Meetings

Sailing Yacht Research

The locomotion of sailing vessels depends upon two mediums—water and air. Thus, it would naturally follow that the study of such vessels would include research in the fields of both hydrodynamics and aerodynamics. In order to review and discuss the newest findings in the field of sailing yacht research, a symposium was held 9 November 1966 at Massachusetts Institute of Technology. In attendance were over 300 yachting enthusiasts—yacht designers, sailmakers, theoreticians, and experimentalists.

After a brief introduction by A. H. Keil, J. E. Kerwin reviewed methods for evaluating hull performance. He described the satisfactory degree of correlation of the full-scale tests of a 5.5-meter boat in the David Taylor Model Basin with a 1:6 size, towed model at M.I.T. The differences were less than 2 percent in drag and less than 10 percent in side force when 80 percent of the equivalent flat plate was used as a scaling factor and when a row of studs 4 inches aft of the leading edge of the scale model was used to create turbulence. Kerwin then described a number of experiments on his own cruising boat where the side force on the plane (lift of the keel) was shown to depend in the expected way upon the square of the draft and to be largely independent of the area of the plate (as predicted from aerodynamics). This result gave a sound theoretical basis for the better speed to windward of "short keel" One Ton Cup and 5.5-meter yachts since they developed the same side force with less wetted area than their long-keel counterparts.

Peter DeSaix (Davidson Laboratory) carried on the discussion of the consequences of Kerwin's statements. DeSaix pointed to the tendency to shorten the keel, a characteristic of many types of present-day designs for cruising and day-racing yachts. He presented the problem of maneuverability and the turning force of the rudder attached to the keel compared with that of the rudder separated from the keel. Superior performance was clearly indicated in the latter case. Turbulence and flow-separation problems with the separated rudder were discussed; data were presented for a number of values of Reynolds number.

DeSaix described a striking series of drag-speed data obtained from a servo control articulated arm, following a model of the 12-meter sloop *Sovereign*. His data showed striking increases of resistance under particular sea conditions. Also significant changes in the drag occurred because of increases of the moment of inertia about the pitching axis.

Active discussions were held, and Haggarty verified that the full-scale tests of separated rudder and keel in his cruising boat had greatly improved her directional stability and controllability on reaches. DeSaix described briefly separated keel and rudder tests on a 5.5-meter (Complex II). There he noted not only greater controllability but also extreme directional stability when the spade rudder was locked, and control was exercised by the usual rudder attached to the keel.

Newman (David Taylor Model Basin) described his derivation of algebraic equations for the forces acting upon a sailboat running before the wind with a spinnaker set in a following sinusoidal sea. Assuming sinusoidal rudder motions, it was apparent that for a 5.5-meter yacht under particular conditions, the overall oscillating motions were small if the yacht is simply allowed to yaw with the waves and not steered at all! Steering so as to prevent yaw would cause excessive roll. In the discussion it was found, however, that sophisticated forms of rudder control employing higher integrals of the yaw angle probably would be effective in making the best compromise between roll and yaw.

Paul Spens (Department of Aeronautics and Astronautics, Southampton University, England) was unable to attend, and Peter Ward Brown (Stevens Institute) presented his paper. Spens has made a number of interesting observations, particularly with respect to the employment of full symmetrical models of sailboats in a wind tunnel. In addition, as a side issue, Spens presented comparative data on centerboard, bilge board, and lee board, showing the centerboard to be the most effective until high hull speeds were reached.

Sail research in a wind tunnel and with a moored full-size Dragon Class yacht was described. A number of interesting interactions between the sails and the deck of the craft itself were observed; for example, increased performance was obtained by increased proximity of the main boom and the jib to the deck. Accuracy problems arose in the full-scale tests, particularly due to the instability of the intensity and direction of the wind. It was expected that extremely long averaging times would be needed to obtain sufficiently accurate data for comparison of the performance of different suits of sails.

The "Gimcrack" coefficients (a set of values for expressing the sail forces as applied to the model) had been retested with results accurate to 2 to 3 percent.

