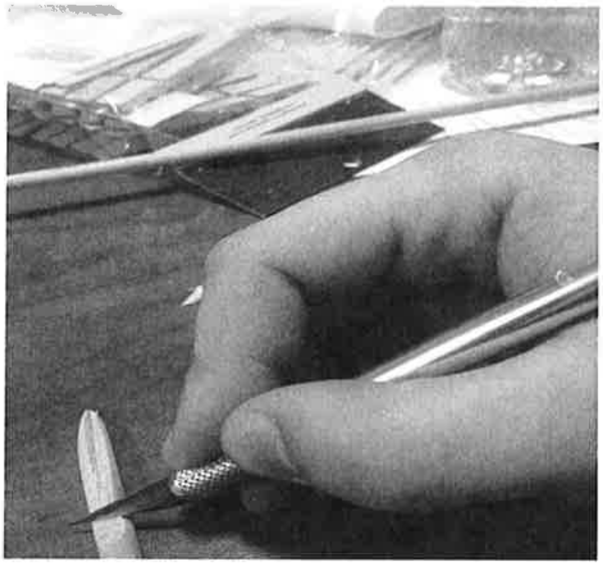
21. Oven mitts

Comment on materials- I thought it would be a good idea to buy excess materials in case of the gliders broke during testing and I needed to repair. I just opened things as I needed them, so I will be returning a few items at the end of the project in order to save some money. Another key to saving money is using scrap pieces where you can and making full use of all materials. I think all in all the materials cost around forty bucks, which is considerably expensive.

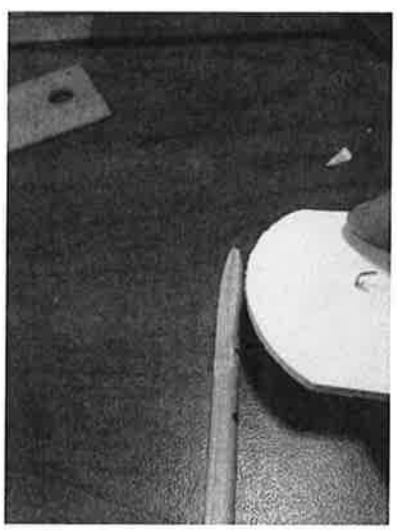
Steps from Building Process- Da Vinci Glider



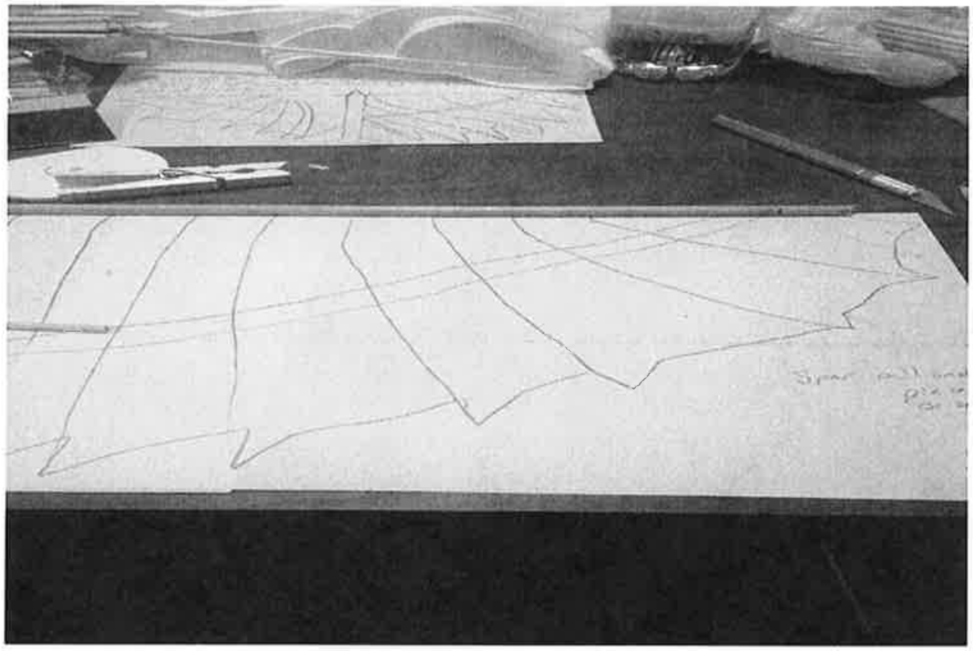
First, I marked 24” on the ¼” wide 36” long dowell rod. I then cut it with the exacto knife. After I cut the wing, I then used the remaining 12” for my fuselage. I made the end that I just cut my nose and I made a flat spot in the wood where I wanted the wings and fuselage to meet with my exacto knife. It made it a tighter fit and inherently more stable.

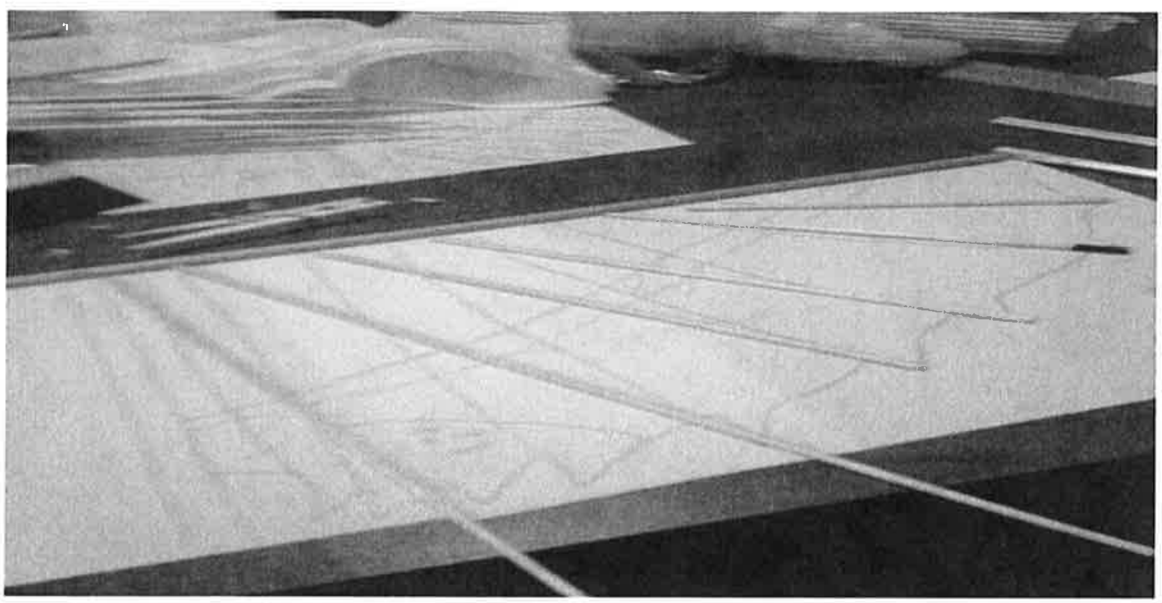


Cutting with the exacto knife- Be careful and hold it correctly, or you could easily cut your finger. The blade is basically an open razor blade so it is kind of dangerous. It is effective for precise cuts and marking your place. My advice- This knife did not work well for the first glider, but the wood was thicker on the first glider. It worked great on the second glider. If you are cutting thin pieces of wood, this knife is vital to the project.



