Air and Space this Week

Item of the Week

PAUL MACCREADY AND THE *GOSSAMER ALBATROSS*

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People have dreamed of having the power of flight long before Daedalus and Icarus. Most folks just dream, but the Royal Aeronautical Society actually put their dreams into action, spurred on by a prize offered by industrialist Henry Kremer. It was one thing to human-fly a short distance, akin to the Wright's accomplishments. It was another thing entirely to pull a Bleriot and human-fly the English Channel. Paul B. MacCready designed an aircraft from scratch to be powered by a human, and Byran Allen pedaled the Gossamer Condor *around the course to win the first Kremer Prize. The Kremer people then added a new prize for the first human to power an aircraft across the English Channel. MacCready went back to the drawing board and built the* Gossamer Albatross*. Allen pedaled it across the Channel on* ***June 12, 1972, 52 years ago this week****.*

THE ROYAL AERONAUTICAL SOCIETY AND HENRY KREMER

The Aeronautical Society of Great Britain was founded in 1866, 37 years before Kittyhawk. Its purpose was "the advancement of Aerial Navigation and Observation in Aerology." It was closely connected with the Society of Arts, and held its first public meeting in the SoA's facility on June 17, 1866. The keynote lecture there, "Aerial Locomotion and the Laws by Which Heavy Bodies Impelled Through the Air are Sustained," was delivered by F.H. Wenham, one of the ASGB's six founders.

"In 1940, the RAeS responded to the wartime need to expand the aircraft industry. The Society established a Technical Department to bring together the best available knowledge and present it in an authoritative and accessible form – a working tool for engineers who might come from other industries and lack the specialised knowledge required for aircraft design. This technical department became known as the Engineering Sciences Data Unit.

"The Society now has over 25,000 members and has become an international, multidisciplinary professional institution dedicated to the global aerospace community." (source)

In the 1950s, a group of people from the College of Aeronautics at Cranfield became very interested in human-powered flight. They were invited to join the RAS as the "Man Powered Aircraft Group," in 1959.

British Industrialist Henry Kremer, under the auspices of the MPAG, offered two large cash prizes to stimulate technological development of man-powered flight. He offered a £5,000 prize for the first British citizen flying an aircraft made in Britain who flew a figure-eight course around two markers a half-mile apart.

There were no takers, so in 1973 Kremer opened the prize competition to all comers and upped the prize to £50,000. After that prize was awarded, the Kremer Foundation added a second £50,000 prize, open to all, for first human-powered flight over the English Channel.

BTW: The RAS and MPAG would drop the "Man" part of their charter in favor of "Human" in 1988!

Additional Kremer Prizes have been created since the *Gossamer Condor* and *Gossamer Albatross*. A £20,000 for "Speed" was awarded to a design team from MIT in 1984. They pedaled the *MIT Monarch B* over a 1.5 km triangular course in less than three minutes. Four additional prizes of £100,000 were awarded for improving that time successively by 5%.

Three Kremer Prizes have yet to be won: Flying a 26-mile course in under an hour (£50,000); a "sporting challenge" involving maneuverability (£100,000); and a local challenge for UK youth groups.

PAUL B. MACCREADY

Paul Beattie MacCready, Jr., was born on September 25, 1925, in New Haven, Connecticut. He showed a great interest in inventing things and aviation at an early age. He was still 15 when Pearl Harbor happened, but he enlisted in the Navy and trained as a pilot, earning his wings just before the end of the War.

MacCready then pursued further education in aeronautics, earning a B.S. in Physics from Yale (1947) and an MS (1948) and Ph.D. (1952) from Cal Tech. He then started a research company, and became interested in cloud seeding and using aircraft in meteorological research. He was no stranger to seeing clouds from all angles, having become an expert sailplane pilot. He would win the U.S. National Soaring Championship in 1948, 1948, and 1953, and in 1956, he became the first American ever to win the World Soaring Championship. Not only was an expert pilot, he also invented a device, the "MacCready Speed Ring," that is used to this day by sailplane pilots to determine the best airspeed to maximize lift and glide.