H. Herreshoff gave an interesting summary of the general problems of measuring the efficiency of sails as based upon the wind tunnel tests of the scale models of 12-meter sails for conditions of varying camber and position of the camber in the mainsail. His conclusions indicate that the larger camber, farther aft seemed to be superior. However, the lift coefficient presently obtainable from most sails was pointed out to be inferior to that obtained from aircraft wings by a large factor. It was suggested that the use of the parameters of aircraft wings, such as vortex generators, boundary layer control, and others, might prove valuable when applied to the designing of sails.

Jerome Milgram of M.I.T. described pressure distribution on sails and commented on a number of important factors in sail design. For example, he cited the extent to which a high aspect ratio sail with a high center of pressure could be used effectively in a highly stable 5.5-meter, while it was relatively ineffective in the Star boats which have comparable sail area but less stability. It was shown that for most sail cross sections in use, if two sails were of the same

draft, the one having the maximum draft further aft will develop more force than the other, provided each sail is operating at its ideal angle of attack. Obviously such factors interact with the hull performance for an optimal result. The properties of fabrics were briefly discussed, particularly nonreversible stretch and the minimization of this property by gluing seams prior to stitching. It was pointed out that there is no tension along the leech of a sail and a comparatively large tension just forward of the leech. This is the cause of the frequently encountered "cupped leech." Such cupping can be minimized by the use of a hard finish sail cloth and untabled leeches.

The nature of the slot between the jib and the mainsail was discussed, and notwithstanding the fact that measurement rules often influenced optimization of this, Milgram pointed to the highly effective design for the 5.5-meters where, as a matter of fact, the rig was more efficient without an actual overlap between the jib and mainsail. In this connection, Milgram pleaded for a revision of class measurement rules which had long restricted the exciting development of cruising class rigs. Small, high-aspect ratio mainsails with a short, readily controllable boom were now shown to be highly efficient and effective in the One-Ton Class. Furthermore, realistic measurement of the head sail area could lead to sails of more modest size compared to the large Genoa jibs now in vogue in many of the cruising classes, with very little decrease in performance.

In the discussion, water-flow techniques for studying sail performance were mentioned, particularly with respect to the better visualization techniques that are possible in water flow. However, this advantage was countered by exciting films of turbulence in the 12-meter sails, obtained through the cooperation of the late Freidrich Ringleb (Naval Air Engineering Center, Philadelphia) where wind tunnel tests of 12-meter sails clearly showed many interesting qualitative properties of air flow around the sails.

It was apparent from this meeting that the satisfactory correlation of the full-scale tests on the 5.5-meter model at David Taylor Model Basin with the 1:6 size model now puts the model testing program on a much firmer footing. One can now look forward to a great deal more quantitation of these data. This result, coupled with a better understanding of the properties of keels of low projected area and a realization of the steering problem of such short-keel designs involving separated rudders with or without appropriate skegs, seems now to place the keel boat in a most interesting position. One can expect exciting developments in the America's Cup class (12 meters) and the Olympic class (5.5 meters) and in the new three-man, keel boat of the International Yacht Racing Union, to say nothing of the large number of ocean racing cruising boats of advanced design. This progress, together with the possibilities of studying the performance of models under simulated rough water conditions, will bring into the region of quantitative study some problems whose solutions have been completely empirical or largely unknown to date.

Quantitation of sail performance from wind tunnel tests of scale models or from tests of full-size craft is springing up in several places. These results, when accurately correlated with programs for actually calculating the pressures and lifts of sails of known design, will further provide a springboard of quantitative data for improvement in an area where empiricism has reigned supreme. It seems now that science and sailing sport may go hand in hand to give one of nature's most exhilarating physical experiences an intellectual aspect as well.