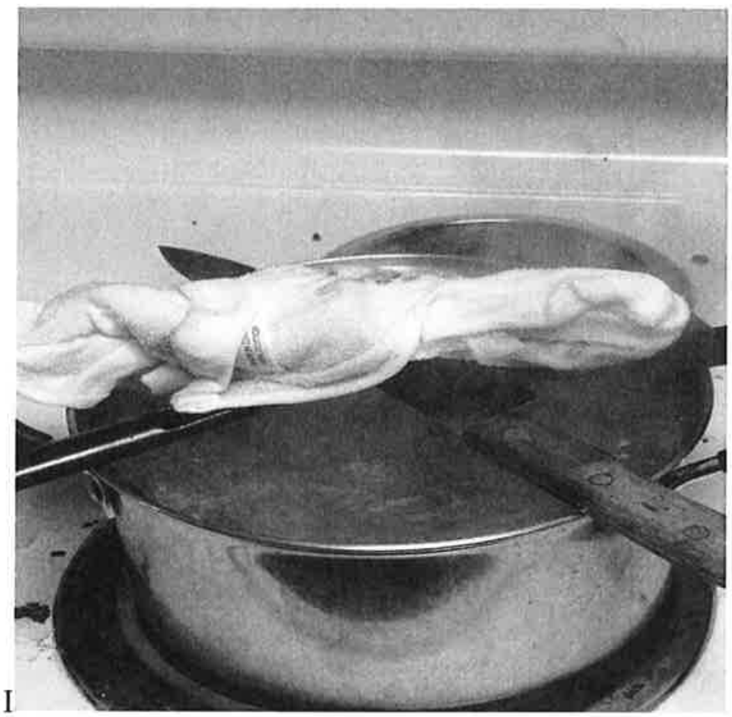
Sanding- I sanded the nose down smoothly because I wanted smooth airflow over the leading point on the aircraft. I used a fine grade sanding paper and it worked great regardless of wood thickness.





Layout- After I cut the wing, I put a put a few pieces of paper under the profile. I drew a rough sketch of what I expected it to look like. I then started placing my spars down close to the spaces they belonged and started making my cut marks with a pencil. I then used the exacto knife to cut each 1/8 " dowell rod into the right length. I sanded the ends afterward to make sure they were not too rough. After I cut the pieces for the right wing, I measured the left wings spars based on the ones I just cut. If you base your cuts off the ones you just made, the wings should be uniform. My advice- Use woodcutting scissors for this. The exacto knife was not big enough to cut the wood very well, making work dangerous and tedious. Be patient and do not throw away any scraps. It is possible that you could use some pieces on the opposite wing.

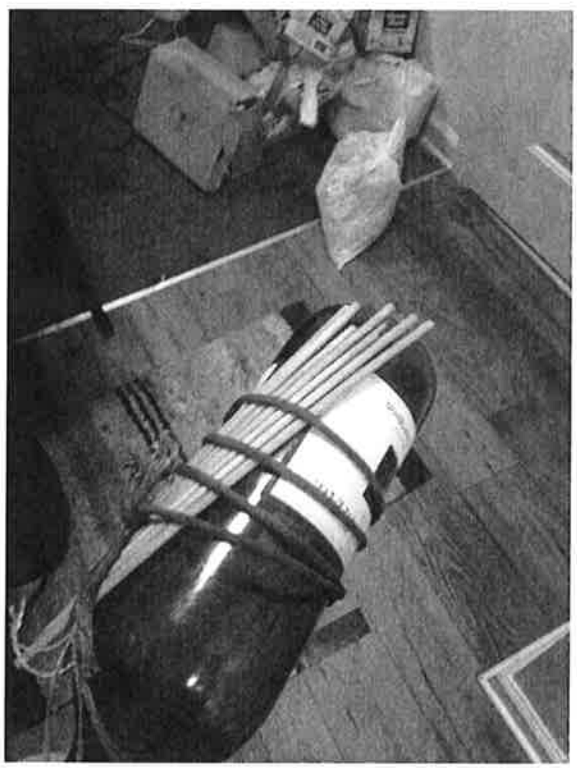
Boiling-Initially, boiling water from the sink seemed like the easiest option for curving the wood. I wanted to do something that was efficient, but I also did not want to mess with the chemicals of acetone until I absolutely had to. I turned the burner up to high and let it sit for 10 mins. After that, I tested to see if it was flexible or not. I broke the first piece I pulled out, so I put the wood back in there for 20 more mins to see if it would help. After 30 mins, the wood was much more flexible. However, it did not meet my standards so I decided to attack with a different plan. My Advice-Rotate the ends of the wood periodically to make sure both sides are getting boiled. Secondly, boil in a well ventilated area and avoid breathing it directly for safety. The wood puts off an odor, but it is not too bad. Use oven mitts or cooking tongs to remove wood from pot.



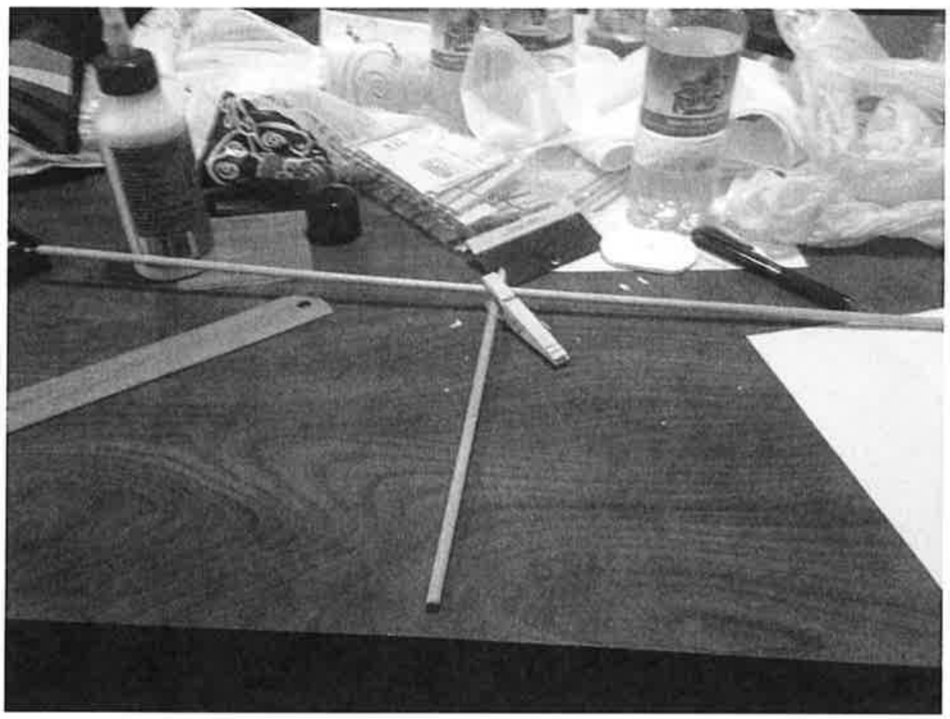
I

Steaming-Boiling did not seem to go well at first. So then I decided to steam the wood by wrapping it in a wet cloth and raising it over the pot. Looking back, it was a pretty dumb move. Steaming will make wood more flexible, but I should have steamed it in an enclosed container for real results.

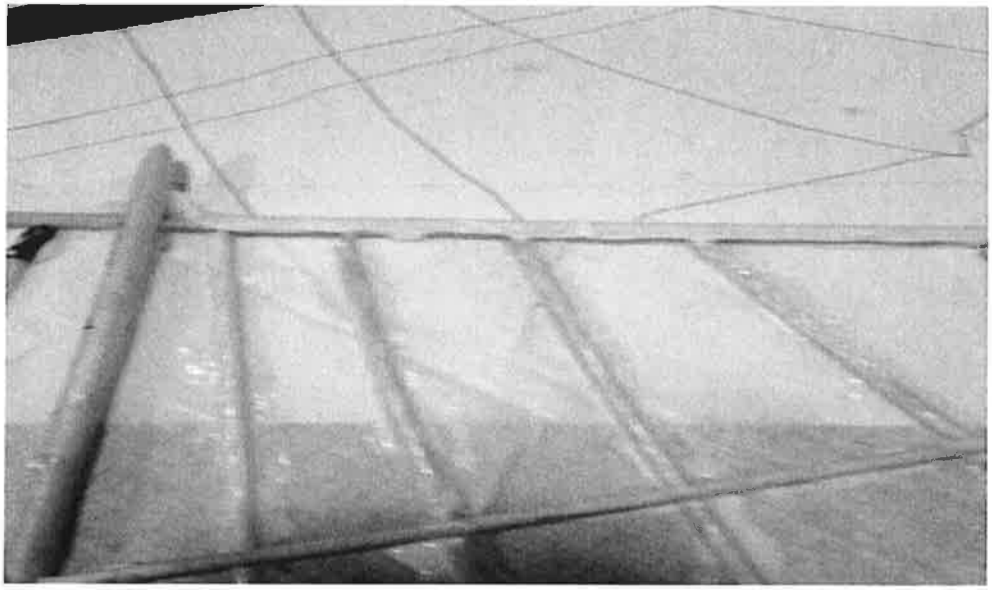
Chemicals- I read that acetone(nail polish remover would weaken the wood online so I figured I would try it. I let one scrap piece soak for about an hour, but it did not seem like the chemical affected it much. I think it would work if using pure balsa and if the wood had been soaking in it for days. My advice- Soak in a well ventilated area and mind the warnings on the label. I mixed my acetone 50/50 with water, if I was doing it again I might mix it 70(acetone)/30 to further influence the wood.