The trade-off of gravitational potential energy and flight kinetic energy is an important part of a pilot's skillset. I routinely see Air Force Academy cadets learning to fly, both in propeller planes and sailplanes as part of the academic program. In a couple of rare cases, a commercial airline pilot's skills as a sailplane pilot saved the day, and a lot of lives; the Item in two weeks will have examples.

[ASIDE: There is a big difference between a "glider" and a "sailplane!" The former were used to transfer people/cargo from air to ground; they had a very limited ability to gain altitude. A sailplane has a lighter design with larger wings, designed to be able to circle in an updraft and stay aloft for hours, perhaps traveling long distances horizontally. I grew up near Harris Hill, in

western New York, which is one of America's best spots to fly sailplanes, and the home of the National Soaring Museum. On a summer day with a few puffy cumulus clouds around (updraft markers), I could see several sailplanes overhead at once. Not all soaring there was for fun; one of the sailplanes built by Schweitzer Aircraft, a local firm that built gliders for WWII and trained military pilots in their use, was used by NASA at the Dryden Flight Research Center (now Armstrong FRC) at Edwards AFB, to study how pilots could handle stalls at very-high angles of attack (see here, page 14).]

MacCready's financial situation made the Kremer Prize for human-powered flight attractive, and it would be a good test of his aeronautical acumen and training. He teamed with Peter Lissamen, and started with a clean slate on the design. The result was the *Gossamer Condor*.

MacCready (and Lissamen) were aeronautical engineers, but not the right guys to provide the motive power to their new invention …

BRYAN LOUIS ALLEN

Bryan L. Allen's path to MacCready and beyond is an interesting one. He was born in southern California, graduated from Tulare Union High School, then attended the College of the Sequoias and Cal State Bakersfield. After earning an AA in Science, he worked for a time as a horticulturalist on a corporate farm (common in the southern San Joaquin Valley). He was an avid hang glider and bicycle racer, with a knack for being in the right place at the right time. He joined the MacCready team in 1977, and became the lead pilot for the aircraft being built to win the Kremer Prize, the *Gossamer Condor*, after the original pedaling-pilot decided to become a professional bicycle racer. He would fly both the *Condor* and the *Albatross*, helping earn two Kremer Prizes. He spent the year after the latter touring with the aircraft. After that, he held a senior position for a major manufacturer of ultra-light aircraft. In 1984, he and Bill Wilson, one of the engineers he knew from the *Albatross* started a business that made props for stage and movies.

Allen's rather-unusual career path became more unusual. One of the primary customers for the new business was Gallagher, the comedian famous for fruit abuse. One of the props they built for Gallagher was derived from a giant watermelon balloon, but they turned it into a human-propelled airship, the *White Dwarf*. Helium provided its lift, and Allen the propulsion; he actually set several flight records with it! The only video I could find of it is on Reddit here.

The Jet Propulsion Laboratory was Allen's next professional stop. He held a number of contractor positions, mostly in software systems and data management, and then joined the Lab's staff. He worked on the Ground Data System for the *Mars Exploration Rovers* twenty years ago, and as of 2007, was working "on *Mars Reconnaissance Orbiter* in two capacities, as an ACE who sends commands to the spacecraft and also as a member of the end-to-end Data Accountability Team tracking numerous data generation and delivery issues," see here.

Allen retired from NASA is February, 2019.

THE *GOSSAMER CONDOR*

A number of inventors tried to win the Kremer Prize, but none of them were particularly successful in covering the one-mile figure-8 while holding an altitude of at least ten feet. Wood was too heavy, and catapult launches couldn't be made to be powerful enough to launch but not wreck the aircraft. At least three improved designs flew but failed in the period from 1961-1972.

MacCready and Lissaman decided to utilize some of the design-work done for hang gliders. Their innovative design solution included a large wing that supported a skeletal gondola for the pedaling pilot. The framework was lightweight aluminum tubing, and the wing was covered with thin mylar sheeting. A small canard wing in front, controlled by the pilot, provided some measure of steering.

