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AN ANNOTATED BIBLIOGRAPHY ON PARAGLIDERS

by Clyde Briggs

January 1963

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Francis M. Rogallo, John G. Lowry, Delwin R. Croom [illegible] T. Taylor, Preliminary investigation of a paraglider. August 1960. NASA Technical Note D-443.

Preliminary tests of flexible wing gliders indicate stable, controllable vehicles at both subsonic and supersonic speeds. Such vehicles may be made extremely light with available materials. The results of this study indicate that this concept may provide a lightweight controllable paraglider for manned space vehicles.

Rodger L. Naeseth, An exploratory study of a parawing as a high-lift device for aircraft. November 1960. NASA Technical Note D-629.

A wind-tunnel investigation was made of the high-lift capabilities of two supersonic airplane configurations equipped with parawings, which are lightweight, stowable, fabric wings of parachute-like construction that may be used for take-off and landing.

Donald E. Hewes, Free-flight investigation of radio-controlled models with parawings. September 1961. NASA Technical Note D-927.

Radio-controlled free-flight tests and static force tests were made to study the performance, stability, and control characteristics of two models with parawings. The glider model incorporated a control system which shifted the center of gravity for both longitudinal and lateral control. The airplane model utilized conventional rudder and elevator control surfaces.

Paul G. Fournier and B. Ann Bell, Low subsonic pressure distributions on three rigid wings simulating paragliders with varied canopy curvature and leading-edge sweep. November 1961. NASA Technical Note D-983.

This paper presents the effect of paraglider canopy curvature on the chordwise pressure distribution, at four spanwise stations, of three rigid metal models simulating a 45° basic flat planform paraglider with leading-edge sweep angles of 61.6°, 52.5°, and 48.6°. These configurations resulted in one-half-circle, one-third-circle, and one-quarter-circle semispan trailing-edge curvature when viewed from downstream. Tests were made at angles of attack from 0° to 74°.

Robert T. Taylor, Wind-tunnel investigation of paraglider models at supersonic speeds. November 1961. NASA Technical Note D-985.

Lift and drag measurements were made on paraglider models in the Langley Unitary Plan wind tunnel at supersonic speeds. Values of maximum lift-drag ratio were about 1.4 at a Mach number of 2.65 and about 1.2 at a Mach number of 4.65. The angles of attack of tests were limited by unsteady behavior of the models.

H. G. Hatch and W. A. McGowan, An analytical investigation of the loads, temperatures, and ranges obtained during the recovery of rocket boosters by means of a parawing. February 1962. National Aeronautics and Space Administration, TN D-1003.

First-stage boosters of two rocket vehicles were used. Burnout occurs at a Mach number of 3.2 and an altitude

of 90,000 feet for one booster and at a Mach number of
6.7 and an altitude of 203,000 feet for the other.
Recovery trajectories were calculated for a parawing
deployed at apogee of the booster trajectory. Lift
modulation was used to reduce the peak loads.

P. G. Fournier and B. A. Bell, Transonic pressure distributions on three r
wings simulating paragliders with varied canopy curvature a
leading-edge sweep. January 1962. National Aeronautics ar
Space Administration, TN D-1009.
An investigation was made of the chordwise pressure
distribution at four spanwise stations of three rigid
metal models simulating a paraglider which had a basic
flat planform with leading edges swept back 45 deg.
These configurations had leading-edge sweep angles of
61.6, 52.5, and 48.6 deg, which resulted in one-half-
circle, one-third-circle, and one-quarter-circle
curvature of the semispan trailing edges when viewed
from downstream. Tests were made at angles of attack
from 10 to 90 deg.

Jim A. Penland, A study of the aerodynamic characteristics of a fixed geom
paraglider configuration and three canopies with simulated
variable canopy inflation at a mach number of 6.6. March 1
NASA TN D-1022.
Three-component force tests have been made on the para
configuration consisting of a canopy having leading-ed
and shroud-line diameters of 1.8 percent of the keel l
and a payload diameter of 11 percent of the keel lengt
Further force tests were made on unshrouded canopies w
three different degrees of simulated canopy inflation.