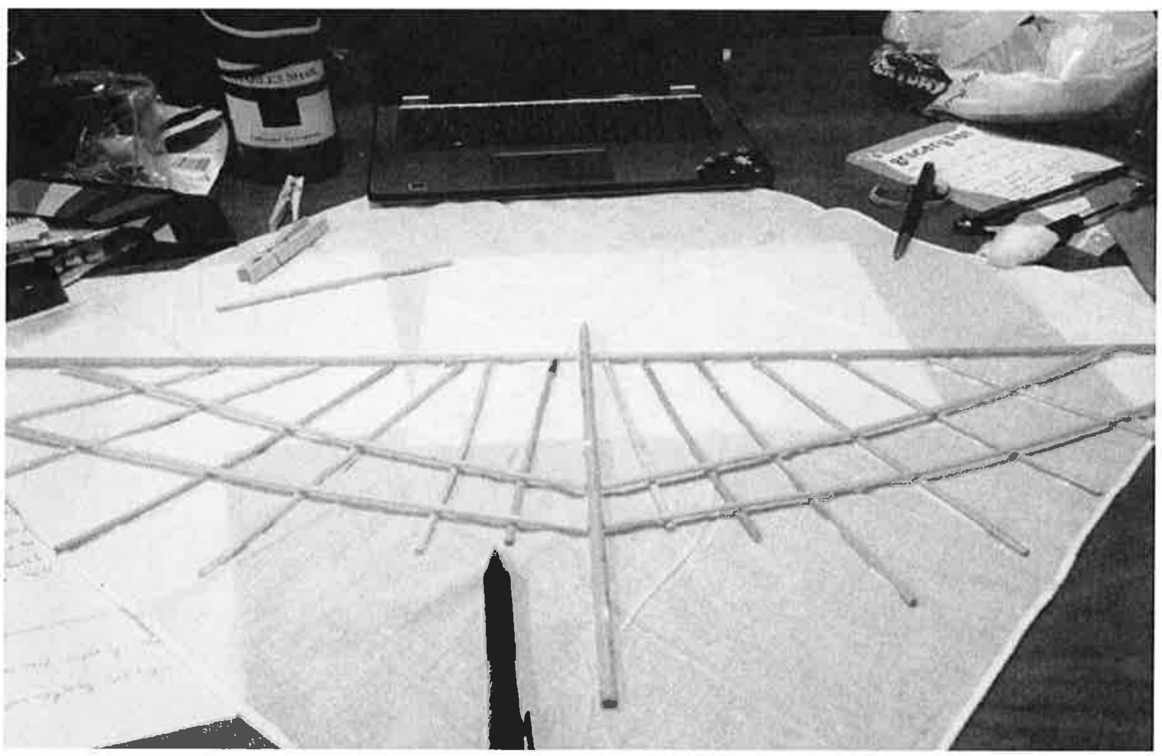


After the wood was through boiling and steaming, I curved it by pressing it against the curve of an empty wine bottle. I held it in place with shoe strings initially, but then I added rubber bands to make sure the wood was tight against the bottle's form. Let the wood sit until it dries. It is important to wait until it dries because if you do not, the wood will try to bow and the glue will not sit right. My advice- Use whatever size bottle you need to get the right shape. Use lots of rubber bands and let it sit 5 mins longer than you think. Be very careful when you initially press it against the bottle because the wood could break.



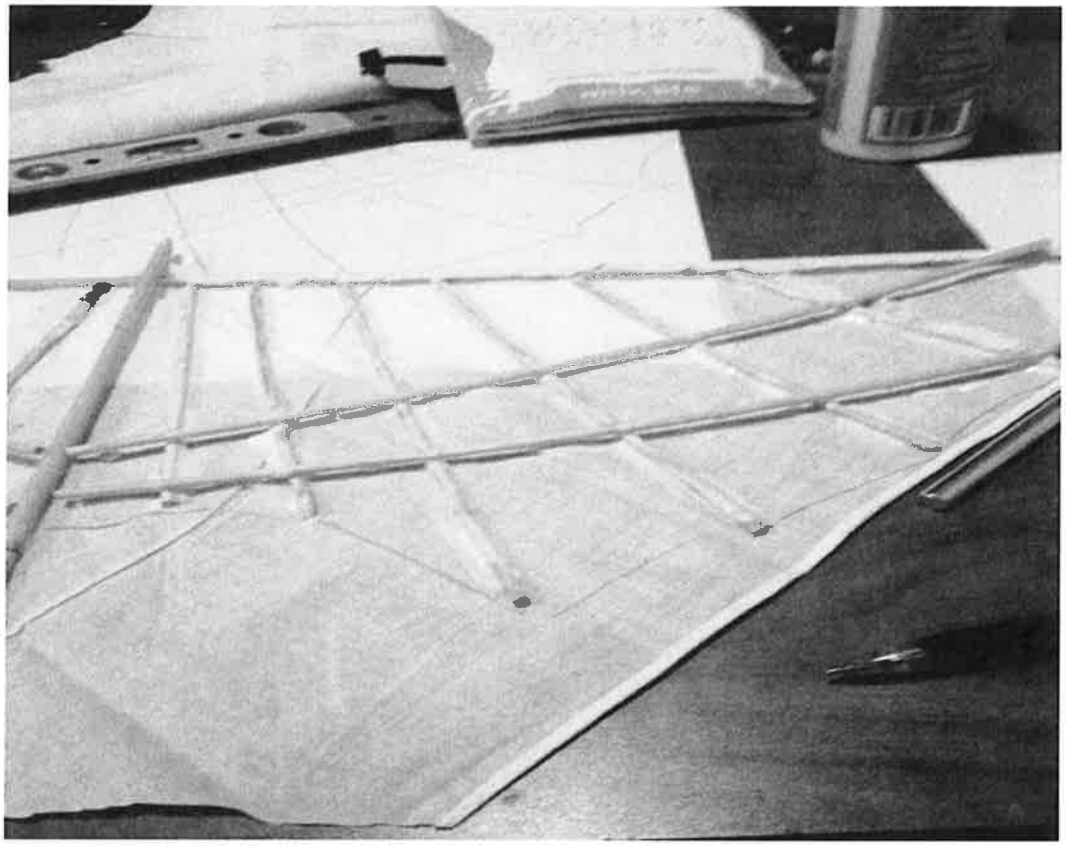
Gluing- While the spars were being bent, I glued the wing to the fuselage. I used a clothesline pin to hold it in place as it was drying. The glue container label suggest allowing 24 hours for the glue to set. I decided to let the wood set until the spars were dry and then moved forward with construction. My advice- Be careful with the clothesline pins. Sometimes excess glue would end up sticking the pin to the glider and it was a dicey situation trying to break the pin off without breaking the glider.

