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Human Flying and Bamboo Fiber,
from the Aviation Pioneer to Contemporary Design

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Abstract

History tends to forget, but if man reached the sky, it was with the help of bamboo. From the legend of kite-flying people to the reality of man using kites to fly (Baden Powell, Cody, Hargrave).

Bamboo fiber is the material early adopted by the aviation pioneers: on the first airship (Renard and Krebs, Severo, Santos Dumont), on the first glider (Chanute, Lilienthal), on the trial of airplane (Ader, Ferber), on the first flying airplane (Whitehead, Santos Dumont), on the first airplane mass-produced (Santos-Dumont), on airplane panels (de Leon), on the first hand glider (Wills, Miller), and, on contemporary design (Abadie).

Introduction

« Or you make it strong and you are too heavy, or you make it light and you are too breakable. »
said Captain Ferdinand Ferber, one of aviation's pioneers. To resolve that crucial dilemma, on his way to build an airplane of the early days of the last century, he was using extensively bamboo. Light and strong, easy to manage with hand tools, the iron vegetable has been the favorite material for many reseachers and adventurers trying to explore a new environment in a way to see humans fly.

From the early lighter-than-air dirigible airships, to the first human gliding, then the first airplane flying, to modern design, bamboo fiber is the best material to be used through elaborate knowledge. Today, does bamboo have any chance to supplant the spruce, the expensive traditional light aviation material ? Indeed, there is an opportunity to explore the use of bamboo fiber as a contemporary material for light aircraft.

The 10 lessons from history.

1 - Bamboo kite legend, is this the first evidence of a human flying ?

- *In China :*

There is documentary evidence for the early emergence of the kite in China, historical analysts concede that China may get credit due to the fact that its history was well preserved in both written and artistic records.

Early kites in these Asian cultures (China, Indonesia, and the South Sea islands) relied on the use of natural materials: Bamboo or similarly strong reed-like branches for framing structure; thin strands of vine or braided fibers for flying/tethering line; leaves, braided reeds and similar fibrous sheets, or in the case of China - woven cloth and later paper, were commonly used for sail material.

The Chinese Daoist writer Ge Hong (284–364 AD) wrote that kite vehicles with frames made of wood from the jujube tree had ox-leather straps "fastened to returning blades" that could allow the device to soar high into the air. As a form of execution, the notoriously cruel Emperor Wenxuan of Northern Qi (r. 550–559) had members of the rival Yuan and Tuoba clans attached to kites and launched from the top of the Tower of the Golden Phoenix in the capital, Ye, China, as test pilots; Yuan Huangtou (d. 559) glided for a while and survived the landing, but he was executed shortly after.

In 549, king Wu Liang prisonner of general Heou-King sent messages by kite to his followers.

During Marco Polo's China travels of 1282, he reported seeing manned kites. Chinese shipping merchants would tie someone (usually a miscreant) to a huge frame (kite) held by eight strings and having launched the kite with the man into the wind, they would determine whether the voyage would be a prosperous one or not. Polo also explained how the men would pull on the rope attached to the eight strings to lift the kite higher. If the kite flew straight up, it was a good omen for the voyage; if the kite failed to rise, merchants were reportedly wary about loading cargo onto that ship.

- *In Japan :*

The beginning of kites in Japan date around the 9th century. According to a legend, the warrior Tame Tomo built an immense kite on which he lashed his son and allows him to escape from an island exile.

2 - Bamboo kite and the reality of human flying

- *BADEN POWELL (1857-1941) Great Britain, one of the "fathers of manned flight".*

June 27, 1894, an officer of Baden Powell flew till 30 meters high on a kite train call Levitor. The model has been officially presented to the London Arts Society in 1898 for the success of the renowned of Baden Powell.

- *Lawrence HARGRAVE (1850-1915) Great Britain, one of the "fathers of manned flight".*

Living in Australia, he developped the idea of the kite box and flew with a train of them on November 12, 1894. This was one of many stages in Hargraves' quest for a stable lifting device which could then be used as a means of aerial transportation. Hargraves is considered by many to be one of the significant "fathers of manned flight". As an aeronautic researcher, this man is the bridge between pioneers like Octave CHANUTE, Captain BADEN POWELL, Alexander GRAHAM BELL and the spiritual mentor of Alberto SANTOS DUMONT.

- *Samuel CODY (1867-1913) USA, the first man crossing the ?Channel pull by a bamboo kite.*

In 1898, Samuel CODY, the flamboyant Wild West showman, began to share his son's fascination with kites and the two of them competed to make the largest kites capable of flying at ever increasing heights. After a great deal of experimentation, financed by his popular show, Cody patented his first kite in 1901. Cody uses trains of kites and elaborate basket systems to develop reliable systems for lifting observers into the air. It was a winged variation of Lawrence Hargrave's double-cell box kite below.

3 - Bamboo dirigible airships structure during the 19th century.

- *Charles RENARD and Arthur KREBS, the first fully controlled free-flight with the La France (1884) France*

In 1884, Charles Renard and Arthur C. Krebs, inventors and military officers in the French Army Corps of Engineers, built an elongated balloon, *La France*, which was a vast improvement over earlier models. *La France* was the first airship that could return to its starting point in a light wind. It was 165 feet (50.3 meters) long, its maximum diameter was 27 feet (8.2 meters), and it had a capacity of 66,000 cubic feet (1,869 cubic meters). Like the Tissandiers' airship, an electric, battery-powered motor propelled *La France*, but this one produced 7.5 horsepower (5.6 kilowatts). This motor was later replaced with one that produced 8.5 horsepower (6.3 kilowatts). A long and slender car consisting of a silk-covered bamboo framework lined with canvas hung below the balloon. The car, which was 108 feet long (33 meters), 4.5 feet (1.4 meters) wide, and 6 feet (1.8 meters) deep, housed the lightweight batteries and the motor. The motor drove a four-bladed wooden tractor propeller that was 23 feet (7 meters) in diameter but which could be inclined upwards when landing to avoid damage to the blades. Renard also provided a rudder and elevator, ballonnets, a sliding weight to compensate for any shift in the center of gravity, and a heavy guide rope to assist in landing.