C. E. Craigo and J. H. Burich, Flexible-wing manned test vehicle. Ryan
Aeronautical Co., San Diego, California, Technical Report
22 June-15 November, 1961. August 1962. TCREC-TR-62-25.
A description and test results are given on a manned t
vehicle employing the Rogallo-type flexible-membrane w
Weights, design criteria, and calculated stresses in t
principal wing structural members are presented, toget
with strain gage records of stresses in flight. Fligh
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The results of various modifications to the original
configuration are discussed and recommendations toward
further improvements are proposed.

Ryan Aeronautical Co., San Diego, California, Paraglider recovery system f
the saturn booster. August 15, 1961. Presented at NASA
Marshal Space Flight Center, August 15, 1961.
Results are presented of a technical and economic feas
study to evaluate the dry land recovery of the Saturn
booster using the Rogalo Flexible Wing. Since the fle
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was based on considerations of the required wing geome

G. R. Cota (Ryan Aeronautical Co., San Diego, California, Concept and aerodynamic improvement of paragliders for spacecraft recovery. SAE, 1962, Preprint 590E. RL 38,783.

Evaluation of studies indicating that paragliders may provide lightweight, controllable re-entry vehicles suitable for spacecraft recovery. During entry, the light wing loadings available with this concept result in peak radiation-equilibrium temperatures below the temperature limits of existing materials, thus, eliminating the need for heavy ablative heat-protection systems. After atmospheric re-entry, this concept provides controlled glide to a preselected landing site, and the capability of landing with very low touchdown velocities.

J. S. Hamilton, Large booster recovery techniques. ARS, Space Flight Report to the Nation, New York, N. Y., October 9-15, 1961, Preprint 2049-61.

Review of proposals for the safe recovery systems for equipment, boosters, booster components, and entire vehicles used in space launchings. Some of the systems now under study are described and illustrated, including (1) paraglider or flexible wing, (2) auto-gyro, (3) air snatch, (4) parachute balloon, and (5) parachutes and retro-rockets.

Francis M. Rogallo, Paraglider recovery systems. For presentation at IAS Meeting on Man's Progress in the Conquest of Space, St. Louis, Mo., April 30-May 2, 1962. RL 38,175.

A study is made of some of the design characteristics of a paraglider, as a possible reentry recovery system. The investigation is conducted on the two-lobe, single-curvature, suspended-load design. The following features make the membrane wing attractive for reentry use: its very light wing weight per unit area make possible very low wing loading; it is able to be rolled up or folded like a parachute; radiation from both surfaces reduces aerodynamic heating, and flexibility reduces thermal stress, its very thin wings reduce wave drag at high speed.

J. G. Lowry and F. M. Rogallo, Flexible reentry glider for bringing astronaut to earth unscorched. SAE Journal, Vol. 68, July 1960. and SAE Preprint 175c.

A promising contender among reentry vehicles under investigation by the NASA for aeronautic and space flight application is the flexible glider. In this conception, the passenger and cargo compartment is suspended on lines beneath the flexible aerodynamic surface, which is essentially a tension structure of very light weight per unit of area. This lifting surface would be kept folded in a bundle like a parachute until deployed for reentry.

K. R. Stehling, Economics is key factor in booster recovery. Space/Aeronau
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Review of the problem of booster recovery. The economi
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Russell Hawkes, Rogallo wing studied for combat mission. Aviation Week & S
Technology, vol. 74, June 5, 1961.
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O. Romaine, Booster recovery by paraglider. Space/Aeronautics, vol. 37, no
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Victor de Biasi, Booster recovery techniques. Space/Aeronautics, 1962-1963
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Society of Automotive Engineers, Paper 432B, October 1961 an
SAE Journal, Vol. 70, February 1962.
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