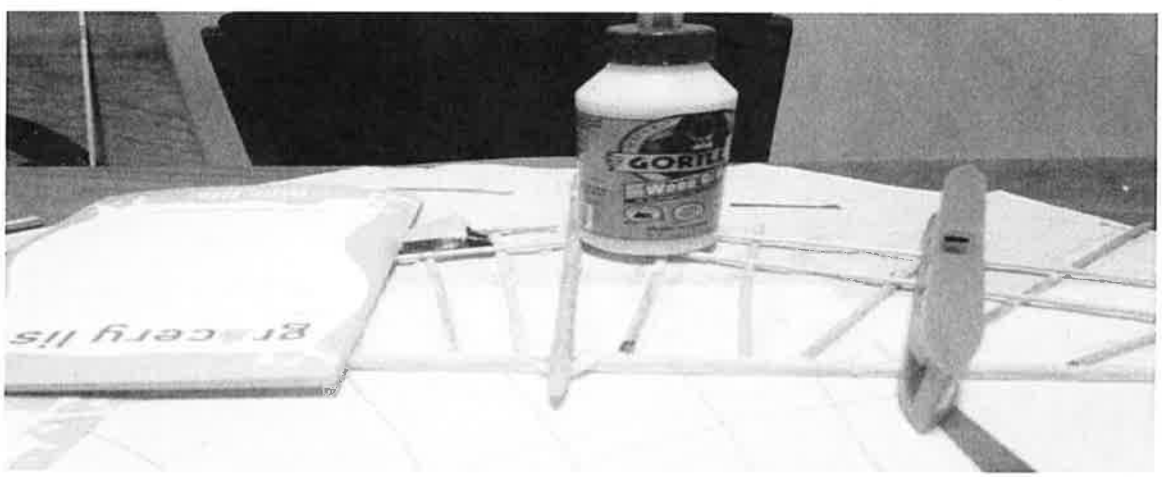




Gluing the wings- I placed the handkerchief on the table. Next I put the wing and the fuselage on. I then added my spars and ribs as planned and began gluing. I let this sit for 24 hours and then I cut the cloth to the shape I wanted with the cloth shears.

My advice- Place a flat towel under the cloth. The handkerchief was very thin, and some glue did seep through and almost glued my glider to the table.





Setting- Put some kind of weight on the spars and ribs so that they do not bow out of shape in the gluing process. Put it somewhere safe to dry.

Notes from first glider

Successes

1. Overall design and drawing worked pretty well considering lack of artistic talent.
2. Making a model with preplanned measurement seemed to be better than just eyeballing it as I went.

Failures

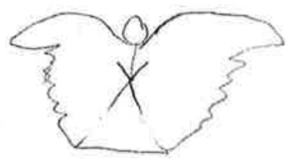
1. I completely botched curving the wood. I used the right techniques, but the wood I used was too thick in order for it to work on the short timeline I had. Boiling water worked to a degree, but need to use the right type of wood for it to work properly. I will build the next glider with thinner balsa wood. It will curve better and have more camber, but it will likely be weaker.
2. Cloth was nice and thin for flight, but wood glue seeped through the cloth and almost glued it to the table.

Brother Eilmers Glider model- The following pages are my initial notes and sketches of Brother Eilmers glider. I did some research on the Western Jackdaw since it is thought that that is the bird he used for the design. It is hard to read my first notes because of the bad scan, but the major idea on this glider was more camber, shorter and wider wings, and thinner wood. This glider was much easier to build because of the experience I gained on the first one. The one element that I left out of both gliders was the pilot aspect. The pilot lays at some point on the fuselage and it effects the center of gravity (cg) for the aircraft. The cg effects the stability dramatically, however it is impossible to know what the original were. I may play with it during testing to see if I get different results.

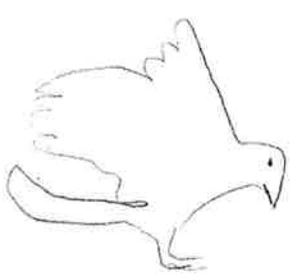
Sheet #2 Brother Ellmer 1010 AD.

dea - the thought process for this glider is a little ifferent. We know that Brother Ellmer was an educated man; however, it is doubtful he was as precise as Leonardo. I think Brother Ellmer's glider would have been a bit -ore crude and rudimentary. I think it would have look oughly similar to the Jackdaw's wing, however it couldn ve had very long wings or he wouldn't have been able to ft it by himself and carry it up the tower for launch. ssuming he launched by himself!) I think it might have een similar to this.

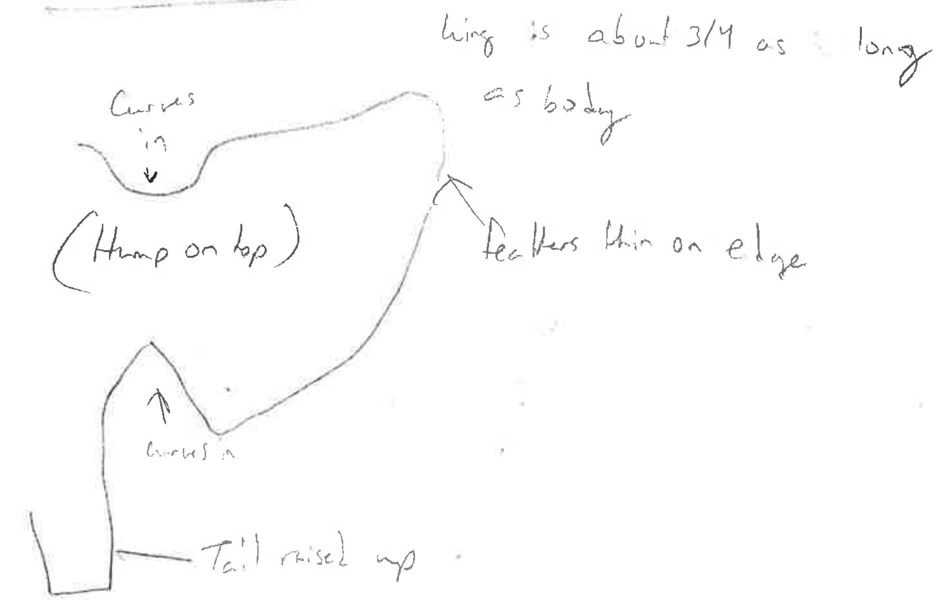
Early Concept Drawings



rom Youtube video) Western Jackdaw



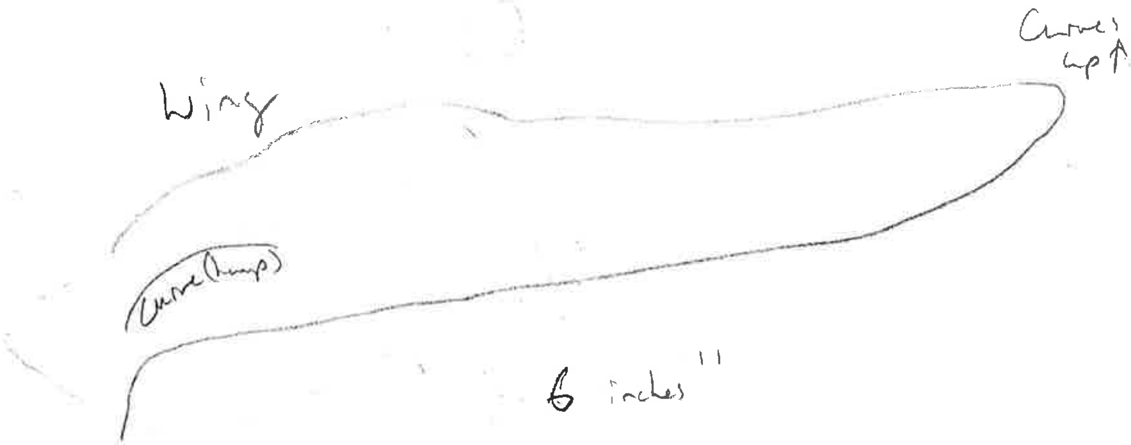
Wing description

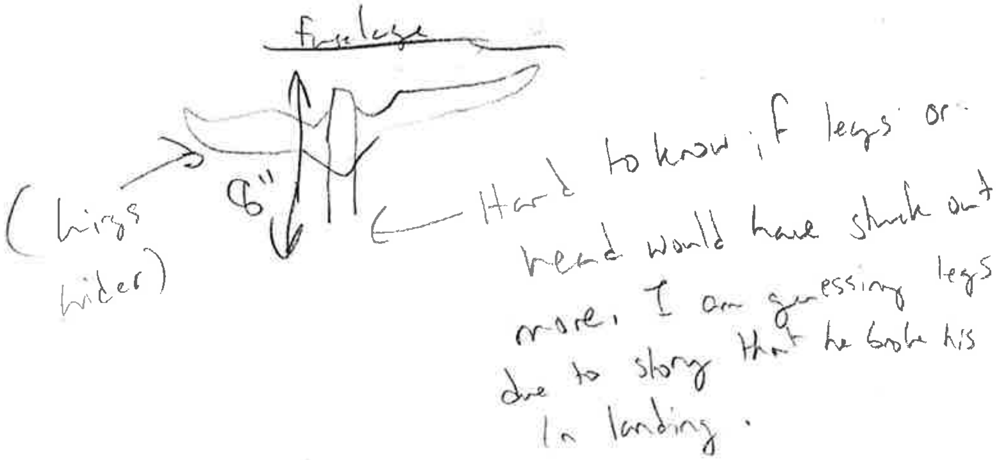


In glide - wings stay locked flat, in q
Short flight, or hops wings move fast.

