

SOARING TECHNOLOGY AT TEHACHAPI

By Bruce Carmichael

THE GATHERING

From the four points of the compass, scientists, engineers, designers and pilots of sailplanes gathered at Mountain Valley Airport in late August 2002. The joining of the meetings of the International Sailplane Development Panel, the Sailplane Homebuilders Association Workshop, and the yearly Ralph Barnaby Lecture combined enthusiasts from Australia, Canada, Argentina and a half dozen European nations with a large American group. Four of the Development Panel members presented workshop lectures while a fifth presented the Barnaby Lecture. All of this occurred on a year when new developments in soaring flight were progressing from the planning stage to physical reality.

LESS EXPENSIVE, MORE CONVENIENT SOARING

The 8HA, since its formation in 1989, has placed emphasis in this area. This year, the 36-foot span composite 155# empty weight Sparrow Hawk by Greg Cole flew. It had already set records in the capable hands of Gary Osoba. The 49 foot 5pan~ 155# empty weight Light Hawk by Dan Howell also flew. While both meet the U.S.A. Ultralight empty weight requirement, Sparrow Hawk has a much higher wing loading. The very low wing loading Bug designs of Mike Sandlin were towed into flight by truck payout winch. Robert Mudd of Genesis fame presented the Apis light sailplane from Slovenia. This is one of four available smaller, less expensive sailplanes, (some of them self launching.) Choices between the hang gliders and conventional racing sailplanes have at long last appeared.

LIGHT VS. ULTRALIGHT SAILPLANES

For many years, Bruce Carmichael in the U.S. and Piero Morelli in Italy have been promoting the ultralight sailplane of very low sinking speed and small turn radius to allow exploration of situations too light for conventional sailplanes. It was hoped that a ship might evolve with a sinking speed as low as 1 foot per second to greatly expand date, time and place possibilities for sport soaring. These machines could not compete in cross-country races with the Sparrowhawk. Piero Morelli, in the first workshop, lecture pointed out the need to separate the two classes. They could both have the same maximum take off weight but the ultralight would have a separate category rounded by a lower wing loading. Recommendations have been made by the Development Panel.

SOLAR POWERED AND ELECTRICALLY LAUNCHED SAILPLANES

An almost silent large span sailplane rolled down the runway and lifted easily into the air from the 4000 ft. ele-

vation runway. Eric Raymond had almost single handedly designed and built this remarkable craft with wing and horizontal tail smoothly covered with solar cells. A pusher prop by Klaus Savier was powered by an electric motor mounted in the T tail. Michael Rehmert observed this flight and later lectured on electrical propulsion. Michael was the principle engineer of the solar powered sailplane nom Stuttgart, Germany which won the international contest. Since thermals normally used in soaring competition are the result of sunlight, power derived directly from solar cells would be considered allowable although a new class would no doubt be defined.

PROFILE DRAG REDUCTION BY SUCTION

The writer described flight experiments in which he was involved in the 1950's. The initial experiment with Dr. August Raspert in Mississippi employed a sailplane with suction applied from the main spar aft to the trailing edge. Span wise running .018 and .012 inch diameter holes at 19 per inch were punched 1/4 inch apart chordwise. Laminar flow was established to the trailing edge up to 100 M.P.H. and a chord Reynolds number of 4 million. He continued flight work with Dr. Pfenninger using a multi slotted airfoil on an F 94-A jet aircraft. Laminar flow to the trailing edge was achieved up to a chord Reynolds number of 30 million where the profile drag including the drag equivalent of the suction power was less than 0.001.

Work by F.X. Wortmann and Althaus in Stuttgart, Germany including a wind tunnel model was described. A very detailed design study of a giant all laminar sailplane by Pfenninger was described. Windmill driven suction pumps provided an L/D of 100 and a minimum sink of 1 ft./second. All system losses were carefully calculated based on Pfenninger's lifetime work on the subject.

The author next described a recent paper by Plesser which proposed a retractable windmill behind the tail, deployed during the climb in the thermal~ storing the energy in a flywheel. This stored power then drives the pumps applying distributed suction and reducing the profile drag to a value of 0.0012. This is all wake drag as the drag equivalent of the suction power has already been paid for in the reduced climb rate in the thermal.

Loek Bormans lectured on his doctorate work at Delft University in the Netherlands. He explained that profile drag reduction by geometric laminarization had reached a maximum of 65% laminar upper surface and 90% laminar lower surface. Attempts to go further result in dangerous non-linear lift and moment curves. Loek first investigated pressure recovery at a single slot at 80% chord with flow acceleration downstream. The drag equivalent of the suction power just balanced out the reduction in wake drag. His present studies are with distributed suction using solar cells to provide the pump power. His calculations indicate that this would increase the 60 L/D of a non-suction sailplane to 90. If the solar cell power were applied directly to a propeller the L/D would rise to 80. New perforation methods can rapidly produce holes of 0.1 nun diameter

and can even be produced through a solar cell covered surface. He will soon go into his low turbulence wind tunnel with a wing model.

INDUCED DRAG REDUCTION

Bowers, Chief of Aerodynamics at NASA Dryden Flight Research Center gave a magnificent historical review on minimizing drag due to lift. Starting with the 1920 Prandtl, Betz lifting line theory giving an aerodynamic minimum for elliptical lift and constant spanwise downwash. Prandtl Horten, and Jones next solved the minimum for constant root bending moment, which allowed a 22% span extension by reducing lift and downwash along the span resulting in an 11% induced drag reduction. Klein and Viswanathan examined the case for constrained bending moment and sheer and found a 16% span extension with a 7% induced drag reduction. Whitcomb of NASA developed the first winglets, decreasing induced drag by creating thrust. Horten with his bell shaped lift distribution also found thrust at the tips. Bowers went on to show the analogy in bird flight where minimum structural weight is required and tip thrust is obtained. He also described the favorable yaw of maneuvering birds and their use of tilted lifting horizontal tail in turning flight.

