Some Problem Areas of Possible Interest to AIAA Members

AS this Journal sails into its twelfth year, we continue to be faced with a dearth of manuscripts, the backlog being of the order of 25 and, as a result, there are wretched people in the ranks. Wretchedness* exists among the administrators who require balanced budgets, among subscribers who seek relevance without mathematics, and in the editorial precincts where fat, sleek "succinct" volumes are revered.

This chief wretch had the recent thought that perhaps there are those in the legion of AIAA membership who are not as aware as they could be of the similarity of the fluid mechanics problems posed by the various categories of vessels and off-shore structures to those with which the aerodynamicist and aerostructural engineer are indeed familiar. To be sure, many of the techniques which have been applied to the field of ship or marine hydrodynamics were mined directly from the mountains of work done by aerodynamicists prior to and since 1950 and, in many notable instances, by researchers who were trained by aeronautical faculties. Naval architectural education had been highly inbred, and the traditional ship designers were so (necessarily) conservative that they found it impossible to give much credance to theories—let alone those in which approximations were made, such as neglect of second-order terms!† Today this situation has been corrected, at least in the educational processes, as may be gleaned from J.N. Newman's recent text (*Marine Hydrodynamics*, MIT Press, Cambridge, Mass., 1976), which reflects the advances in the past 25 years in treating the hydrodynamics of ship and floating structures.

Much use of perturbation methods exploited extensively by aerodynamicists has been made in analyzing the course stability and response to waves of ships and submersibles, the chief differences from the analogous aerodynamic problems arising from the influence of relative density of the body and fluid and the presence of the water surface. Considering the steady maneuvering of a slender vessel in calm water, one must, in principle, account for the fact that the water surface is at once a stream surface and one of constant pressure.

Constancy of pressure on the free surface produces a nonlinear relation between the main stream, the perturbation velocity components, and the water surface deformation, $\zeta(x,y)$, to be evaluated, in principle, on this unknown surface $z=\zeta(x,y)$. Approximate treatments are made by linearizing the free surface condition and evaluating all quantities on $z=0$ when $\zeta(x,y)$ can be considered small. Essentially "aerodynamic" boundary conditions are recovered at extremes of the Froude number since the combined first-order kinematic and pressure conditions impose a constraint on the perturbation potential ϕ of the form

$$\frac{\partial^2\phi}{\partial x^2}+F^{-2}\frac{\partial\phi}{\partial z}=0; \quad (z=0, \quad \text{all } x,y) \tag{1}$$

where all quantities have been consistently normalized by a characteristic length, say l, and the reference speed U, and F is the Froude number $U/\sqrt{gl}$. Thus, for $F\to 0$, the gravitational influence predominates, $\partial\phi/\partial z=0$ on $z=0$, and the free surface acts like a rigid, nonporous wall. As $F\to\infty$ (high-speed), dynamic pressures overwhelm those produced by gravity yielding $\partial^2\phi/\partial x^2=0$ and, as $\phi\to 0$ at large distances, $\phi(x,y,0)\equiv 0$ for all x,y. This condition is like the aerodynamic condition on the boundary of a free jet and is met basically by imposing an image distribution at reflected points above the water surface of opposite sign to those needed on body elements below the surface. Between these extremes of F, the basic solution of Laplace's equation meeting (1) is complicated, but well studied (see, e.g., Wehausen and Laitone, *Handbuch*, Band IX, Springer-Verlag, Berlin, 1960). For maneuvering of ships at low speed, the water surface effect generally can be accommodated by the rigid wall limit. At wave-making Froude numbers, the linearized theory as applied to ships has not been sufficiently accurate for engineering purposes, although more elaborate numerical methods by Gadd, Salvesen, and others are showing better agreement with measurements.

The aerodynamics of a lifting surface in cyclic gusts have been adapted by Tsakonas in the U.S.A and van Gent in the Netherlands to ship propellers operating in the spatially nonuniform flow provided by the ship hulls. An outstanding problem here is the prediction of the influence of the propeller field on the viscous wake of the ship, which is almost always determined from measurements made behind model hulls in the absence of the pressure gradients and velocity field of the propeller.

Unsteady cavitation, currently of high interest, has been broached only recently because of the occurrence of intermittent cavitation on heavily loaded ship blades as they sweep through regions of low inflow. The behavior of surface effect ships in waves involves free surface and aerodynamic plenum flow interactions, which have not been explored sufficiently; what has been done has not been adequately disseminated.

For those who may be intrigued to examine these and other problems, I recommend reading the state-of-the-art summaries given in the *Proceedings of the International Towing Tank Conference, Ottawa, 1975*, and, for structural matters, *Proceedings of the International Ships Structures Congress, MIT, Boston, 1976*. Although these volumes are not generally available, I could refer you to members in your area who might provide them on loan.

A concerted effort is being made to enlarge the Journal's topical coverage and volume of manuscripts. Largely through the efforts of Ralph R. Ragan, Vice President—Publications, we are endeavoring to enlist the assistance of specialists in ocean-oriented instrumentation, advanced vessels, marine structures, underwater acoustics, and physical oceanography. As a significant step in this direction, we are pleased to announce the appointments of Dr. D.R.S. Ko, President of Dynamics Technology, Inc., Torrance, Calif and Professor D.M. Layton, Department of Aeronautics, U.S. Naval Postgraduate School, Monterey, Calif., as Associate Editors.

I wish to thank most heartily all contributors and to note that we are especially indebted to the reviewers cited below for their devoted efforts in evaluating manuscripts during the past year. Only through the outstanding work afforded by Mrs. Anne Huth and her staff, and the support of Miss Ruth F. Bryans, has it been possible to render the service represented by our last year's issues. We shall endeavor to carry on in 1978 to reduce all wretchedness in the ranks!

J.P. Breslin
Editor-in-Chief

*Webster defines wretchedness as a state of deep affliction, dejection, of being very miserable—we use it figuratively.

†Designers of ships and off-shore facilities per force must be conservative since the ferocity of storm seas has always to be countered.