I would say wings are 3/4 as long as body

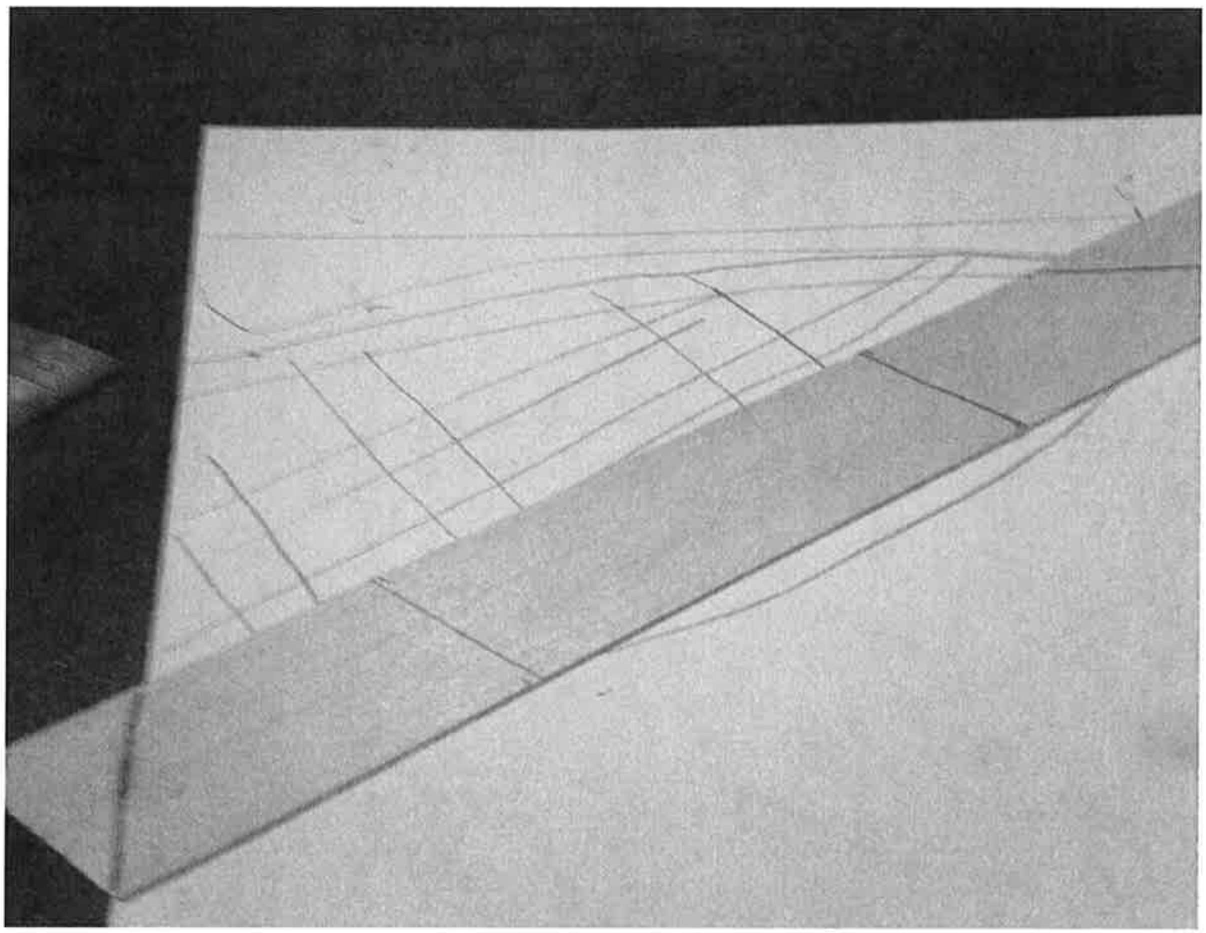
Assuming Brother Eilmer was around 5ft tall, the fuselage will be 8" (Inches). If wings are assumed to be 3/4 as long as fuselage (b/c of Jackdaw Shape), this means wings are 6" at longest point. The wings will be short + fat. There is hump, or camber in the wing right where it attaches to fuselage. This may be hardest part to replicate.

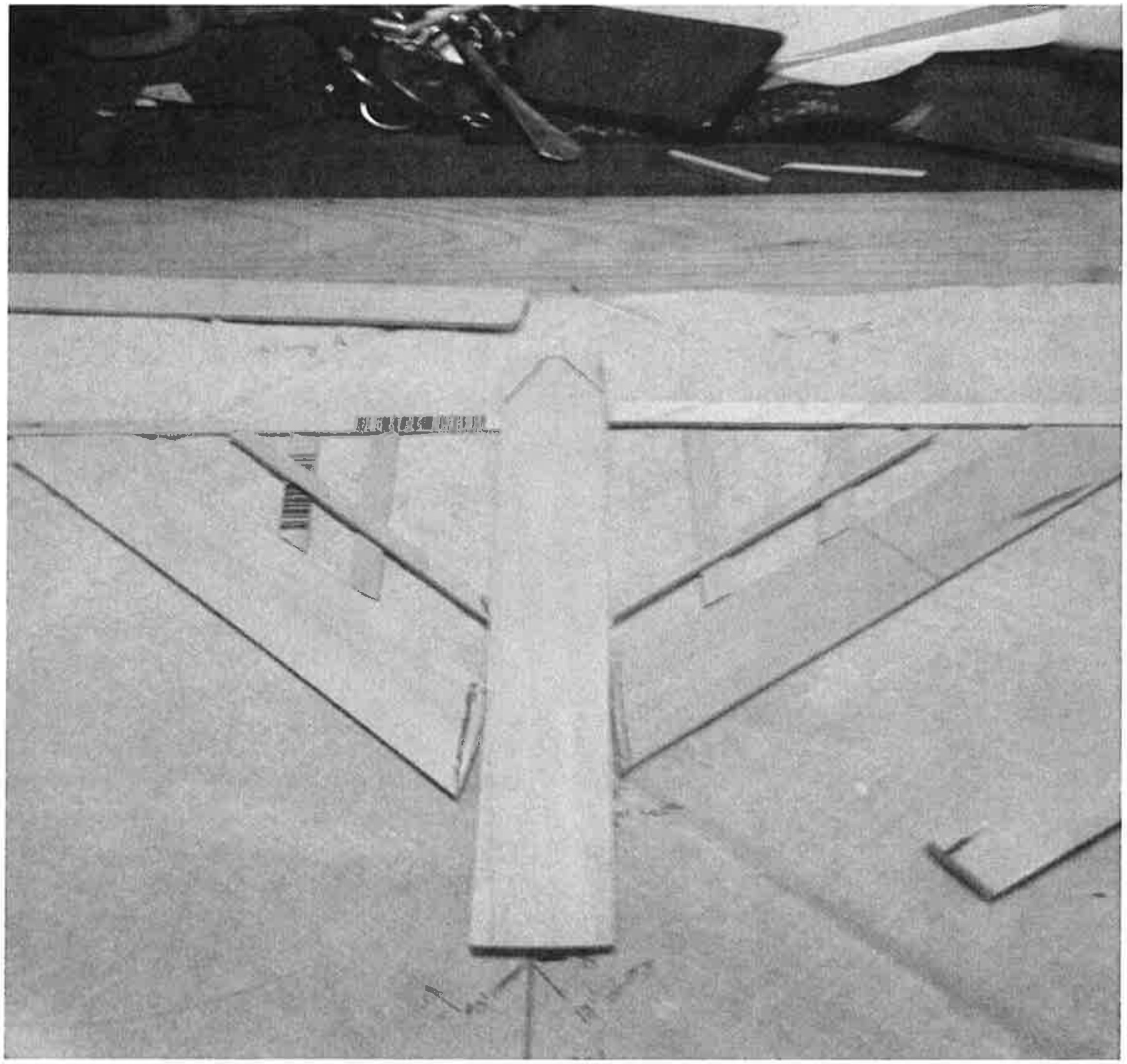




Building Process

I repeated most of the same steps from the first glider. I decided to use balsa wood from the assorted bag because it was easier to shape and cut. I determined that this glider should be significantly smaller because the first one was too big. I knew the wings would need to be boiled in order to get that initial curve shape, so I went ahead and put them in the pot. While they were cooking, I made my measurements for the fuselage, spars, and the ribs. In this photo, I was making the rough drawing and marking my cut marks for the main spar.

