ment of resilient linings to give relief before castings are made.

Standards and specifications exist only for a limited number of materials in medical use. It is felt that these numbers should be increased and should take account of the use to which material is to be put. For example, gastric juices may leach out a particular plasticizer from a PVC that would be quite satisfactory if used in contact with urine. In another case, of forty-eight varieties of tubing available for medical use, twenty-five contained one or more ingredients which were known to migrate to tissue and cause toxic response.

Collaborations at all stages of materials selection is perhaps indicated, so that the materials scientist can work closely with the clinician. Firms which wish to enter the manufacturing and supply side should obtain expert guidance well in advance, and here the role of the Ministry of Health is particularly to be emphasized, since it has the power to regulate the potential dangers to the patient.

HYDRODYNAMICS

Mathematics and Ships

from a Correspondent

A SYMPOSIUM on "Mathematics in Ship Hydrodynamics" was held at the Ship Division, Natural Physical Laboratory, on September 25. It was organized jointly by the Institute of Mathematics and its Applications and the National Physical Laboratory with the intention of bringing the mathematical problems of ship hydrodynamics to the attention of mathematicians unacquainted with the subject. Most of the speakers dealt with conventional displacement ships, but some attention was also given to hovercraft.

One of the chief topics in ship hydrodynamics is the prediction of the resistance of the ship in steady forward motion and the design of the hull to minimize it. The wavemaking part of the resistance depends on the pattern of surface waves produced by the ship. Dr G. Gadd (Ship Division, National Physical Laboratory) described attempts to carry out calculations taking account of the non-linearity in the surface boundary condition.

A radically different approach to hull design is possible when a large amount of information has been accumulated about ships of a particular type, so that the resistance is known for many combinations of the parameters which define the shape of the hull. As described by Mr J. G. Hayes, director of Numerical and Applied Mathematics, NPL, a statistical investigation by regression methods can then reveal the effect on resistance of variation of each parameter and lead to improvement in hull design.

Apart from any hydrodynamic considerations, the purely geometrical problem of specifying the shape of a ship's hull is rendered difficult by the fact that it is a large three-dimensional surface of a complicated shape, especially near the stern and bow as outlined by Dr J. Wellicome, Ship Division, NPL. Until recently the method of giving the builders the necessary information has involved the preparation of large-scale drawings from the designer's small-scale drawings. The introduction of numerically controlled machine tools and draughting machines, however, has led to the investigation of the use of computers to specify the shape numerically, either by using them to scale up the designer's drawing, or to design the hull in mathematical terms starting from the beginning. This procedure raises problems of describing three-dimensional surfaces mathematically and of organizing the computer programs.

In lectures by Mr D. Clark of the British Research Association, Professor F. Ursell of Manchester University, and Mr R. P. Brown, Ship Division, NPL, it was suggested that the forces on the ship's hull are also required to predict its behaviour when being manoeuvred on a course which is not straight, and also when it is responding to waves by motions such as pitching and rolling. Because ships are elongated bodies, the first approach is to regard each cross-ship section as part of an infinite cylinder and to calculate the hydrodynamic forces on it by two-dimensional flow theory. There still remain some mathematical problems in this approach, but even if it were perfected there would still remain the fact that most ships are not sufficiently slender for it to be accurate. The forces on a ship being manoeuvred might be calculated by extending aerodynamic slender wing theory; those on the ship when it is pitching or rolling may well require a full three-dimensional potential solution.

From the hydrodynamic point of view—put forward by Professor R. I. Lewis of the University of Newcastle and Dr J. W. English, Ship Division, NPL, the part of the ship next in importance after the hull is the propeller. Problems arising out of the use of ducted propellers were considered; these seem likely to be amenable to methods similar to those used in the theory of turbomachinery. The duct may be represented mathematically by a surface singularity distribution and the vortices by the Biot-Savart law.

Most of the urgent problems of unconventional craft arise from hovercraft which were discussed by Mr P. R Crew, British Hovercraft Corporation. Problems of hydrofoils are more amenable to established mathematical methods, but hovercraft behaviour tends to be dependent on non-linear mathematical equations, particularly dynamic stability and the effect of flexible skirts.

HOLOGRAPHY

Holography in Engineering

from a Correspondent

A SYMPOSIUM on the engineering use of holography, organized by the Department of Mechanical Engineering of the University of Strathclyde in association with the National Physical Laboratory, was held at Strathclyde from September 17–20, 1968. Thirty-four varied papers were read.

Papers on general holographic techniques, of a largely tutorial nature, were given by Lehmann of Stanford Electronics and by Bradford of EMI Electronics. Nassenstein and others from Germany presented a useful investigation of the properties of the Agfa–Gevaert materials which, by providing much faster materials of high resolution, have recently eased the practical problems involved in obtaining good quality holograms.

The improvements in this respect were most apparent in the papers on strain and vibration measurement. The excellent series of holographic interferograms presented by Leadbetter of the National Engineering