The first flight of *La France* took place on August 9, 1884. Renard and Krebs landed successfully at the parade ground where they had begun—a flight of only 5 miles (8 kilometers) and 23 minutes but one where they had been in control throughout. During 1884 and 1885, *La France* made seven flights. Although her batteries limited her flying range, she demonstrated that controlled flight was possible if the airship had a sufficiently powerful lightweight motor.

- *Augusto SEVERO and bamboo dirigible airships Bartholomeo de Gusmao and La Pax (Brazil)*

In Brazil, during the armed revolt of 1893 against the government of Floriano Peixoto; Augusto Severo, a member of the House of Representatives, proposed to contribute an airship -- “seeing indistinctly the possibility of the job of the balloon in the fight against the rebels”. On this pretense, Severo travelled to Paris in 1893 to order the construction and to follow the manufacture of the airship *Bartholomeu de Gusmão*, by the well-known firm of Lachambre & Machuron, responsible for the construction of several of the Santos-Dumont balloons.

The *Bartholomeu de Gusmão* was 60 meters in length and the car measured 52 meters; the structure built of bamboo. Severo intended to make it of aluminum, but the material was not available in the Ministry of the War and Severo did not make use of resources for aquiring it.

On February 14th, 1894, the airship carried out its first ascension. However, during the stability tests of the device, the gondola broke, damaging the airship framework. At the same time, the Civil War followed its course. Floriano Peixoto bought, in Europe, a new squadron, composed of used warships, as a way to possibly stop the fighting quickly. In March of 1894, the squadron was ready to confront the rebel naval forces by bursting into the Bay of Guanabara. The rebels decided then to prevent a decisive battle and retreated to the open the sea. The imminent danger to Rio de Janeiro was removed and thus began the decline of the revolt. The movement ended, and the government was no longer interested in Severo's invention, therefore the *Bartholomeu de Gusmão* did not receive the repairs necessary and was abandoned. Later on, in France, he built airship La Pax with a full bamboo structure. Unfortunatly, the airship crashed in the middle of Paris during the first flight.

- *Alberto SANTOS DUMONT and bamboo dirigible airships*

Since his No. 1 model in 1898, Alberto SANTOS DUMONT built forty dirigible airships mostly in Paris where he was living. « However, it was his N°6 of 1901 that brought Santos-Dumont real fame. It had the shape of an elongated ellipsoid and was 100 feet long by 20 feet thick with cone shaped ends… Suspended from the envelope was the bamboo bridge. In it he won the 100.000 francs prize offered by M. Deutsch de la Meurthe, a wealthy memeber of Aeroclub, for a flight of about 11.3 km from Parc de St Cloud, around Eiffel tower and back. » (Hidalgo-Lopez)

Another peak of his lighter-than-air aviation career was the No. 9 dirigible, nicknamed “Baladeuse” which means as much as “the promenader”. Built to demonstrate the possibilities of urban travel, Santos-Dumont often used it to "drop in" on unsuspecting friends, powered by only a 3 h.p. motor and a gasbag capacity of a mere 220 cubic meters. It was the first real air-car that was built and with it, Santos-Dumont reached one of his main objectives, to build a small airship that can be used to travel around in town. He indeed used it as such and started the airship from the corner of his street and the Champs Elysees to fly to his favorite restaurant for lunch. And when he returned at his home in the afternoon, his butler would waiting with coffee !

4 - Bamboo between kite and airplane, the gliding…

- *Octave CHANUTE (1832-1910) USA,*

Aviation Pioneer. Born in Paris, France he moved as a child to the United States, where he became known as a pioneer in the transportation arena. He spent most of his life as an engineer in the railroad industry, but later gained international fame for his contributions to the study of aeronautics. He designed and oversaw the construction of many of the first railroads and railroad bridges in the United States as well as the union stockyards in both Chicago and Kansas City. He invented a system that preserved railroad ties and telephone poles by pressure treating them with creosote. In 1889 he retired from his engineering business and revived an interest in the new study of aviation. He visited with and conferred with aviation pioneers around the world and in 1894 compiled and organized all the data he had collected and published “*Progress in Flying Machines*”. This work became recognized as the first written collection on aviation research and became a guidebook for the world’s many would-be aviators. Although too old to fly, he worked with many of the world’s early aviators, helping invent the “Katydid” glider and the “Chanute- Herring Biplane”. He was an active encourager of the work of Orville and Wilbur Wright. He shared advice with the brothers, and visited Kitty Hawk, North Carolina on several occasions during their flight experiments. Wilbur Wright presented the eulogy at the engineer’s funeral. The town of Chanute, Kansas is named in his honor as well as the former “Chanute Air Force Base” in Rantoul, Illinois. The decommissioned base is now home to the “Octave Chanute Aerospace Museum” which shares the history of aviation to its many visitors..

- *Otto LILIENTHAL (1841-1896) Germany,*

A German mechanical engineer, Otto Lilienthal (b1848-d1896), began researching aerodynamic effects of wing shapes in the 1870's. In 1889, he published the *'Birdflight as the Basis for Aviation'* book that detailed aerodynamic formulas. The book was the most informative aviation book of the time. From 1891 to 1896, Lilienthal built five gliders that had a single wing (monoplane) and two gliders that had stacked wings (biplane). Lilenthal's wing design was shaped as a true symmetrical curve rather than the parabolic shape of the airfoils today. During his flying career, he managed to complete over 2000 flights. During Lilienthal's first flights, he suspended himself in the glider with only his arms. By 1895, he developed a harness that was used to hang from the glider. In retrospect, with the application of the harness, Lilienthal was the first hang glider pilot. Lilienthal managed to fly for distances of over 800 feet (250 meters) in gliders that were foot launched from man-made hilltops near his home in Gross-Lichterfelde, Germany. On August 8, 1896, Otto Lilienthal crashed his hang glider from an altitude of 50 feet (15.3 meters) after a wind gust ripped apart one of his wings. He died the next day in a Berlin hospital from a broken back. His last words were 'Sacrifices must be made'. Lilienthal's knowledge in aerodynamics would prove beneficial to the Wrights who would later read his book and use the concepts as a beginning point for building their gliders.

5 - Bamboo at the beginning of airplane adventure : trial and error...