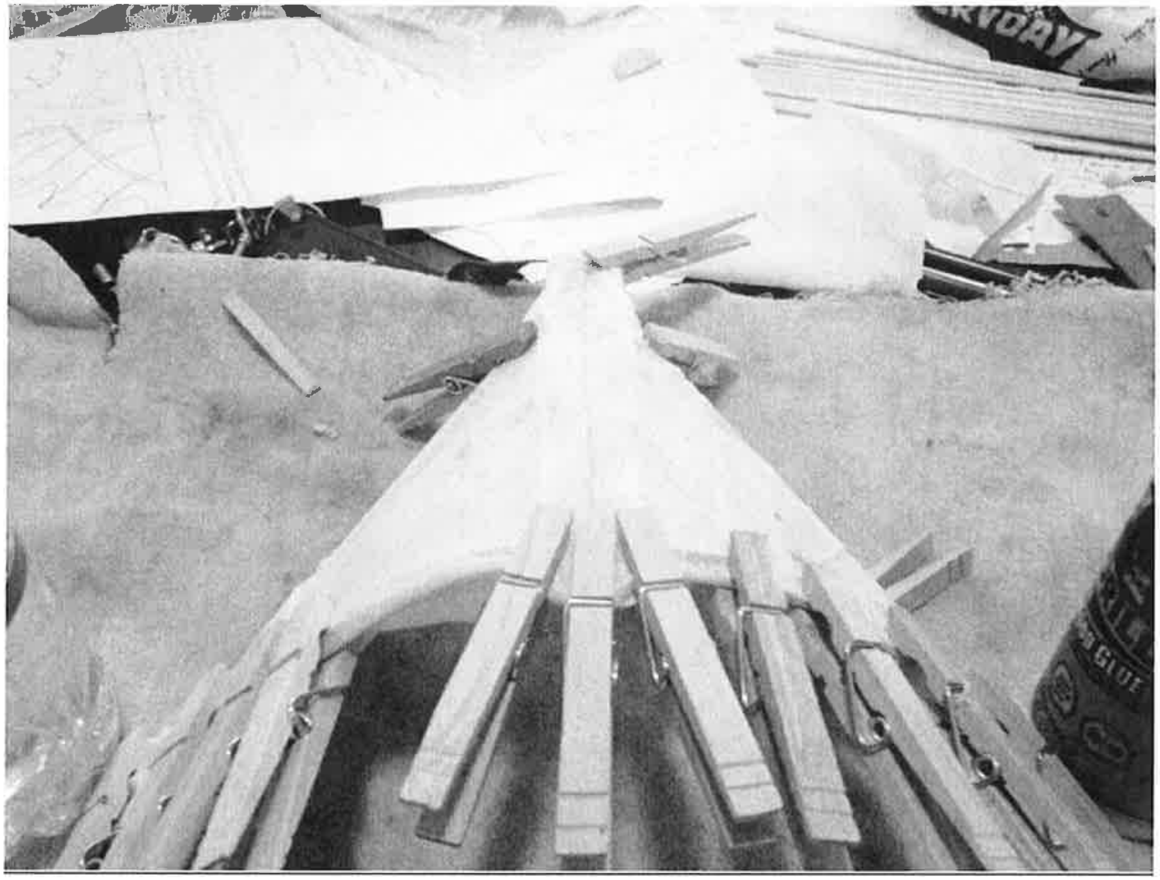




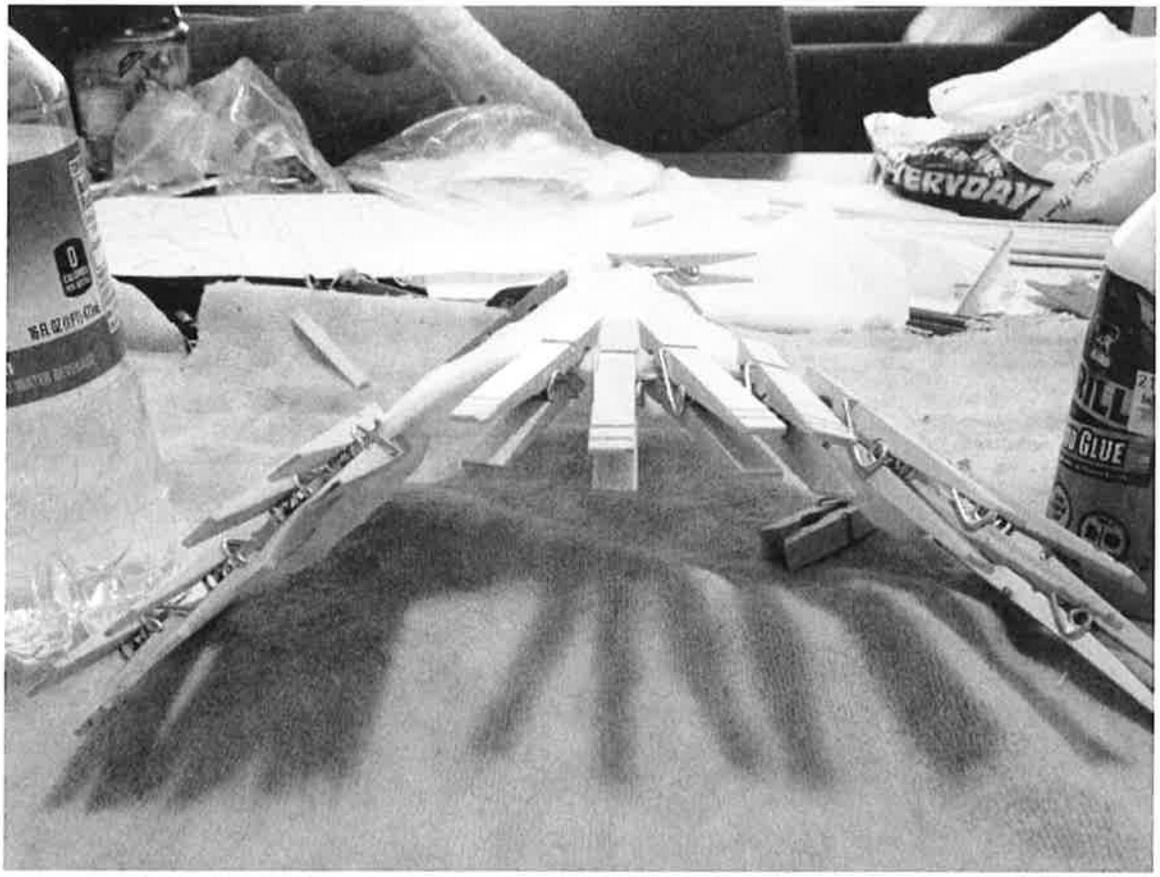
Layout- I made measurement marks on the cloth this time around to get a better idea of where everything would sit. I decided that the tail should be longer than the nose because of the story of Brother Eilmer breaking his legs. Perhaps his legs were exposed in the craft. If it does not fly this way, I can always flip it around and fly it the opposite way. Again, it is really hard to guess what the center of gravity would have been. I cut the nose and the tail into a sharper shape and smoothed it out with the sanding pad.

