published in March 1966. The same report suggested that savings of about £500 million a year could be achieved in the United Kingdom by greater attention to education and research in the subject.

The types of tribological failures which were responsible for some of the losses accounting for the £500 million were described by Mr L. S. Hall. He drew attention to the need for an understanding of surfaces and the mechanism of lubrication, friction and wear in different types of machinery, and explained that many of the failures attributed to bearings are not caused primarily by a mechanical failure of the bearing system but by such factors as faulty storage, incorrect handling, lack of cleanliness and corrosion.

The possibility of avoiding many failures by careful tribological design was discussed by Mr M. J. Neale. Careful consideration of the design problem, selection of the most appropriate bearing and the use of modern bearing design procedures were factors considered. Mr Hall had noted that contamination of the processed material by oil could be a problem in the food industry, and Mr Neale remarked that a solution to this type of situation could often be found by designing the bearing to use the processed material as the lubricant.

The meeting was held during the week of the official opening of the new Industrial Unit of Tribology at the University of Leeds, and in the final lecture the Director of the Institute, Professor D. Dowson, outlined the tribological services available in the region. The Bradford Technical College is now co-operating with the Institute of Tribology at the University of Leeds to enable the two establishments to offer a wide range of courses at all levels. These cover the requirements of operatives, Higher National Certificate and City and Guilds level courses at Bradford, together with undergraduate and MSc courses at Leeds. The institute offers three main services: advanced courses, fundamental research and an industrial service. The first MSc course covering tribology was started at Leeds in 1964, and is now providing a steady stream of specialists.

The new industrial unit offers an advisory, consultancy, bearing design and contract research and development service to industry on a commercial basis. Similar services are available at Swansea and Risley and each centre has a special national responsibility. The unit at Leeds will specialize in a bearing selection and design service.

## Biological Semiconductors

from a Correspondent

A TOTAL of about seventy people from eleven different countries attended the first international meeting entirely devoted to biological semiconductors which was held by the British Biophysical Society at Nottingham from April 1 to 3.

The general tenor of the discussion may be briefly summarized. It is nowadays realized that to secure reliable values for D.C. dark conductivity and activation energies, biomolecules such as proteins and nucleic acids must be examined in a definite state of hydration (or dehydration). Even then, some problems of reproducibility remain as, for example, in the photoconduction activation spectrum for DNA. Self-consistent field molecular orbital calculations may be made, but the activation energies calculated are frequently greater than those observed experimentally. At the meeting Dr Rosenberg suggested that the calculations were neglecting polarization energies. The most detailed picture for organic substances relates to photoconduction in anthracene, where band-to-band transitions are not found, and exciton states are the normal precursors to photoconduction. Attempts to model cytochrome systems by mixed crystal co-ordinate complexes give activation energies for dark conduction notably higher than those observed in nature. Radiofrequency loss measurements for solid DNA lead to much lower activation energies than those observed with D.C. However, dielectric and electro-optical studies on dilute aqueous solutions of DNA offer promise of distinguishing proton and other ionic contributions, which completely swamp any electronic effects in this environment. Measurements of Hall coefficients at microwave frequencies yield the sign and mobility of charge carriers, around 1 $cm^2V^{-1}s^{-1}$ for proteins and DNA, which has so far eluded conventional D.C. and A.C. techniques. Unfortunately, Dr E. M. Trukhan (Moscow) was not present to give his paper describing these results. Similar values for protonic conduction in ice have, however, been derived by conventional methods. Charge-transfer complexes show catalytic activity for simple hydrogen reactions, which may reflect a biological role.

In the section dealing with organized systems, one paper dealt with the analogies between $\beta$-carotene photoconduction and photovoltaic effects and the $S$ potentials of the retina, which suggest interesting speculations on colour vision. Studies of photoactivated electron transfer from a pair of cytochromes to bacteria chlorophyll show zero activation energy over 4·2 to 140° K, but its slowness (a half time of 2·3 ms) points to a short range tunnelling mechanism. Convincing evidence was produced for a potential at the fracture surface of bone leading to the onset of fresh bone growth. A final very stimulating lecture outlined the processes of calcification in crustacean cuticles by electron transport through a tanned protein-quinone membrane.

## Stanford comes into Line

from our High-energy Physics Correspondent

A RECENT study of elastic electron-proton scattering (*Phys. Rev. Lett.*, **20**, 292; 1968) performed by collaboration between groups from the Stanford Linear Accelerator Center, Massachusetts Institute of Technology and the California Institute of Technology has greatly extended the range of information on the electromagnetic structure of the proton.

The standard assumption in experiments like this is that the scattered electron provides a single photon which probes the charge and magnetic moment distributions of the proton. Relativistic invariance and the conserved nature of the electromagnetic current then ensure that the number of particles scattered at a particular angle and energy is indeed given in terms of only two functions of the square of this invariant four momentum transfer. If this momentum transfer (which roughly measures the inverse of the depth to which the proton is probed) is kept constant