- *Clément ADER (1841-1925) France,*

October 9, 1890, the Frenchman Clement Ader flew 50 meters at 20 cm with the Eole, a bat-looking airplane with use of bamboo in the wings. The *Eole* was described as a single engine (steam) tractor monoplane, with a four-bladed bamboo propeller made in the form of bird feathers. The wings were bat-like, with extreme canopied curvature. There was no elevator, no rudder, and no conventional flight controls. Each wing could be swung forward and aft separately by a hand-operated crank, thus changing the position of the center of pressure and consequently the pitch of the airplane. Wings could be flexed up and down by foot pedal; the wing area and chamber could also be changed by crank action. In all, six hand-operated cranks, two foot pedals, and engine controls had to be operated by the pilot in flight.

- *Captain Ferdinand FERBER (1862-1909) France,*

Ferber's experiments in gliding began in 1899 at the Military School at Fountainebleau, with a canvas glider of some 80 square feet of supporting surface, and weighing 65 lbs. Two years later he constructed a larger and more satisfactory machine, with which he made numerous excellent glides. Later, he constructed an apparatus which suspended a plane from a long arm which swung on a tower, in order that experiments might be carried out without risk to the experimenter, and it was not until 1905 that he attempted power-driven free flight. He took up the Voisin design of the biplane for his power-driven flights, and virtually devoted all his energies to the study of aeronautics. His book, « *Aviation, its Dawn and Development* », is a work of scientific value--unlike many of his contemporaries, Ferber brought to the study of the problems of flight a trained mind, and he was concerned equally with the theoretical problems of aeronautics and the practical aspects of the subject. Although he never built a successful plane by himself, he did aid somewhat in the design of the Antoinette. During 1909 he competed at Reims. He won several minor competitions but on 19 September 1909 lost his life in a crash at Boulogne.

Ferber in his airplane of bamboo.

6 - Bamboo use on the first airplane to have ever flown.

- *Gustave WHITEHEAD (1874-1927) USA,*

On August 14, 1901, almost two and one half years before the Wright Brothers flew at Kitty Hawk, Gustave Whitehead lifted his acetylene-powered monoplane into the air at Fairfield, Connecticut, for his first flight. The machine which took him into the air for the first time, his No. 21, included advanced features such as powered landing gear, folding wings and adjustable pitch propellers. He was also the first to land a plane on water !

Of the first flight of the aircraft N. 21, designed and constructed in 1901 in Connecticut by the Bavarian Gustav Weisskops (subsequently Whitehead), only testimonies of dead persons remain, but no photographic documentation in flight. Perhaps this, with other complex and also incredible reasons, can only partially justify the total absence of this pioneer of aviation from the history of flight. A few years ago, a full-scale replica was flown with success, thus demonstrating that Weisskop's perceptions and his design choices made sense indeed !

Allegedly chased out of Pittsburgh by the police on account of his "dangerous" experiments, Whitehead found employment in Bridgeport, Connecticut in 1900 as a mechanic. His new home had space for a small workshop, and the neighbors (and local law enforcement) must have had more understanding for his inventors' ways. Scientific American, reported in June, 1901, of Whitehead's motorized flying machine. *« While standing on the ground, the two front wheels are connected to the kerosene motor and the rear wheels are used for steering... On either side are large wings or aeroplanes shaped like the wings of a flying fish or bat. The ribs are of steel tubing in No. 22 instead of bamboo as in No. 21 machine and are covered with 450 square feet of the best silk obtainable. In front of the wings and across the body is a steel framework to which is connected the propellers for driving the machine through the air ».*

Two months later, with this motorized "hang glider" - Number 21 - Whitehead completed a flying distance of about 2.5 km at about 10-15 meters altitude. In so doing, he had proof it was possible to start a flight without artificial aids from land and with two motor driven propellers, and to land without damage. Whitehead had recognized that a successful takeoff requires a definite minimum speed; other aviation pioneers were still using catapults for takeoffs.

In spite of the Whitehead's flight, all the pilots of the world and even the last of the schoolboys know that the Wright Brothers were the first to fly a motorized aeroplane and, for this reason, they are considered the very pioneers in the history of aviation.

- *Whitehead / Wright brothers and Smithsonian controversy*

It has been long believed that the Smithsonian refuses to recognize Whitehead due to a deal made with the estate of the Wright Brothers in 1948. This agreement stipulated the Smithsonian would only retain the right to display the famed aircraft "The Flyer" <u>if it did not display any other work belonging to predecessors of the Wrights.</u>

The agreement reads in part: "Neither the Smithsonian Institution or its successors, nor any museum or other agency, bureau or facilities administered for the United States of America by the Smithsonian Institution or its successors shall publish or permit to be displayed a statement or label in connection with or in respect of any aircraft model or design of earlier date than the Wright Airplane of 1903, claiming in effect that such aircraft was capable of carrying a man under its own power in controlled flight."

Some theories even go so far as to say that the Smithsonian has knowingly lost or destroyed the only known photograph of Whitehead in flight. Although there have been attempts to meet with the Smithsonian over this issue in the intervening decades, it has never been resolved to the satisfaction of Whitehead's living supporters who believe his "foreign-born" status contributed to his lack of recognition in his time.

- *Alberto SANTOS DUMONT and XIV bis model with a bamboo body structure.*

After some other less successful projects, like a helicopter, that the engines of that time just couldn't bring into the air, Alberto Santos Dumont then built a strange looking plane that was nicknamed "Canard" or in English "duck". After several tests on Sept 13, 1906, he made <u>the FIRST ever official flight with an heavier-than-air</u>

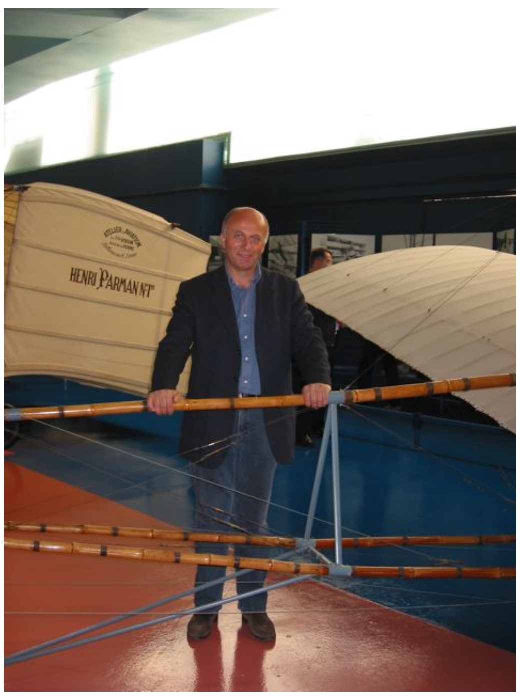
flying machine, that could lift the ground by its own means, as the Wright brothers flight never had official witnesses and also the plane back then was launched by a catapult.

