SCHRIFTENREIHE SCHIFFBAU

LESEPROBE
ON PROBLEMS OF WAVE RESISTANCE RESEARCH

Georg P. Weinblum

Institut für Schiffbau, University of Hamburg
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Synopsis

The impact of theory on shipbuilding practice is modest, even model research does not make proper use of theoretical solutions. This state of affairs is largely due to erroneous judgment, but to inspire actual design, efforts must be made to develop basic theory as well as its application and evaluation and experimental research. The synopsis is restricted to uniform motion in calm water. Some problems of ship geometry and generation of bodies by singularities are discussed. Results of linearized theory are enumerated dealing with wave pattern (shortly) and with resistance. The problem of optimisation is reviewed. Second order and non linear effects are briefly touched upon. Experimental methods are appraised and results of an investigation on resistance of simple ships are communicated.
Introduction

During the process of planning the program of the symposium I asked my colleague Wehausen to contribute an introductory synopsis on our subject, eventually as a joint enterprise. My humble request has been declined essentially by pointing out that such an attempt is superfluous at a meeting consisting of specialists. I agree to a wide extent with this reasoning — a summary of the discussions produced at the conference will be much more productive. However, since the participants come from different camps and our family is being rejuvenated, some general if by no means systematic remarks on our subject may be nonetheless justified. The purpose is to point out some weak spots in the earlier approach and to suggest increased activity in the field of basic theory, of its application and evaluation and of crucial experimental work. Occasionally the survey of literature may lead to a communication of less known information.

When we consider as starting point the surveys given by Wigley 1 in the early thirties the principal trends in the development of our subject could be followed till recently by studying Havelock's work 2 and such highlights as the wave resistance conference in Moscow 1937 3, the publication of the already famous II. volume of the Japanese Ship Theory 4 and the Symposium at Wageningen 1960 5. We wish that the present seminar may play a similar role.

Several years ago a prominent member of the Moscow conference remarked to me that there is no need to toil about the wave resistance theory since ships can remain afloat without any hydrodynamic theory; the latter has a more_
or less decorative value only - an opinion shared by many practical people. This questionable statement is justified in so far as up to now the impact of theory on actual shipbuilding practice is modest only. There are some obvious indications of this sad state of affairs; a less serious one stems from the fact that the numerous ITTC Congresses have not acknowledged officially the existence of our theory, (i.e. it has not been a topic of its meetings notwithstanding attempts to make it presentable at this court). As a more serious shortcoming we consider the fact that the rather popular systematic model series are being planned without making use of wave resistance theory.

It is the definite purpose of our meeting to promote the development of theory as well as its application to model work and ship design. Obviously, our difficult subject could and can be treated theoretically by introducing drastic simplifications and abstractions only; but endeavours should be made in due course to relax restrictions and to enlarge the scope of problems presented by practice which frequently are unpleasant and difficult to handle. Further, when practical application is aimed at the influence of other design criteria on wave resistance research must be studied. Such considerations have been made but in a rather cursory fashion.

Contrary to the pessimistic or ignorant opinions quoted it is our contention that theory should represent already now an indispensable tool in model research work and thus should influence at least indirectly design.
There are from the viewpoint of practice two main problems which theory must solve - the determination of resistance for a given hull form and the development of shapes of least (low) resistance, although in principle, an adequate theory is able to handle both problems. Since, however, only approximate methods were available these practical aims have produced different trends in research.

I welcome the fact that our kind hosts have included the discussion of an experimental determination of wave resistance in our programm as far as these experiments are connected with scientific ideas. For a long time there has not been any progress at all in pertinent experimental methods; a more satisfactory approach has been developed actually not earlier than the application of theoretical means. Looking back, my teacher Föttinger was right in asserting (1924) that his proposal concerning double models was almost the only new basic idea since W. Froude.

Although wave resistance is the 'economically' most important 'free surface effect' phenomenon as far as ships are concerned other generalized forces can be determined almost as byproducts in our field. It appears that they will be studied especially in the case of the motion in a seaway. Although there is a certain danger that the scope of our seminar may become too ample, it may be still more dangerous to restrict ourselves artificially to resistance only.
Obviously, mathematicians and naval architects sometimes have different opinions as to what is important in studies of wave resistance. Some painstaking developments are a bogey to engineers; in their opinion methods are needed which lead to explicit results; the difficult work should not be burdened by mathematical niceties. However, it is now generally understood that investigations, e.g. on second order and non linear effects represent an indispensable prerequisite of the practical as well as of the scientific progress.

Even when we restrict ourselves to the resistance only, the scope of our studies is ample: Steady and unsteady motion, rectilinear and curved path, unrestricted and restricted water, smooth and corrugated water surface (the latter regular and irregular), displacement vessels of various types and hydrodynamic craft - in fact an impressive list!

In what follows I shall confine myself to remarks on the simplest problems - the resistance experienced by ships moving uniformly rectilinearly at or under a smooth water surface. We shall briefly discuss the classes of ships but eliminate completely hydrofoil craft since this topic has been the subject of other recent meetings.

Ship theory is widely indebted to aerodynamics. Aerodynamicists have ridiculized our inefficiency in handling problems of ship resistance (although they themselves have frequently failed when they condescended to deal with the (water!) wave resistance). We
admit that ship resistance has been investigated frequently more industriously rather than intelligently; this applies to experimental work as well as to theory and especially its application. Possibly the productivity of thinking has suffered in our field by the need for tedious auxiliary work caused by the complicated hull form. In the experimental field it has been disastrous that dependence rather on 'running models' than on investigating resistance problems.

It had been almost a dogma amongst naval architects that it was practically impossible to calculate the wave resistance of ships. Thus Havelock's and Wigley's work opened a new area in ship theory. Naturally, after the long stagnation romantic feelings arose as to possibilities furnished by the existing theory. The present writer was especially responsible for pressing it hard from the point of view of application to practice. He feels grateful for the opportunity given here to express a more moderate appraisal of earlier results.

On the other hand erroneous deprecating statements have been made occasionally by prominent theoreticians on the practical value of Michell's theory based on a superficial comparison of calculated and measured results which actually refer to non-identical ship forms! Obviously, the practical merits of theory can no more be supported to-day by demonstrating such a common place as the correct dependence of the resistance upon \( \varphi = c_p \) in a well known range of the Froude number. In order to be helpful theory must be able to disclose finer form effects. To make a modest contribution in this direction (with success) some we have repeated...