Journal of Engineering Mathematics **42:** 223, 2002.

Introduction

Free-boundary problems occur in many applications of science. They can be defined as problems whose mathematical formulation involves surfaces (free surfaces) which have to be found as part of the solution. Examples of free-boundary problems arise in waves on a beach, bubbles rising in a fluid, melting ice, sails blowing in the wind and the wake of a body. In these examples the free boundary is the surface of the sea, the interface between gas and liquid, the surface of the ice, the surface of the sail and the shape of the wake, respectively. In this issue we restrict our attention mainly to problems arising in fluid mechanics.

The theory of free-boundary problems has been an active field for more than 150 years. In particular linear theories, weakly nonlinear theories and fully nonlinear numerical solutions have been developed. Many results have been obtained for steady two-dimensional free-surface flows. A large part of this success is due to the fact that these problems can often be formulated in terms of complex variables and analytic functions. Tools such as conformal mappings and Cauchy integral formulae can then be used to derive efficient boundary-integral formulations. These are not usually available for three-dimensional flows or unsteady flows. Much effort in recent research has been in the development of efficient methods for such flows.

This issue describes some recent advances in the theory of free-boundary problems. Three-dimensional flows, coating flows, the stability of jets, time-dependent flows, weakly nonlinear theories, solitary waves with depth effects, slamming flows from violent impacts, waterline dynamics, full nonlinearity, air-liquid films on iced surfaces, rivulet behaviour and viscous sintering are among the subjects treated.

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