7 - The bamboo Demoiselle, first airplane mass-produced

- *Alberto SANTOS DUMONT and The Demoiselle, Nov. 16, 1907 in Bagatelle.*

Once Santos-Dumont had flown a heavier than air machine in Europe, airplanes spread over Europe very fast and a lot of pilots built their own aircrafts. Also Santos-Dumont improved his airplanes and in the end came up with his No. 19 project, called “Demoiselle” (dragonfly or young lady). It was the first prototype of a small and very light monoplane and the birth of the first ever sports-plane. Santos-Dumont never held patents for his inventions ; he saw them as a gift for humanity. In his Nos. 20, 21 and 22, Alberto Santos-Dumont perfected his Demoiselle, and as he offerd the plans free to anyone who was interested the Demoiselle was very often reproduced all over Europe and also in the United States. Some aviation heros, like for example Roland Garros, learned how to fly in a Santos-Dumont Demoiselle.

The No 19. was a small monoplane, 8m long and with a 5m wingspan. The wings were of Japanese silk, covering a bamboo frame. In the rear there were two diamond-shaped frames, that formed the rudder, controlled by piano strings. He added a 20 HP engine with two cylinders, placed between the wings, above the pilot. The plane itself only weighed 56 kilos. It was an extremly light and elegant construction.



The author, Michel Abadie, with the <Demoiselle>

8 – The first airplane with a bamboo panel fuselage

On 1951, the Institute of Science and Technology (Philippines) conducted research about the use of traditional material for aircraft. The study conducted by Antonio J. de Leon with the help of the Philippines Air Force started in 1952. It was about using bamboo-woven mat glued to wood or laminated to another bamboo mat for use as stressskin covering for light aircraft. The result was positive. Its fatigue strength under bending stress was found to be much higher than that of wood, and the bond strength of bamboo to bamboo was comparable to that between bamboo and wood.

The L-14 Maya was a Filipino three-seater experimental general-utility aircraft developed during the 1950's to test the suitability of locally produced materials, such as locally grown woods, or bamboo panels for use in aircraft construction. The XL-14 Maya was a high-wing strut-braced monoplane of locally grown wood construction powered by a Lycoming O-235-2 four-cylinder horizontally-opposed air-cooled engine providing a top speed of 184 kmh and a range of 480 km.

9 - The revolution of hand gliding

On 1948, aeronautical engineer Francis Rogallo invented a self-inflating wing which he patented on March 20, 1951 as the *Flexible Wing*, also known as the *flexwing* and Rogallo wing. Francis Rogallo had first proposed his flexible wing concept to the Langley Research Center in the late 1940s as a simple, inexpensive approach to recreational flying, but the idea was not accepted as a project.

The simplicity of the Rogallo wing, ease of construction, capability of slow flight and its gentle landing characteristics did not go unnoticed by some hang-glider and ultralight glider enthusiasts. The publicity on the Fleep and the Paresev tests sparked interest in independent builders like Barry Palmer and John Dickenson, who separately explored distinct airframes and control systems to be adapted to a Rogallo wing and be flown as a hang glider.

On August 1961, American engineer Barry Palmer developed and flew the first foot-launched Rogallo wing hang glider.

On May 23, 1971, the hang gliding officially became a sport.

Taras Kiceniuk, a Cal Tech student, flew a version of Richard Miller's Bamboo Butterfly, called The Batso. Taras Kiceniuk later wrote, "The Bamboo Butterfly demonstrated [that day] that this design was capable of excellent control in the hands of a skilled pilot-and very limited in aerodynamic performance. The gliders ... showed the opposite face of the coin-acceptable aerodynamic performance and practically no control!"

10 – Open the way for a contemporary design bamboo experimental plane and airship

- *Michel ABADIE and Flyboo (1998) France.*

Ninety years after The Demoiselle, the project FLYBOO (for FLYing bamBOO) is an ultra light aircraft, entirely made of bamboo, proposed by The World of Bamboo, a Paris (France) based organization which promotes bamboo as a renewable resource and material for the future.

In May 1996, The World of Bamboo/Paris received the Henry Ford European Awards for Nature Protection with an bamboo airplane project. By autumn 1996, a small team was working on the project with design projections and display. An innovative shape of four but-jointed wings displayed in diamond shape was decided for structure resistance and aerodynamic advantage.

After research on history, design, and feasability conducted with a school of aeronautics (Estaca / Paris) and an aerodynamic research in the wind tunnel of National Superior School of Aeronautic (SUPAERO Toulouse - France), one of the oldest "Grande Ecole" in aeronautics and space, the shape of the future aircraft was decided.

In May 1997, during the Paris Bourget Airshow, a scale model was presented to the visitors. Five remote control scale models were tested before the decision to go ahead early 1998.

FLYBOO 01 - In June 1998, the real building of FLYBOO 01 began. With a wingspan of 7.70 meters and 5.50 m length, the plane weighed 260 kilos with four wings joined together in a special losange display. The body of the aircraft was built with two bamboo poles (15 kilos each) supported by two laminated rings of 2.20 meters wide (23 kilos each). Covered with bamboo mats specialy woven for the purpose in China, the wings of 4.62 meters length (23 kilos each) were made with a traditional structure in spruce. The 64 horsepower engine and the propeller were located inside the back ring. The pilot and the passenger were positioned under the protection of the first ring.

In September 1998, not yet finished, the prototype was presented for the first time in the main public Paris subway station prior to be on display on the Champs Elysées avenue during the Centenary festival of the French Aero Club. Thousands of enthusiastic visitors (Parisians and foreigners) arrived to discover and support the idea. But the plane was too heavy, not fully made of bamboo and, because of the rings, not easily transportable.

FLYBOO 02 - In October 1998, the decision was made to build a new prototype to be presented at the International Bamboo Conference in Costa-Rica. This was done by a team of seven people working very hard, six days and nights, with the challenge to be ready in time. And, it was done !

In November, the new prototype Flyboo 02 was exhibited in San Jose, Costa Rica.