M and L used a three-step process for success. First, they built a nameless proof-of-concept version that they flew only once, in the parking lot of the Rose Bowl! The second was the *Gossamer Condor, Mojave version*, which had the pilot in an open position. MacCready's sons flew this test model at the Mojave Airport on December 26, 1976. It was a good design, but there was too much drag for even a strong bicyclist to make the one-mile course. The third model, the *Gossamer Condor, Shafter Version*, included an mylar-enclosed pilot gondola and other improvements. They laid out a one-mile figure-8 course near Shafter, California, and Byran Allen lifted the GCSV off on leg-power alone and flew the course at or above the needed height, claiming the Kremer Prize on August 23, 1977.

The *Gossamer Condor* was donated in 1978 to the Smithsonian National Air and Space Museum and was on display at NASM's National Mall Building for a number of years. I do not know if it still is on display, due to the recent and ongoing renovation of that building. NASM's website has a one-line description saying that it is on display, but the accompanying figure is clearly pre-renovation, so ….?

THE *GOSSAMER ALBATROSS*

The Kremer people were impressed and offered a £100,000 prize for the first human-powered aircraft to complete a successful take-off and crossing of the English Channel. Shades of Louis Bleriot and Harriet Quimby!

Of course, Paul MacCready was interested in the challenge. He and his team started with the *Condor*'s design and tweaked it to make a cross-Channel flight possible. The aluminum frame was replaced with the stronger and lighter carbon fiber, and expanded polystyrene foam was used to make the proper airfoil shape where needed. The wings were elongated at tapered at the end to increase lift. The "cockpit" was enclosed with mylar to reduce drag. You can see a three-view detailed drawing of the *Albatross* at: https://www.thisdayinaviation.com/12-june-1979/gossameralbatross3-view.

MacCready built three copies of the *Albatross*. After the Channel flight, the *Albatross II* was fitted with some aeronautical instrumentation and used as a test aircraft by NASA for research

into low-speed flight, in April, 1980. *Albatross II* would end up making 27 research flights as part of a NASA Dryden/Langley program.

The *Gossamer Albatross* is presently on display at the Smithsonian National Air and Space Museum's Steven F. Udvar-Hazy Center: https://airandspace.si.edu/collection-objects/maccready-gossamer-albatross/nasm_A19810428000.

AFTER THE CHANNEL

AeroVironment

MacCready had founded a company, AeroVironment, in 1971, and under its auspices had built the *Condor* and the *Albatross*. Their next ultra-light aircraft was the *Gossamer Penguin*, similar in design to the *Albatross*, but smaller (3/4 size), with a solar panel that provided energy for propulsion.

AeroVironment followed up the *Penguin* with the *Solar Challenger*, a more conventional design (high-wing, normal tail) with solar cells lining the rudder and the upper side of the wings and elevators. In full Sun, the cells could generate 3.8 kilowatts of power, enough to allow the *Challenger* to make a demonstration flight from France to England, covering 163 miles in 5 hours and 23 minutes, on July 7, 1981. The *Solar Challenger* was donated to the Smithsonian National Air and Space Museum soon thereafter, and was displayed briefly in the former Air Transportation Gallery in the National Mall Building. I could not find its location after the present renovation project closed that gallery, and there is no entry for it on NASM website.

The final solar-powered aircraft I'll mention is the *Pathfinder*, a flying wing that can fly at 80,000 feet and stay up indefinitely. It was designed and built by AeroVironment for a now-cancelled classified program and originally known as the *HASOL* (High-Altitude SOLar) aircraft, tested at Dryden FRC. It was put in military storage for a decade after the program was cancelled, then brought back by the Ballistic Missile Defense Organization in 1993 for more development work. From BMDO the aircraft went to NASA in 1994 to support its Environmental Research Aircraft and Sensor Technology project. For more details on the *Pathfinder*, see here.

Today, AeroVironment is the U.S. military's top supplier of small drones, like the Raven, Switchblade, Wasp, and Puma.

