

each appoints a full time manager to look after the commercial activities. Once the centres are operating successfully, it is expected that they will be self supporting, and the money will be freed to start new centres at other universities.

The first centres reflect the British Government's interest in tribology—the study of interacting surfaces in relative motion, including friction, wear and bearing design. The universities of Leeds and Swansea and the establishment at Risley will be concerned with tribology. The University of Strathclyde has a general brief covering the whole of engineering; Cranfield will look after precision engineering and Bangor will be responsible for instrumentation and control engineering. Each unit will be undertaking contract research for industry and the project is intended to be a thoroughly commercial one. But the ministry foresees no conflict between the units and the universities proper, and the minister himself goes near to saying that the commercial pressures will be a good thing for all concerned. "The universities are going to sell themselves to industry," Mr Benn declares.

In approving the centre at Risley, the minister seems implicitly to have rejected the recommendation of the Select Committee on Science and Technology, which reported last week. The committee said that the authority should not undertake work on subjects not inextricably linked with its primary task. Mr Benn said that the policy of diversification is "well established".

The emphasis on tribology, and the name, derive from a working party set up by Lord Bowden when he was Minister of State at the Department of Education and Science in 1964. The committee, under the chairmanship of Mr H. Peter Jost, was the originator of the now celebrated claim that industry could save £500 million a year by the better use of lubrication. In support of these figures, Mr Jost has quoted the experience of East Germany, where training in lubrication has been made compulsory, and qualified lubrication engineers have been appointed to state owned works. Within a few years, Mr Jost said, the East German steel industry has saved £2–£3 million, which would have meant £21 million in Britain. One of the conclusions of the Jost report was that inadequate training in tribology would be a major stumbling block—but Mr Benn's new proposals make no direct provision for this.

Glass Reinforced Plastics

A HAPPY accident in 1940, when catalysed polyester resin was spilt over several layers of glass fibre, produced the first glass reinforced plastic (GRP). Since then the highly satisfactory structural properties of this material have been studied and it can now be considered alongside the more conventional building materials of concrete and steel. The development, properties and design qualities of glass reinforced polyester resins were described by Mr Brian J. Bell at a meeting of the Society of Engineers on December 4.

Polyester resin has the great advantage of polymerizing at room temperature and low pressure. GRP can therefore be moulded (laid-up) by hand, and can be used for moulds of any size and shape. It is resistant to weather and many chemicals. These advantages are somewhat offset by the slowness of production

compared with injection moulding methods, and skill is required to produce a material of consistent strength. Glass fibre for reinforcement and the resin itself are expensive, but no costly equipment is required for production of GRP. Fillers can be added which alter the gelation time, and mechanical, thixotropic and self-extinguishing properties of GRP and the form of reinforcement can also be chosen to suit the required design properties. The most common form of reinforcement is the chopped strand mat in which 2 in. random strands are bonded together with resin to form a mat which weighs from 1 to 2 oz. per square foot.

GRP can be produced by contact pressure and by low or high pressure moulding. Each method has variations which are introduced to suit the size, shape, dimensional tolerance, cost, strength and quantity of the required product. In all cases a release agent is required for releasing the product from the mould. Mr Bell gave examples of the general properties of various laminates that can be made from GRP, and compared its properties with those of mild steel. Volume by volume GRP can be almost twice as strong as mild steel, while weight for weight it can be thirteen times stronger. But sometimes it lacks rigidity, and variations can occur in mechanical properties because of differences in manufacturing conditions or in composition. Mr Bell described ways in which the limited span of GRP can be extended, particularly by folding the material—despite the unsolved problem of pre-stressing, GRP obviously has a great future.

Another Food Supplement

LAST week the American University of Beirut announced that a high protein food supplement, called "l'aubina", had been developed in Beirut under the direction of the Columbia University Institute of Nutrition Sciences and financed by the United States National Institutes of Health. It is the latest addition to the growing list of food supplements developed from local products in various parts of the world in an attempt to combat local malnutrition with locally grown produce. "L'aubina" is made from chick peas and parboiled wheat—both are grown in the Middle East, North Africa, India and Pakistan—with small amounts of bone ash and skim milk. It is easy to make—apparently any food manufacturer could make it with existing machinery—and cheap. In tests, the nutritional health of children was maintained by a daily supplement of 7 ounces of "l'aubina" which would cost only about 2s. 1d. (25 cents) to produce. It contains 17.1 per cent protein—about the same amount as roast leg of lamb—adequate amounts of vitamins A and D and some vitamin B and calcium.

The question now is whether a commercial producer can be found to produce "l'aubina" in bulk and, even more important, whether it will be accepted by those who are suffering from malnutrition. Past experiences are not at all encouraging. In Peru, a supplement called "Peruvita", which is made from the local plant quinoa, was developed over a period of five years but abandoned last year because it was not accepted. Similarly in Guatemala, "Incaparina", made from cotton seed and sorghum, has not been accepted. It is still produced but only reaches 2 per cent of the children in the country. So great is the prejudice against these supplements that even

when they are offered free they are not used. Giving them away often increases suspicions. Anything which is free must be no good, is the feeling. Recent events in India suggest that some people would rather starve than change from eating one cereal to another. It may be encouraging that in experimental tests with "Paubina", the children seemed to like it and their mothers have accepted it.