Fully made of bamboo, with the wings covered by Dacron textile, it was 160 kilos ligther and easier to carry. Unfortunately, during the transportation to the conference hall, a wing was badly damaged making the display incomplete.

FLYBOO 03 – In July 1999, the construction began of the third model of Flyboo with the challenge to be lighter than the SANTOS DUMONT's Demoiselle (70 kilos). Using small bamboo strips (1 cm x 0.5 cm), the new prototype was done with a different body, a kind of laminated ladder. Smaller, with a span of 5.30 meters, Flyboo 03 is lighter than ever = only 30 kilos without the engine (25 kilos or less depending of the type of engine). In August 1999, after one month of work, the Flyboo 03 went out from the hanger to be presented during the European Bamboo Congress in the Netherlands.

The very original shape of the wings - covered by transparent Mylar – highlight the harmony between the bamboo material and the design of the airplane. The use of these natural and resilient materials make the manufacturing quite inexpensive except the time investment to build it. Flyboo 03 is easy to take apart. Very light, the whole plane can board a commercial aircraft on two bags.

Unfortunatly, the builders ran out of money to finance an electrical engine to complete the model.

The main idea of building Flyboo was to conduct a campaign to promote the contemporary use of bamboo in an innovative way. A new way to enhance the idea of bamboo as a strong, light and renewable material for the future. At the end, it was also an acknowledgement of bamboo, as a plant who facilitated the flying of humanity, the ultimate in symbol and potential.

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Bamboo and Climate Change: The Imperative

David E. Sands
President/Chief Architect, BAMBOO LIVING Homes, Resorts and Communities

What if there were a building material which by choosing to use in their buildings people everywhere were actively addressing climate change? There is such a material. It is bamboo.

Bamboo, as perhaps the fastest growing plant on the planet, has a very important role to play in restoring balance to the Earth's climate system.

Currently, the 30 billion tons of carbon dioxide equivalent produced each year by human activity are wreaking havoc on the global environment. Efforts to curb our CO2 emission are essential but much more needs to be done. And soon!

Global efforts are underway to reduce our planetary carbon emissions below 1990 levels. That still leaves a lot of CO2 being put into the atmosphere each year by human activities. Bamboo offers perhaps the quickest way to remove vast amounts of that carbon dioxide from the atmosphere. Build buildings with that bamboo and you have sequestered the carbon for a hundred years. At the same time, you are creating jobs and opportunities for farmers and builders throughout the world. Bamboo buildings are a carbon capture and storage system.

Bamboo plantations will soon become possibly the greatest natural carbon sink. Each acre of bamboo sequesters up to 40 tons of CO2. The bamboo plant eats carbon dioxide. It takes CO2 from the atmosphere and through the process of photosynthesis turns it into sugars. The bamboo plant transforms these sugars into the compounds that make up bamboo fiber. The carbon from the atmosphere is thus locked up in the bamboo fiber itself. When that bamboo fiber is used to construct buildings the carbon in it is sequestered for the 100 year lifetime of the building. A bamboo building has taken out of the atmosphere over 15 tons of carbon dioxide for every 100 square meters of floor area.

Bamboo is only effective for longterm carbon sequestration if the bamboo plant is being regularly harvested and that harvest turned into durable goods or biochar. Left unharvested the sequestration rate of the bamboo plant levels off. By harvesting 20% of the biomass of the plant each year as 3+ year old mature bamboo culms, the high rates of carbon sequestration are maintain for the 50-75 year life of the bamboo plant. Unlike most trees you are not killing the bamboo plant when you harvest. Each year the mat of primitive roots called rhizomes is expanding, sequestering additional carbon for the life of the bamboo plant. Also unlike trees the bamboo plant produces microscopic plant stones that encapsulated carbon in silica and sequester an additional half ton per acre of carbon for possibly thousands of years.

Biochar is an agricultural amendment made by heating organic material in a low oxygen environment. The heat needed to form the char is derived from burning the gases released in the charring process. In the case of bamboo, all of the bamboo not used for construction material or other durable goods can be turned into biochar. The biochar is ground up and added to soil to improve its productivity without releasing the carbon in the char. In tropical climates biochar dramatically improves soil fertility. Biochar is considered by climate scientists, James Hansen and James Lovelock, as the fastest method of sequestering carbon in the vast quantities needed to offset humanity's production of carbon dioxide. Fast growing bamboo, the quickest source of biomass, is an obvious candidate for making biochar. Bamboo, because of the perennial rhizome mat it forms, also regenerates watersheds and protects against the loss of topsoil. Many species are drought tolerant and can create a barrier against desertification while providing a fuel and food crop with the material not being used for making durables or biochar. However, the most valuable use of the bamboo is in making building material. We can help build the market for bamboo by specifying bamboo for projects and by developing new and creative ways to use bamboo as a building material. As an architect I have pioneered the use of bamboo for construction in the U.S. My company obtained the first ICC Evaluation Services report for structural bamboo in 2004. We are currently working on ICC certification for a bamboo composite for use in construction as a structural material.

The growth rate of bamboo is up to 20x the production rate of trees commonly used for lumber and nearly 3x that of the very fastest growing trees. The result is that a tremendous amount of building material is produce by each acre of bamboo. Unlike trees bamboo produces an annual crop providing regular income for the farmers growing it. As mentioned unlike most trees the bamboo plant is not killed when it is harvested. It is more like mowing a lawn than cutting down a forest. The living rhizome mat of the bamboo plant continues to protect against erosion.

There are well over a thousand species of bamboo. Bamboo has a PR problem to deal with as a result. There are invasive species of bamboo that are problematic. However there are many species which are excellent for construction that are not invasive. The durability of the bamboo varies dramatically between species and there have been problems with some of the bamboo flooring made from nondurable species or immature bamboo. All bamboo is not the same! It takes a bit of research to find out which products perform but for the sake of the planet I encourage that effort.

How much bamboo will need to be planted? To absorb the entire 30 billion ton green house gas (GHG) output of humankind *without emission reductions* would require an area roughly 5x the size of the state of Texas planted in bamboo. That is a lot of land but it is not beyond the range of possibility and we will make GHG emission reductions in the coming years significantly reducing the amount of land required. To absorb the entire carbon dioxide output of the United States (again without emission reductions) would require an area planted in bamboo about the size of Texas. Distributed over the possible bamboo growing areas this is again within the range of possibility. The United States government has spent $1.8 billion a year on the Conservation Reserve Program holding 35 million acres of farm land out of production. That land converted to bamboo production would offset 20% of the entire carbon dioxide output of the USA. Of course, not all of that land is appropriate for growing bamboo, but it does give an idea of the potential for using bamboo as an offset.

