given in 1968–69 prices, and the 1969–70 figures in 1969–70 prices. The percentage increases calculated do not then give a true impression of the growth of the research council expenditures. Unfortunately, there is no simple rule of thumb which can be used to convert increases in money terms into increases in real terms, but the Department of Education and Science has provided the list of growth rates for the research councils, shown in the table, together with the expenditure figures taken from the Vote on Account.

These figures, although they show that the research councils will be doing substantially better in financial terms, also indicate that increases in costs have eaten away much of the advantage. The ARC, in particular, must be feeling very sorry for itself.

SHIPBUILDING

Turbine Trouble Diagnosed

SIR ARNOLD LINDLEY, called in by the Minister of Technology to investigate defective turbines in the Queen Elizabeth 2, has turned up nothing unexpected. His report, delivered last week, confirms that the turbine blades failed in fatigue, caused by resonant vibration in the tangential mode. The blades in rows 8, 9, 10 and 11 were set vibrating at their resonant frequency by the steam issuing from the preceding steam nozzles, and the condition was made more serious by the nature of the blade mountings. A secondary cause of vibration may have been torsional vibration of the rotor, caused by lack of truth in the main coupling from the rotor to the reduction gears, but Sir Arnold is convinced that steam excitation was the principal cause. To remedy the deficiencies, Sir Arnold says that the blades in rows 7 to 12 should be changed to "rhubarb" section, which gives better strength at the junction between blade and root, and that the first 1·1 inches of each of these blades should be thickened, again to increase root strength. Midway along each blade, lacing or binding wires should be provided to damp out the principal mode of vibration. Finally, in the rows of blades from 2 to 6, the method of mounting should be modified to remove stress concentrators; this can be done by removing fillets at the junction of the blade with the root.

Happily, Sir Arnold's report has been accepted by all involved, including Cunard, who had previously made angry noises about appointing their own independent expert. "We are very greatly encouraged by this report", said Sir Basil Smallpiece, chairman of Cunard, adding that, of course, there would still be a need for full sea trials and subsequent stripping of the turbines to make sure all was well. Sir Basil revealed, with some reluctance, that the delay had cost Cunard "£2·5 million in gross revenue", but John Brown Engineering would not be drawn on the cost of the repairs. Sir Arnold's schedule provides for the turbines to be reassembled and in the ship by March 21, and for a proving voyage early in April. If all goes well, the ship should be handed over by the second half of April. To judge by the alacrity with which the port turbine has been returned to Southampton, Sir Arnold's report does no more than put the seal of approval on steps already taken by John Brown Engineering.

Mr Anthony Wedgwood-Benn, clearly relishing the role of peacemaker, hinted that his department would be taking up Sir Arnold Lindley's recommendation that "more work should be done in turbine development and instrumentation", although all agreed that in matters like these it was impossible to be right every time. To have tested the turbines fully before they were installed, Sir Arnold said, would call for boilers "as big as Battersea Power Station", at a cost nobody was willing to bear.

In effect, Sir Arnold's report clears all those who are still around to care. Blame is attributed only to Pametrada, the now defunct organization which designed the turbines in the first place. The failure of the blades, said Sir Arnold, "is no reflexion whatever on the quality of workmanship or of material used in any part of the construction of the HP turbines". It is, perhaps, a reflexion on John Brown Engineering's enthusiasm for monitoring the design work contracted out to Pametrada. Even if it was impossible to anticipate exactly the resonant frequency of the blades, it would surely have been possible to avoid stress raisers in the junction between blade and root. In this sense, the whole episode is a lesson in the dangers of divorcing design from construction. Mr Benn, who is an advocate of contract research, particularly if it helps to employ Government establishments, should not have missed the point. But he almost certainly has.

ENGINEERING

Ronan Point Discussed

THERE were more than mere murmurings of discontent at a meeting organized by the Institution of Structural Engineers at City University last week. The engineers were discussing the report of the investigation into Ronan Point, the twenty-two storey block of flats in Canning Town, London, a section of which collapsed dramatically last May. The meeting, attended by Mr Hugh Griffiths, the chairman of the tribunal which conducted the investigation, and Sir Alfred Pugsley, a fellow member of the tribunal and a past-president of the institution, was called to discuss the long term implications of the report, rather than the precise circumstances of the collapse at Ronan Point which is the subject of legal proceedings. The principal complaint was that the actions taken after the tribunal had reported were motivated by "panic" and "hysteria". Some blocks, one speaker complained, were standing empty awaiting rules from the Ministry of Housing which might never be made, and some local authorities were finding it difficult to accept blocks as "satisfactory" because the word had not been defined. When the new rules were published, all the people who had just set up home in the flats might have to move out for alterations to be made.