Controlling Pollution

MORE than £30 million is spent each year in Britain on the treatment of sewage and industrial waste water, according to the report of the Water Pollution Research Laboratory of the Ministry of Technology for 1966 (HMSO, 15s. 6d.). About half of the laboratory's resources are concerned with various methods of treatment of wastes, but other work includes a study of the effects of pollution on rivers and estuaries and the coastline. During 1966, the last of these was the largest single project; the object was to study the influence of environmental factors on the rate of dispersion of sewage discharged into the sea by coastal authorities. To do this, physical dispersion of liquid sewage has been followed using a radio-tracer, bromine-82. Bacteriological examinations of sea water samples have also been undertaken. In this way, it is hoped to provide an improved basis for choosing sites for discharge of sewage into the sea and for deciding on the degree of treatment required before discharge.

The control of aquatic weeds such as *Elodea canadensis*, *Myriophyllum spicatum* and *Zannichellia palustris* costs river authorities some £300,000 each year; the use of a proprietary herbicide is now being investigated for this purpose. An important and continuing line of work at the laboratory is the determination of the effect of pollution on fisheries—the toxicity of zinc to trout eggs, for example. Results of research have shown that sudden rises in temperature increase the sensitivity of trout to phenol and toxicity of phenol to rainbow trout also increases with salinity.

Studies designed to improve the performance of unit processes used in the treatment of domestic and industrial waste water have formed an important part of the laboratory programme. In addition to conventional methods, a new method of treating sewage has been developed which involves wet oxidation at high pressure. The contribution which protozoa make in the activated sludge treatment of sewage has also been followed; it seems that these organisms bring about a marked clarification of the effluent.

The treatment and disposal of sludge present more difficulties than almost any other waste treatment operation. In the 1965 laboratory report, it was pointed out that in some sewage the concentration of synthetic detergents had risen to a level which caused acute inhibition of sludge digestion: digestion can now be restored by the addition of a long-chain amine which causes precipitation of the detergent, and an experimental study of twenty-two new detergents has been carried out.

Aid by Modelmaking

THE development of econometric models has offered economists a better chance of making the right decisions. By designing quantitative models which

behave like the economy of the country concerned, it should be possible to assess more precisely the effect of small changes—in tax structure, age distribution, birth rate, or the supply of trained manpower. The history of the past three years of British economic policy indicates the sort of errors it might then be possible to avoid.

The Organization for Economic Co-operation and Development has now attempted to apply the same sort of reasoning to development assistance (*Quantitative Models as an Aid to Development Assistance Policy*, OECD, 1967). The sorts of questions which need answering are concerned with the effects of decisions about aid on the development of the country concerned. Would the development plan be overturned by a 10 per cent reduction in aid? Should the transport sector be developed at the expense of primary production? How would changes of birth rate or migration influence economic progress? One difficulty, of course, is that econometric models are only as good as the data that go into them, and most underdeveloped countries are short of reliable statistics—often, the OECD expert group reports, the records include a quantity of miscellaneous information and statistics, without combining them into any coherent pattern. Despite this, the expert panel went on to assess how valuable the models might be.

It is clear from the start that the notion of a comprehensive model which could provide an answer to every question is unrealistic. The solution to this, according to Professor Chenery of Harvard University, and a member of the panel, is not to make the model more complicated, but to design instead a set of related sub-models to carry out the more detailed work. The group considered two models of the Pakistan economy, one prepared by Professor Tims at Harvard, and the other by Professor Chenery. The models take as one fixed point the desire by the Pakistan government to end foreign aid by 1982. Interestingly, the model reaches different conclusions from the planners in Pakistan; they assumed that aid would fall steadily as a proportion of GNP from 8 per cent in 1965 to 1 per cent (representing enough to cover external interest and dividend payments) in 1985. But the model shows an increase in aid in the early period, to a peak of 10 per cent in 1975, and then a fall to zero by 1982. This is because in the early period heavy investment is needed to produce rapid growth in the economy: demand for capital therefore exceeds what can be supplied from home resources, although 24 per cent of the growth in GNP would be saved. Demand for foreign capital therefore increases in the short run. After 1976, the emphasis would shift to the task of import substitution, or increasing exports, either of which would have the effect of improving the balance of payments. Total investment falls, and can thereafter be financed from Pakistan's own resources. After 1983, the model predicts self-sustaining growth, with sufficient investment to prevent imports from out-running exports.

Industrial Biology

THE Institute of Biology last week held a conference on "Improving the contacts between industry and university". More than a hundred people settled into the comfortable orange seats of the Royal Society's