The Flying Pterodactyl

Paul MacCready did not rest on his laurels after the success of the *Gossamer Albatross*. He was able to analyze fossilized remains of a pterodactyl, *Quetzalcoatlus Northropi*, found in Big Bend National Park, Texas, in 1972. This particular species was the largest flying animal known, with a wingspan of 11 meters! It lived in the latest part of the Cretaceous Period, just before the Chicxulub impact event. From the bone structure and positioning, he realized that he could build a remote-controlled flying replica!

"In April 1984 the Smithsonian Institution's National Air and Space Museum initiated the project to build and fly the replica (called QN™), and subsequently the Johnson Wax company

agreed to provide the major funding. The project team is based at AeroVironment, Inc., with outside consultants helping in specialty areas. One goal of the project is to fly the QN replica on the National Mall in Washington, D.C., in June 1986 in conjunction with the opening of the National Air and Space Museum's IMAX film, "On the Wing," also funded by Johnson Wax. The QN replica will play a significant role in the film, which explores the connections between nature's fliers and aircraft." (source) Its scenes were filmed in Death Valley, and the replica flew just fine for the film.

The QN could not get aloft under its own power, because its legs weren't designed to be operational, so it would be towed aloft. Doing that on the National Mall for the film's debut was out of the question, so the flight was held at Andrews AFB, on May 17, 1986. Thousands of people showed up, only to watch the QN go unstable as soon as it was towed aloft, going into a rapid erratic spin vigorous to snap its neck in two. Both pieces crashed to the ground. See the Reference List for more info about the QN.

The remains of QN flying pterosaur replica are still in NASM's collection. There was a detailed article in the *Smithsonian Magazine* by Riley Black about it in September, 2023. Check it out here: https://www.smithsonianmag.com/science-nature/how-pterosaurs-might-inform-the-next-generation-of-flight-180982880. See also a *Chicago Tribune* article about MacCready and the QN, here: https://www.chicagotribune.com/1986/02/23/pterodactyl-takes-a-flight-of-film-fancy. For MacCready's own take on the project, see: http://calteches.library.caltech.edu/596/2/MacCready.pdf.

Awards

Paul MacCready won numerous awards for his work; his Wikipedia listing has 52 separate awards and honors! Most notably, he won the Collier Trophy from the National Aeronautics Association, the Reed Aeronautical Award from the American Institute of Aeronautics and Astronautics, and the Franklin Institute's Longstreth Medal in 1979; the Engineer of the Century Gold Medal from the American Society of Mechanical Engineers and the Spirit of St. Louis Medal in 1980; and the National Air and Space Museum Trophy for Current Achievement in 1988; among many, many others.

He was inducted into the U.S. Soaring Hall of Fame in 1954, the National Aviation Hall of Fame in 1991, and the National Inventors Hall of Fame in 2015.

Public Outreach

MacCready enjoyed sharing his love for creativity and engineering with students and the general public, especially in his later years. His two TED talks are still available, "Nature vs. Humans (1988) and "A Flight on Solar Wings (2003). He passed away on August 28, 2007, in Pasadena.

Legacy

Paul MacCready was not the only innovative engineer inspired by the prospect of long-distance solar-powered flight. Bertrand Piccard, who flew a hot-air balloon around the world in 1999, was inspired by the work that AeroVironment and others were doing in the late 1990s, and worked with Andre Borschberg of the Swiss Federal Institute of Technology to build a solar-powered aircraft capable of flying around the world with only the Sun as its energy source. On July 26, 2016, the two finished the trip successfully. It wasn't a non-stop flight by any means, taking 550 hours aloft over a 14-month period to cover over 25,000 miles, but they used only solar power for the entire journey. It was the subject of a NOVA documentary film, *The Impossible Flight*, that aired on January 31, 2018.

Piccard, Borschberg, and the *Solar Impulse 2* aircraft are a story deserving of its own Item of the Week treatment, and I will do so in late July, for the eighth anniversary of the flight.

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Legacy

Gossamer Albatross II

Testing of the *Gossamer Albatross II*: http://www.dfrc.nasa.gov/gallery/photo/Albatross/HTML/ECN-12604.html

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Gossamer Penguin

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Solar Challenger

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Pathfinder

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