By our efforts we shape the world we live in. Our decisions ripple out into the world affecting everyone around us. Many of these impacts extend out in time for many years. I am heartened by the fact we are actively addressing the climate issue by reducing the energy needs of our buildings. This is very important work. In addition, what if going beyond mitigating the negative impacts of our buildings on the environment, our buildings could now have a restorative power simply by their existence. Each building could be an embodiment of the balance we seek.

Imagine the end of global warming. Imagine the earth in balance. It is a personal decision limited only by our imagination.

The Bamboo Compendium

Bernt Carstenschulz
architectural design

Motivations to write the 竹 compendium :

Information about bamboo are scattered in diverse places such as books, electronic documents and websites making it more difficult than necessary to access them. Similarly to periods when information has been buried in books, it is now buried in websites or electronic documents, a clumsy and time consuming way to get hold of them.

The revolution of information technology has shaken in the last 20 years the way society, businesses and science are working and the digitalization of information has the capacity to reveal crusts of errors, to fix them and enable a faster and easier access to what really matters.

Being not an expert, I noticed with bewilderment when compiling this encyclopedia, that botanical names and their synonyms have become a system almost as complex as Chinese bamboo names within their 5000 years of history and diverse geography.

In addition, poorly and adventurous transcripts from Japanese bamboo names might have been acceptable during the 19th century, but are certainly not present-day. This is a quite awesome situation, but unfortunately, not a positive one and is in dire need to be addressed.

The 竹 compendium wishes to address formerly mentioned problems by being a central repository with a powerful and quick search-engine in which information is poured and classified. This dictionary uses the advantages of information technology to democratize the access of information by making it available to everybody interested and concerned by this subject.

Similarly to other collaborative projects, the 竹 compendium wishes to leverage the knowledge of the international bamboo community to become the first resource about all information bamboo.

Everybody is invited to review the initial work and subsequent revisions to address possible errors and to further refine the 竹 compendium by adding their knowledge for the profit of all.

Thus, the 竹 compendium will not only be an initial free download (however, donations are very welcome), but all subsequent updates will be accessible free of charge. These updates will reflect the pace information is flowing in.

At this present date these classifications of idioms have been implemented and can be accessed within the blink of an eye :

[Known limitations : The framework of Apple's Dictionary does at present only allow to search words in Latin, Chinese, Japanese and Korean]

botanical names and their synonyms

local names in Latin script

language search

script search

local names in Thai script and transcription

local names in Japanese kana and kanji and transcription

local names in Korean hangul and transcription

local names in Chinese in traditional, simplified ideograms and pinyin

These further classifications are expected to be partially implemented before initial release:

geographic locations

genera

rhizome types

morphology descriptions

Further additions could be high quality imagery, physical attributes (ex. for building purposes), and other suggestions will be examined attentively.

Admittedly, the most exciting way to have the 竹 compendium with you would be on the Apple iPhone, as its implemented capacities such as GPS, capable camera, Chinese ideogram drawing, powerful search capabilities and great display among others, in a small lightweight portable device would allow to even further extend the compendium in usefulness.

Already, a 竹 compendium mobile for the Apple iPhone is in the planning phase, but as the programming of this kind of application is beyond this authors scope, it can not be distributed for free. An adequate amount will be charged to cover the costs of development.

At present, the 竹 compendium is only available as plug-in for the Mac OS X 10.5 Leopard dictionary.

About the author:

Bernt Carstenschulz' enthusiasm for bamboo started when visiting the ZERI pavilion at the World Expo 2000, Germany, which deeply impacted him.

Since then, he participated in bamboo construction workshops with Jörg Stamm in Belgium and Colombia, and refined his knowledge of techniques with 門田祐一 (yuichi monden) in Japan.

After experimenting with Thai bamboo, Bernt is actually working on his first construction project, the Crimson Moon Pavilion, and in parallel on the 竹 compendium, which will be presented and released during the 8th World Bamboo Congress in Bangkok.

In Honor of Bamboo Pioneers

Susanne Lucas
CEO, World Bamboo Organization

Living creatures all around the world depend on bamboo for their survival. This includes *Homo sapiens*. We all know that for centuries, human cultures have cultivated and utilized bamboo for their daily needs and through innovation improved their livelihoods and economies.

On the village level, farmers and craftsmen developed techniques which were passed down from generation to generation. In more modern times, man has looked to science for solutions and progress. Through committed research, we have discovered new approaches of how bamboo as a managed resource can lead to the betterment of mankind.

Dedication, determination and collaboration are required to advance any scientific endeavor. There exists individuals whose lifelong commitment to bamboo science deserve our attention and honored recognition. Today, as part of the inauguration of the 8th World Bamboo Congress, we honor 4 of these great Bamboo Pioneers:

Ueda Koichiro

Krit Samapuddhi

Floyd Alonzo McClure

Walter Liese

Ueda Koichuiro 1899 - 1991 (Japan)

Koichiro Ueda was a well-known Japanese scholar recognized throughout the world as one of the leading authorities on bamboo. One of his most esteemed awards was the Order of the Sacred Treasure from the Emperor of Japan. He was professor at Kyoto Industrial College and president of the Japan Bamboo Industries Association.

Of his many published works, these two books are outstanding:

Studies on the Physiology of Bamboo, Kyoto University Press, 1960.
Bamboo, by Robert Austin and Koichiro Ueda, photos by Dana Levy, Weatherhill Inc, 1970.

A highlight in his bamboo life was a special bamboo conference at the XVII International Union of Forest Research Organizations Congress in Kyoto (1981), with 33 reports and the Inauguration of his designed Rakusai Bamboo Park, a living monument garden using bamboo as a replacement for the deforestation around Kyoto due to industrialization.

Photo of Professor Ueda taken by Walter Liese, 1979.

Krit Samapuddhi 1911 – 1991 (Thailand)

Krit Samapuddhi was the former deputy director general of Thailand’s Royal Forest Department, and former managing director of Thailand's Forest Industry Organization. He was instrumental in developing the forest village system.