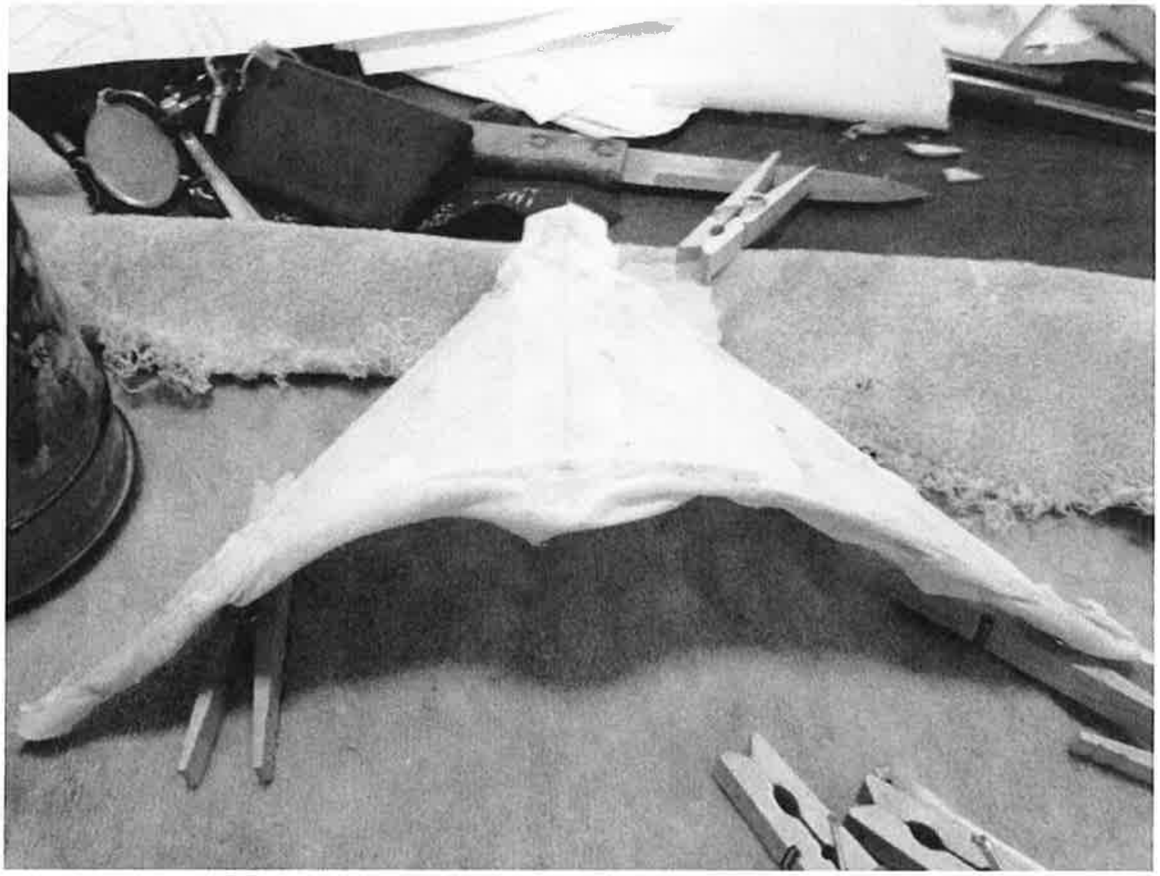
Curving- I boiled the thinner wood and had drastically better results. I then used a coke bottle to curve the wood. I used rubber bands to hold it on place and I used the peanut butter jar to keep the straight end flat. I used the hair dryer to speed up the drying process.

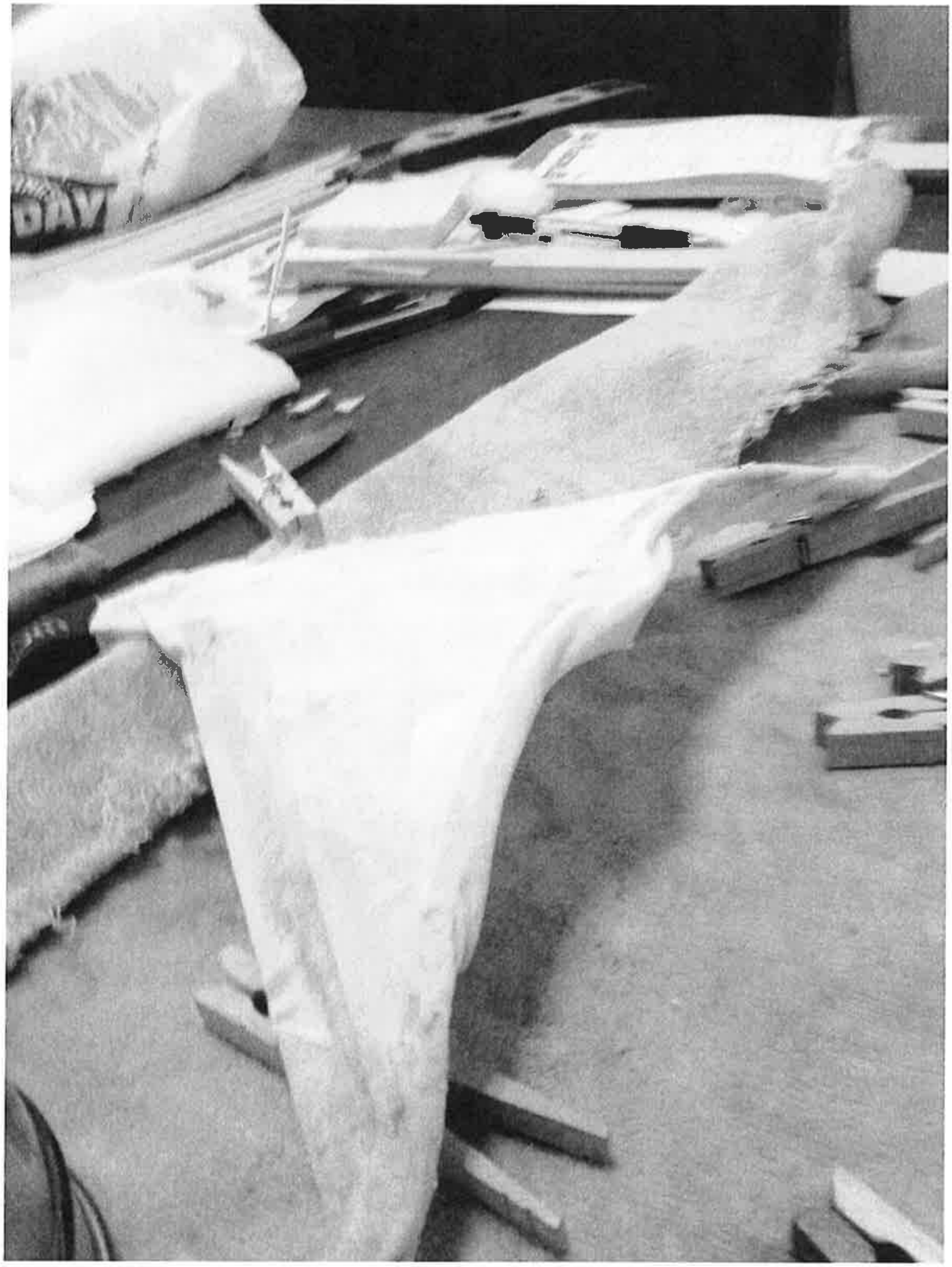
Gluing- Again the clothespin was very useful in keeping it set while the glue dried. This glider was harder to glue into place because of the shape of the wings. I covered this top portion with glue and flipped it onto the handkerchief skin. My advice- Use the Q tip and cotton swabs to take care of excess glue and try to make it precise as possible.



<u>Gluing the wings-</u> After I glued the spars and ribs into place, I put clothesline pins all over the glider and just let it set. My advice- Note that the glue is close to the right wing and a bottle of water is close to the left wing. I used them to position the wings in a curved up position until the glue dried. It worked pretty well. Also note the towel underneath. It made the cleanup process a lot easier and the glider did not stick to the table.