While it was generally agreed that codes of practice were useful guidelines for the designer and that they needed to be brought up to date, it was argued that they were not substitutes for professional experience and skill. Some of the engineers who spoke feared "codes of mandatory practice" which would restrict initiative. It was made only too obvious how little is known about structures and the forces acting on them. Mr Gordon Rose, a member of the institution, suggested that there should be a two-tier system with

codes of practice for traditional buildings, and a team of experts to vet other designs before construction started. Sir Alfred Pugsley said in his opening address that, although there had been great refinements in the design of engineering structures, there had been a decline in the independent checking of design calculations, and he referred particularly to the need for independent criticism of the codes of practice issued by the British Standards Institution.

One speaker implied that it was high time that engineers were put in charge of professional teams instead of architects, and it was further suggested that there ought to be better supervision of young graduates doing site work. After one consulting engineer had said that he wondered whether the extra cost of making tall blocks safe against gas explosions was worth "the marginal benefit of cooking with gas", a representative of the Gas Council defended gas by saying that if buildings could not be designed to be fit for gas, they were "not fit for human beings".

The measures taken by local authorities with blocks of flats of the Ronan Point type may have shaken the confidence of some structural engineers, but they should be pleased at the news that engineers at the Greater London Council have devised a new method of strengthening tall blocks that may be both easy to do and comparatively cheap. The GLC is not releasing details for about 10 days, but the technique is now being developed after vetting by the Ministry of Housing's technical panel. No hint has been given as to the reliability of the new technique, or whether the GLC will now consider restoring gas to its blocks and removing the bollards hastily erected around the bottom of some of the blocks to stop uncontrollable vehicles from crashing into one of the structural members.

INVESTMENT

Economic Benefits

THE value of overseas investment is something about which no British Government has quite made up its mind. In general, the attitude of the present Government is that foreign investment in Britain is gently to be encouraged, while the investment abroad by British firms is a much more dubious activity. To judge by a study just published by PEP (*The Role of American Investment in the British Economy*, by John H. Dunning, 10*s*), the Government has got at least the first part of its policy right. Professor Dunning concludes that the effects of American investment in Britain "have almost certainly been beneficial to the British economy", and produces detailed evidence to justify the claim. American companies manage better, export more, do more research and contribute more to development areas than their British counterparts. So long as this situation holds, the net effect of the investment is beneficial.

Professor Dunning traces the growth of American investment in Britain since the war and predicts that, by 1981, between a fifth and a quarter of British industry will be American owned. If Britain had been in Europe since 1963, it is a fair bet that the proportion would have been higher. Between 1957 and 1966, American investment in Britain increased by two and a half times, but in Europe over the same period it went up by a factor of eight. Much of this new investment, in Britain at least, was self-financed; about 45 per cent of the $4,500 million invested in Britain by American firms in Britain since 1950 came out of profits reinvested by established American companies. In the early years after the war, the profits earned by American companies in Britain were very high—88 per cent more on every pound invested than their British competitors—but since then the gap has narrowed. In the period 1961–66, American companies in Britain were 44 per cent more profitable than their counterparts. Between 1950 and 1966, the average rate of return on capital of British companies was 8·7 per cent, while the American companies managed 14·9 per cent.

American companies in Britain have also exported more vigorously than their native counterparts. Their share of British manufacturing exports is about 75 per cent larger than their share of manufacturing output; in 1965, they exported 25 per cent of total sales, compared with a national average of 14 per cent. In 1965, the net balance of payments contribution of American firms operating in Britain was £284 million, which is probably around £150 million more than would have been achieved if their place had been taken by British firms. American companies also seem to find the bait of the development areas more compelling than do British companies, and by the end of 1966, 100,000 people were employed by American firms in the less prosperous areas of the UK. But Professor Dunning says that the main way in which American investment has aided the British economy is by improving the efficiency of resource allocation. This has been done in two ways: by causing resources to be moved from less productive sectors to more productive ones, and by raising the productivity of the resources in their present uses. In almost all areas of industry, the American firms had better records of productivity than the British ones (see table).

	Productivity (UK)	(US)
Chemicals	100	158
Metal manufacture	100	125
Electrical engineering	100	108
Non-electrical engineering	100	103
Metal goods not elsewhere specified	100	95
Food, drink, tobacco	100	125
Textiles, footwear, clothing	100	107
Vehicles	100	137
Other manufacturing	100	109
Total manufacturing	100	118

There are, of course, problems raised by the large scale investment of foreign funds in any country, and Professor Dunning does not shirk them. Possibly the most important of these is the fear that American companies, once they have gained substantial control of the British economy, can thwart national sovereignty and government policy. The occasions on which this has happened are comparatively few, but they exist—and the Canadian experience, particularly with the vehicle manufacturers, shows that this is a real danger. Professor Dunning's recommendations are modest enough, and are indeed based on the line taken by the Canadian Government; he suggests, for instance, that the Government issue some "guidelines for good corporate behaviour" and set up a special body to