The forest village system, developed by Thailand's Forest Industry Organization, offers hill tribesmen and others who practice slash and-burn agriculture considerable inducements to settle down. One of its principal aims was to keep a steady labor force on hand for the long-term needs of forestry, while at the same time providing rural families with an income and other benefits from the kind of farming they choose to practice.

He published many books, including: *The Forests of Thailand and Forestry Programs* (1957), *A preliminary study in the structure and some properties of some Thai bamboos* (1959), *Forestry Development in Thailand* (1966), and *Grouping of Thai Hardwoods* (1972).

Krit Samapuddhi. Royal Forest Department, Thailand, archives.

Floyd Alonzo McClure - 1897-1970 (U.S.A.)

Floyd Alonzo McClure was one of the world's leading authorities on the bamboo plant. Born in Shelby County, Ohio, McClure went to China as a teacher in 1919 after completing his undergraduate work at Ohio State University. He stayed in China for 24 years, working most of the time as professor of economic botany at Lingnan University in Canton. When the Japanese invaded China, McClure returned to the United States and became a consultant on bamboo for the United States Department of Agriculture. In the 1940s, he was appointed honorary research associate for the National Museum of Natural History, a position he held until his death in 1970.

Floyd McClure was instrumental in the introduction of Tonkin bamboo to the world. During his tenure as an instructor and professor at Lingnan University in Guangdong, China from 1919-1941, he assigned the scientific name of *Arundinaria amabilis*. Upon a visit to China in 1925, McClure was the first to scientifically describe the plant and recognized that it was a distinct and previously unreported species. At the time, this bamboo had already been in use for building fly rods and was known by a variety of different common names. The name was amended to *Arundinaria amabilis* McClure in the doctor's honor and translated, means 'The Lovely Bamboo.'

He is best known in the United States for his book, *Bamboos: A Fresh Perspective*, by Harvard University in 1966. McClure was a contributor to the USDA Agriculture Handbook on bamboos in 1961. *The Bamboos* is the classic treatise on bamboo in U.S. literature, with sections on the vegetative phase, the reproductive phase, elite bamboo species, and propagation methods, as well as interesting historical notes, photos, and illustrations.

Frederick G. Meyer, a colleague of McClure’s at the USDA, wrote this tribute : “ The many friends of Floyd Alonzo McClure were saddened by his death of April 15, 1970, short a few months of his seventy-third birthday. Those who knew him personally lost a true friend, and the world lost a teacher and pre-eminent authority on bamboos, the tree grasses. A former Chinese student likened McClure’s life to the villager, who, after gazing for years at the Great Stone Face on the mountain, became himself the person with wisdom, strength, honesty and solidarity like that of the mountain, the person the whole village had been searching for. Bamboo was McClure’s Great Stone Face, and teacher of truth in the green plant world. ……..In fact, he died in his garden, digging a bamboo plant for a young friend. “

Walter Liese – 1926- (Germany)

If ever Germany was to have an ambassador at large for forestry, and for bamboo in particular, Prof.Walter Liese would eminently qualify for the post. His international assignments have carried him far and wide - from the lowlands of Bangladesh to the high mountains of Chile; from the humid forests of Indonesia and Vietnam to the arid zones of Nigeria and Tanzania; from the near shores of Portugal to the far shores of the Philippines. In his career as a wood biologist and forestry expert, which spans nearly five decades, Prof. Liese has stretched his faculties to their limits to become an institution in himself.

Walter Liese was born in Berlin on 31 January 1926, when the Weimar Republic was eight years old and appeared stable and prosperous. His childhood and adolescent years were spent in Eberswalde, a small town south of Berlin where his father was Professor of Forest Botany. By the time he was seven years old, the Weimar Republic had collapsed and Adolf Hitler was in control of Germany. Like all other able-bodied German youth, Walter Liese was also drafted into war service at the age of 18.

At the end of the military service, Walter Liese pursued his studies. He chose forestry as his main subject, probably influenced by his childhood images of lush forests near Eberswalde. He studied forestry from 1946 to 1950, first in Freiburg in the Black Forest and then in Hann.Münden at the Forest Faculty, University of Göttingen. In 1951 he graduated and began his career with a one-year study on root physiology at the Forest Research Institute in Düsseldorf.

The year 1951 added another dimension in the history of botanical studies in Germany. Although palms and bamboos were botanically known through their earlier descriptions by Linné, all palms were classified as bamboos. Their structural characteristics came to be examined only much later, through the efforts of scientists like Hugo von Mohl (1845), Schwendener (1874), de Bary (1877), Strasburger (1891), Haberlandt (1924), and Solereder and Meyer (1928). Then, for some inexplicable reason, the anatomies of bamboos and palms were much neglected. It was only in 1951 that interest in these areas was revived in earnest. As destiny would have it, the seeds for this revival were sown through a chance meeting under favorable circumstances.

In April 1951, Walter Liese had started working as a research scientist at the Forest Research Institute in Lintorf, near Düsseldorf. Dr Franz Erich Eidmann, then Head of the Institute, kindled Liese’s interest in bamboo. The discussion centered on the suitability of culms as pit props in coal mines. Liese, motivated by Dr Eidmann’s enthusiasm, carried out a series of experiments on the properties of bamboo for its use in mines.

Liese also had contacts with Prof. Bodo von Borries of the Institute of Higher Microscopy in Düsseldorf, who was part of the team that developed the electron microscope. The apparatus was still a novelty then and awaiting newer applications. Liese made good use of the transmission electron microscope to study the structure of bamboo, the "new" material, and produced in 1951 the first electron micrographs on the fine structural details of the cell walls of bamboo fibers. This was followed in 1953, while working at the Institute of Forest Botany, University of Freiburg, by another series on structures in the cell walls in bamboo. These achievements brought both the researcher and the research subject into the limelight.

Liese’s six-year sojourn (1953-59) at the University of Freiburg, where he had once been a student of forestry, launched his outstanding career as a wood biologist and bamboo scientist. The study of anatomical structure using advanced microscopy and other techniques, which began there as a curiosity that developed out of a chance opportunity, became a life-time passion.