Testing

It is unfortunate that the life size glider built by Brother Eilmer and the models of Da Vinci (if they existed) are no longer here today. If so, they could be analyzed and flight tested in a wind tunnel by modern aviation engineers. Guesswork and interpretation can be used to recreate their gliders. I will attempt to recreate both using light weigh balsa wood, light cotton cloth, and wood together. I have decided that each glider should be limited to around 12 inches of overall length around 6 inches maximum for the width. Considering that Da Vinci used bat wings as a model, and Brother Eilmer most likely used Jackdaw wings, it can be deduced that Da Vinci's wings were longer and wider. Conversely, Eilmers were probably a shorter in length and wider in camber.

Test-

I decided to test the gliders on March 29, 2015 at the side of the Mcfarland building that faces the dorm parking lots for Jim Cummings Hall. It had a 9 ft. brick wall on one side for reference, and the ground was relatively level and flat, and the ground was also covered in grass so it was a soft landing spot for my gliders. The wind was blowing out of the South at 180 at 15kts with gusts up to 25 kts. according to the KBNA (Nashville Airport) terminal area forecast. Usually glideslope is calculated in still wind conditions, but the wind was blowing and it could not be stopped. I decided to throw my gliders into the wind, for a maximum headwind. Headwind creates more lift than a tailwind, so I was trying to take advantage of the conditions. The weather was sunny and clear, and the temperature was around 60 degrees. It was a great day to test. The gusting winds compromised a few throws, but that may be due to thrower technique as well. I planned my test as follows.

1. Glider efficiency is based on the glide slope ratio. The glide slope ratio is calculated by using the following formula.

Glide Ratio = Horizontal Distance divided by the Change in Altitude

2. I used my height as the reference for altitude because my arm was level with my head at the starting point. I am 6ft. tall, so I divided each distance by 6ft.

3. 10 regular head height throws, measuring maximum height (at its highest point) minus the origin point (I am 6ft tall so I subtracted 72 inches from each maximum height) and maximum distance (the distance from the place I threw it to place where it touched the ground first).

4. 1 hard throw each glider- It is assumed that both Leonardo and Brother Eilmer did not have a launching mechanism, but what if they did? I brought my roommate from MTSU, Tyler Grundy, in to throw these.

5. One test without the tail for Leonardo- There was never a tail mentioned in his drawings, but most modern recreations have included one. I decided to break the tail off after the initial tests and the hard throw and just tried it. - It was unsuccessful.

6. Two backwards throws Brother Eilmer. His glider resembles a backwards jet fighter to me, so I decided to throw it backwards and see if there was any aerodynamic difference. The glider basically just fell straight to the ground backwards. If it resembles the original at all, it definitely flew forwards.

7. Tyler Grundy videotaped the experiment on his iPad and I uploaded it onto YouTube afterwards. We decided to tape the experiment at an angle because it captured the entire scene better.

8. If any repairs were needed I would use tape for a quick fix- The gliders held up reasonably well. I did not have to make any repairs. I did glue the tail back on later after I intentionally broke it off.

Test Results-

The first two columns are the results from the Da Vinci Glider. The last two are from the Brother Eilmer Glider.

Hgt(ft)	X distance ft	hgt(ft)	X distanc ft
3	12	4	13.5
4	10	4	12.75
0	5	5	14.75
0	9.8333	5	14.5
0	3	6	13.75
5.583	11.666	2.833	11.166
8	9	5	13.5833
6	14	4.5	13.5
8	9	2	6

General Synopsis

The Da Vinci glider flew very poorly, while the Brother Eilmer glider seemed to shine. Neither glider really had a stable glide. Both got tossed around by the wind and did not have much control. However, the Brother Eilmer glider performed consistently and it performed consistently well. I made a ratio of maximum height (Length) versus maximum distance. This ratio is the L/D ratio. The average L/D ratio from 10 throws of Da Vinci was 1.508. The average L/D ratio from 10 throws with Brother Eilmer was 2.167. The hard throw glideslope average was 0.833 for Da Vinci, and 3.458 for Brother Eilmer conversely. To put everything in perspective, MTSU's DA-20 airplane has a glide ratio of 14:1. The Cessna 150, another two-seat trainer airplane, has an average glide ratio of 7:1. The glide ratios of the recreation gliders are nowhere close to the industry standard today. I did not record the throw without a tail for Da Vinci or the backwards throws for Brother Eilmer because both basically did nothing.

If my gliders are in any way accurate, the Brother Eilmer glider has a greater probability of flying than the Da Vinci glider. I think some of the biggest factors that contribute to this are design error, thrower technique, not accounting for the aviator's weight, and the gusty winds. Regardless, the experiment was conducted and the results stand as they are.

Conclusion

In conclusion, if the recreation gliders are similar to the original design, it is highly unlikely that either one of the ancient astronauts gliders would have been successful. Neither one of the recreation gliders had a very stable glide path. The Brother Eilmer glider was much more consistent than the Da Vinci glider, but it was still nowhere as efficient as most modern gliders. There are a few reasons for this.

First off, aviation technology has come a long way since impetus theory. Isaac Newton, Daniel Bernouli, and Albert Einstein changed the way people think about motion and fluid dynamics hundreds of years after both Brother Eilmer and Da Vinci were dead. The aviation industry has progressed to the point that aviation engineers have wind tunnels, NACA tested airfoils, and synthetic materials. The technological disadvantage is why modern historians do not give aviators like Leonardo and Brother Eilmer the credit they deserve. The lack of technology and means is the main argument against the possibility of success of the ancients.

Secondly, it is hard to replicate the exact conditions that would have existed for the original flights. The wind was gusty on test day, and the materials and designs that were used may not be as accurate as they could have been. The designs used for the experiment were based on drawings, other replications, and a little bit of guesswork. It is unfortunate that precise measurement records of the original aircrafts do not exist.

The factor of spontaneity also exists. Murphy's Law of anything that can go wrong will go wrong is real. Problems came up in building the recreation gliders and unconventional techniques were used to fix the problem and move forward. Most of the solutions that were found were based on my past personal experiences doing carpenter work. Leonardo and Brother Eilmer likely faced similar challenges in building and designing and there is no way to know what they might have used to absolve those problems.

It is difficult to recreate the weather they might have used. If they were basing their experiments on impetus theory, then it is conceivable that they would have used a windy day to "store up" all their energy before they sprang into flight. It is similar to positioning a device on a really high platform where it will have a high potential energy so that when moved it will carry a high a kinetic energy. Malmsbury Abbey is a windy, gusty place so it is probable that Brother Eilmer would have taken this into account. But there is also the chance that the aviators would have only flown on a clear sunny day. It is just hard to predict.

Finally, both Da Vinci and Brother Eilmer worked on their gliders for years, not months. They probably had gliders that did not fair very well in the beginning as well. As stated earlier, Da Vinci was constantly testing his ideas and trying to make his machines work. He even developed a scientific method for trying to solve the problem of flight. Eilmer may have not had any understanding of aeronautics, but he did use his own scientific process by studying the birds that called the abbey home. Both aviators spent countless hours honing their craft and zoning in on the problem of flight. They were both highly knowledgeable about what they were doing and they were both highly driven. Even though man has been successfully flying for years, it is possible that they had better solutions to certain problems than modern man. Their designs far surpassed any recreation attempts. It is much easier to design something from scratch than it is to recreate something that has been lost.

History has forgotten these inventors' contributions to the field of aviation. Neither man has been credited with the first glider flight. It is possible that neither man ever flew. Leonardo Da Vinci has plenty of drawings and schematics for drawings, but none claim that they were proven to be successful. Over half of his original designs have been lost, so there is still a small chance that there could have been proof at one time. The historical records of William of Malmsbury and Roger Bacon definitively prove that Brother Eilmer was a real person and some attempt at flight was made. Since Brother Eilmer lived to see Haley's comet twice, it would seem probable that Brother Eilmer had to survive his attempt at flight.

The recreation flight test that I executed proved two things. First, I am terrible at designing models. Second, it is much harder than it looks. It suggested that neither man flew, but it did not prove anything. The initial hypothesis that he was held back by both a lack of understanding and a lack of technology seems to have stood true. The other hypothesis about whether Brother Eilmer flew or not is an issue that will likely never be resolved. I think that the evidence is overwhelming that he did fly for over a furlong. He had as much ingenuity in 1010 A.D. as people do today in 2015. The technology might not have been there, but he figured out a way to make it work. Common people can accomplish incredible feats, regardless of the time period they are born in.

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