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Forthcoming Events

May

1–2. **Adhesion** (Cold Welding) **of Materials in Space Environments**, natl. symp., American Soc. for Testing and Materials, Toronto, Ont., Canada. (The Society, 1916 Race St., Philadelphia, Pa. 19103)

1–2. Association for **Research in Ophthalmology**, Clearwater Beach, Fla. (H. E. Kaufman, Dept. of Ophthalmology, Univ. of Florida College of Medicine, Gainesville 32601)

1–2. Colloquium on the **Pupil**, Univ. of Pennsylvania, Philadelphia. (A. Laties, Old Medical School Bldg., Univ. of Pennsylvania School of Medicine, Philadelphia)

1–2. Rocky Mountain **Bioengineering** Symp., Univ. of Colorado Medical Center, Denver. (RMBS, P.O. Box 59, USAF Academy, Colo. 80840)

1–2. 1967 **Rural Electrification** Conf., Cedar Rapids, Iowa. Office of Technical Activities Board, (Inst. of Electrical and Electronics Engineers, 345 E. 47 St., New York 10017)

1–3. American **Astronautical** Soc., 13th annual mtg., Dallas, Tex. (R. Gilmer, Varo, Inc., 800 Garland Ave., Garland, Tex.)

1–3. **Geology and Technology of Gulf Coast Salt**, symp., Louisiana State Univ., Baton Rouge. (D. H. Kupfer, Dept. of Geology, Louisiana State Univ., Baton Rouge 70803)

1–3. **Markov Processes and Potential Theory**, spring symp., Madison, Wis. (J. Chover, Mathematics Research Center, Univ. of Wisconsin, Madison 53706)

1–4. American Soc. of **Lubrication Engineers**, 22nd annual, Toronto, Ont., Canada. (The Society, 838 Busse Hwy., Park Ridge, Ill. 60068)

1–4. **Pulp Bleaching** Conf., 4th intern., Toronto, Ont., Canada. (Canadian Pulp & Paper Assoc., Technical Section, 2280 Sun Life Bldg., Montreal 2, P.Q.)

1–5. American **Industrial Hygiene** Assoc., conf., Chicago, Ill. (The Association, 14125 Prevost, Detroit, Mich. 48227)

2–4. Purdue **Industrial Waste** Conf., Lafayette, Ind. (D. E. Bloodgood, Purdue Univ. of School of Civil Engineering, Lafayette 47907)

2–4. **Research Reactor Utilization** and **Reactor Mathematics**, intern. conf., Mexico, D. F. (O. J. Du Temple, American Nuclear Soc., 244 E. Ogden Ave., Hinsdale, Ill. 60521)

2–5. Biological Effects of **Pesticides**, conf. New York Acad. of Sciences, New York, N.Y. (Executive Director, The Academy, 2 E. 63 St., New York 10021)

2–5. **Pulp and Paper** Industry Tech. Conf., Houston, Tex. (W. S. Hines, Westinghouse Electric Corp., Box 4808, Atlanta, Ga. 30302)

2–5. Use of **Subhuman Primates in Drug Evaulation**, symp., Southwest Foundation for Research and Education, San Antonio, Tex. (L. R. Smith, Jr., The Foundation, P.O. Box 2296, San Antonio 78206)

3. **Current Concepts in Etiology** and **Diagnosis of Cancer**, American Cancer Soc., 1967 scientific session, Dallas, Tex. (Vice President for Professional Education, The Society, 219 E. 42 St., New York 10017)

3–5. **Electronic Components** Conf., Washington, D.C. (Office of Technical Activities Board, IEEE, 345 E. 47 St., New York 10017)

3–5. **Human Factors in Electronics**, 8th annual symp., Institute of Electrical and Electronic Engineers, Palo Alto, Calif. (R. J. Randle, Biotechnology Div., Ames Research Center, Moffett Field, Calif.)

3–5. **Pulp** and **Paper Instrumentation symp.**, 8th intern., Instrument Soc. of America., St. Paul Minn. (S. Slenning, Honeywell, Inc., 415 E. 27 St., Minneapolis, Minn. 55408)

5–6. **Clinical Colloquia** of Vienna, Vienna, Austria. (Mrs. M. Peutlschmid, Vienna Acad. of Medicine, Alser Strasse 4, A-1090 Vienna)