The latter half of the 1950s marked the beginning of Walter Liese’s presence in the international arena. Before joining the University of Freiburg, he had spent one year working in the wood preservation industry in Mannheim. This experience in wood preservation came of use in 1957, when Liese was contracted by the United Nations Food and Agriculture Organization (FAO) to India to study and propose an impregnation method to preserve bamboo from deterioration, and in 1958 to work on wood preservation in Indonesia. In 1958, barely eight years after his graduation, Liese was already a visiting scientist to the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Melbourne, Australia. In 1962, while working at the Institute of Forest Botany, University of Munich, he was serving as a visiting scientist at the prestigious Harvard University in the United States. Later, when his fame as a top-order forestry expert spread, many other universities - Berkeley University of the United States, Canterbury University of New Zealand, Nanjing Forestry University of China, Universidad Austral of Chile and National University of Taiwan-China — followed suit.

Although his primary vocation as a wood biologist and forest botanist prompted Liese to move to Hamburg in 1963, taking up the position of Professor of Wood Science at Hamburg University, bamboo remained a source of fascination for him. His enthusiasm on the subject attracted several young scientists, and some of them became his research partners. During the Freiburg years, Prof. Liese carried out seminal work on the histometry of the cell elements in various bamboos, with special emphasis on tissue composition. The Munich years also saw several studies being carried out on bamboo, not only on anatomy but also on the permeation properties of bamboo culms.

Prof. Liese's research on bamboo anatomy peaked during the Hamburg years (1963-91) though he still continues to work as Professor emeritus. The first stimulus came from his association with Dr Dietger Grosser, who had the aptitude and patience to search for even the most minute details in anatomical studies. Together they presented an impressive array of histological studies on bamboo — the characterization of the four basic vascular bundle structures, and their relation to taxonomical classification; variability of fibre lengths in bamboos; distribution of vascular bundles and the cell types in bamboo culms etc. Prof. Liese's joint work with Prof. Narayan Parameswaran added a competitive depth to bamboo research. Their initial research covered the fine structure of cell walls, especially of fibres and parenchyma cells. This was followed by studies on the occurrence of warty structures in certain bamboo species, fine structure of protoxylem elements, and ultrastructural aspects of bamboo cells, culms etc. Much of this research remains to date the most important contribution to the subject. In between and after these fruitful joint research associations, Prof. Liese has made several forays on his own and published research papers of excellence.

Although enamored by the lure of bamboo, Prof. Walter Liese never allowed that to affect his other academic interests — wood biology, wood pathology and wood protection. He has delivered lectures in over 50 countries on these subjects, and has carried out research on a number of related areas such as: wood and bark anatomies; fine structure of wood; wood quality; wound reactions in trees and monocotyledons; micromorphology of wood degradation; physiology and enzymology of wood fungi; and promotion of wood utilization in developing countries. A prolific writer, Prof. Liese has to his credit well over 400 scientific papers (70 of which are on bamboo and 20 on palms, mainly co-authored by Gudrun Weiner). He has also guided 70 diploma students and 35 doctoral students.

Apart from teaching at the Hamburg University, Prof. Liese also served as the Director of the Institute for Wood Biology and Wood Protection, and from time to time as the Executive Director of the Federal Research Centre for Forestry and Forest Products. During the Hamburg years, and after his official retirement in 1991, he lent his expertise to several international and national entities, including: the FAO Advisory Committee on Forestry Education (1966-90); the International Union of Forest Research Organizations (IUFRO — as President during 1977-1981 and in various other capacities from 1968 to 1995); the FAO/IUFRO Committee on Bibliography and Terminology (1964-73); the International Academy of Wood Science (as Fellow in 1966 and as Vice

President during 1969-72); EUROSILVA, the European Research Cooperation on Tree Physiology (as Chairman of the Joint Steering Committee during 1988-93 and as Vice Chairman in 1994); Deutsche Gesellschaft für Holzforschung (as Chairman for Wood Protection during 1972-76); the Research Advisory Board of the Forest Research Institute, Malaysia (1989-90); etc.

Prof. Liese was instrumental in getting the International Development Research Centre (IDRC) of Canada interested in bamboo, and played an important part in the creation of the International Network for Bamboo and Rattan (INBAR). He is often referred to as the "grandfather of INBAR".

During his IUFRO presidency Prof. Liese strongly advocated and spearheaded the involvement of developing countries in the organization, and helped focus IUFRO's activities more on issues of tropical forestry. He was instrumental in initiating the call for action on tropical forestry, which later developed into the IUFRO Special Programme for Developing Countries. It was also during his presidency that IUFRO turned truly international.

International recognition of Prof. Liese's expertise in his chosen fields was never found wanting. He was accorded honorary memberships of the Philippine Forest Research Society, Finland Society of Forestry, International Association of Wood Anatomists, Indian Academy of Wood Science, Society of American Foresters, l'Académie d'Agriculture of France, IUFRO, Chinese Bamboo Association, Academia Italiana di Science Forestate, German Society for Wood Research, Polish Academy of Science and the European Bamboo Society, amongst others. In appreciation of his academic brilliance, Prof. Liese was awarded five honorary doctorates, including ones from the University of Sopron, Hungary; University of Zvolen, Czech Republic; University of Istanbul, Turkey; University of Poznan and University of Ljubljana, Slovenia. He also received numerous medals of merit for his achievements in forestry.

Prof. Liese is very highly regarded in Asian countries, especially China and India, not only for his research contributions but also for helping Asian scientists.

Although he retired from official engagements in 1991, Prof. Liese continues to contribute to the world of forestry with his profound knowledge and extensive experience.

Since then, 10 years have passed with about 60 additional bamboo papers and a book " *Bamboo Preservation Compendium*" with S. Kumar as INBAR/CIBART Techn. Rep. 22, 231 pp., many bamboo lectures and bamboo consultancies in Ethiopia, Costa Rica, Colombia, China, Thailand, Northeast India, among other activities

The World Bamboo Organization is extremely fortunate to have Prof. Liese as a member of its Honorary Council. When he heard of the proposed 8th World Bamboo Congress in Thailand, he heartily sent emails of support and offered to help. He worked as Chairman of the WBC Paper Review Panel, and will be present to make an oral presentation entitled, *Bamboo as CO2-Sink—Fact or Fiction ?*, as well as Chair the Session entitled: In Partnership for a Better World. We all can say <thank you> with genuine sentiment to a man whose work has led to a better understanding of bamboo. Fortunately, Walter Liese is here with us today; alive and well and a true bamboo pioneer.

Walter Liese with *Guadua*

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