Al's fine lecture was supplemented by Prof. David Marsden, who had previously demonstrated improved cross-country flight through large slotted flaps and higher wing loading. This was applied to his 2 place Gemini and by modifications to the British Sigma sailplane. David has also developed one and two element winglets in his low turbulence wing tunnel and applied them to bath sailplanes and power planes. He also backed up previous comments on induced drag and winglet thrust.

Retired Flight Test Engineer, Robert Hoey, brought full size RJC models of a gull and a Raven and is now working on a Pelican. Without vertical tails he has demonstrated favorable yaw in the turn with deflected wing tips whether the single surface of the Gull OT separate tip feathers of the Raven. He has also demonstrated yaw into the turn by banking the lifting horizontal tail. He described a Da-Vinci like hang glider which he developed for a film company.

MICROLIFT AND DYNAMIC SOARING

These subjects have been considered a bit speculative by many of the soaring community to date. Recent flights by Gary Osoba, first in the Carbon Dragon ultralight sailplane, later in the Woodstock light sailplane followed by the Marsden modified British Sigma lead sled, and the experience of radio controlled model sailplanes in wind sheers has supported recent theoretical studies by Taras Kiceniuk. Excellent lectures were given by Osoba and Kiceniuk. Lists of theoretical papers by scientists from the 1800's revealed the interest in the subject now being accomplished in human flight. Energy is transferred to the sailplane when its lift vector is in the direction of the gust. This holds for up, down, and side gusts, and the amount of energy is increased when pulling g. Taras has studied cases

with variations of gust intensity, duration, and spacing. Gary has flown extensively over Kansas' flat land without circling.

ADDITIONAL LECTURES ACROSS THE SOARING SPECTRUM

Helmut Fendt of the International Sailplane Development Panel spoke about certification and licensing issues in Europe and the United States. Sailplanes are presently designed to JAR 22. Careful consideration of safety must accompany any divergence from this.

Danny Howell described the initial flight tests of the Light Hawk and the plans to build two more. Danny has encouraged university students to work with him to learn hands on the latest composite aircraft construction techniques. The Light Hawk, as a continuation of the Carbon Dragon philosophy, should enhance the exploration of micro lift and dynamic soaring.

Eric Raymond told about his time in Germany learning very light sailplane design and construction from Gunther Rochelt before embarking on the development of his solar powered sailplane. He described his method of applying solar cells to the wing and horizontal tail while maintaining laminar smoothness standards. He also talked about solar powered lighter-than-air craft and compared to problems when applied to both rigid and non-rigid designs.

Mike Sandlin showed photos and movies of his delightful Bug Ultra-light sailplanes including rolling take off from shallow slopes. These beautiful biplanes, built from hang glider materials, have given ultralight soaring experience to many.

Martin Hollmann spoke about the development of laminar wings, beginning with Prandtl's boundary layer theory, the work of Eastman Jacobs at NACA, and the work of Eppler and Nagele resulting in their Phoenix sailplane, the dividing line between former methods and the present composite construction.

Jeff Byard gave a fascinating illustrated lecture of Vintage Sailplanes many of which he has built, restored and flown. Jeff has played a leading role in American and International Vintage Sailplane work. He has also year after year made his fine insulated hangar available to the SHA for our workshops.

David Raspet reviewed the life and work of his father, Dr. August Raspet and the interesting people with which he was involved. Dr. Raspet served as the catalyst for Soaring Technology in the 40's and 50's, much as did Oskar Ursinus in Germany in the 1920's. His enthusiasm was infectious. Many people including Dr. Paul MacCready have spoken and written of the influence of Dr. Raspet on their lives and careers. David described his father's preference for the large step rather than incremental progress in research and development

Jim Short who has built, restored, and flown many vintage sailplanes spoke of the joy of wood aircraft construction. Radio controlled model sailplanes were flown by Parker MacCready and Carl Rankin in the early morning.

THE RALPH BARNABY LECTURE

Leading European sailplane designer, the jovial and popular Gerhard Waibel, delivered this year's Ralph Barnaby lecture. With numerous charts he reviewed high performance sailplane development, projecting ahead to the year 2050 and an anticipated L/D of 100. After projecting size extrapolation of existing practice, he reviewed the influence of newer concepts including, Solar Power, Induced Drag Reduction, Suction Profile Drag Reduction, and Dynamic Soaring as detailed in this SHA workshop. He interrupted his presentation in mid-flight to play, "Honey I Need A New Sailplane" to the delight of the largest SHA Banquet attendance to date. We are so indebted to Gerhard for putting the perfect cap on our 02 Workshop.

SUMMARY

The eager and talented participation of both American and European speakers delineated 5 alternate developments in soaring technology. Dr. MacCready who has often lectured at our workshops, attended, took numerous notes and remarked that this was a soaring symposia of highest caliber coming at a time of many new approaches, an exciting time for the World of Soaring.

ACKNOWLEDGEMENTS

The inspiration of combining the Sailplane Development Panel~ the SHA Workshop and the Barnaby Lecture was due to Janice Armstrong, SHA Sailplane Builder Editor. Much of the hard work of organizing these events and arranging for a tour of the local windmill farm was done by Janice and her aero engineer husband Dan. The Australian contingent of John Ashford and Alan Patching arrived early and pitched in. Mrs. Tony Segal did much of the work involved with the evening hangar meals. Jeff Byard provided his fine Insulated hangar for the lectures and meals. The Armstrongs provided their adjacent hangar for book and T-shirt sales. The SHA lecturers were tracked down, committed to speak and shot down at the end of their hour by Bruce Carmichael.