Climbing the technology tree

from Andrew Holmes-Siedle

THE Institute of Electronic and Electrical Engineers, one of the largest professional societies in the world, has turned some of its effort to helping those scientists and engineers faced with redundancy to plot their careers in such a way that they avoid the trap of 'irrelevance'. Its Technology Forecasting and Assessment Committee, whose original purpose had been to advise industry and government on planning, has now turned all its attention to an advanced form of career guidance. The committee has picked areas of application for which technology is being developed intensively and drawn for each a 'technology tree' which relates these areas logically and lists the technologies involved in each.

To give an example, the Nuclear and Plasma Sciences Tree (Published in the IEEE Nuclear and Plasma Sciences Society Newsletter, October 1974) carries a limb entitled 'Radiation Effects' which contains eleven branches with 43 twigs, the subjects ranging from charge loss in capacitors to food preservation. To put it another way, the IEEE has identified some technological bandwagons and given us a few clues as to how we might climb on; the rest is up to us.

be likely to produce results both of scientific and practical importance within a decade. One of the fields chosen was Brain and Behaviour and in 1972 OECD published a report with this title prepared by two of its consultants, Dr Otto Wolthuis and Professor Stuart Sutherland. The report summarised the scientific status of the field and analysed a number of defects in its organisation in Europe including Britain. Among the defects mentioned were the lack of mobility of scientists, resulting in a slow flow of ideas and parochial journals; lack of communication between European countries; small laboratories with insufficient interaction between, for example, neurophysiologists and psychologists; and authoritarian departmental structures.

The OECD investigation led in 1970 to the setting up of ETP with a generous grant from the Max-Planck-Gesellschaft. It now receives contributions from Austria, Britain, France, Germany, Italy, Netherlands, and Switzerland and seven additional countries have representatives on the steering committee and participate in the programme. So far funds have been used for the following purposes:

- The training of young scientists in countries other than their own and usually in disciplines other than their primary subject.
- Four highly successful winter schools for young scientists from all European countries—again with a multi-disciplinary emphasis.
- 'Twinning' grants awarded to about 100 laboratories, enabling the members of each to travel to a sister laboratory abroad which is engaged on complementary work.
- Grants enabling young scientists to attend conferences abroad organised by bodies other than ETP.

In the five years of its existence ETP, operating on an insecure budget of about £50,000 a year, has done much to promote cooperation between workers in brain and behaviour in different European countries and in the different component disciplines. It is hoped that when the European Science Foundation starts functioning ETP will become affiliated, and that a more permanent flow of funds will be secured through international treaties. Unlike EMBO, ETP has set its heart against the founding of a large international laboratory since it is thought that the centralisation and bureaucracy involved are not in the best interests of the subject.

High-pass phonon filter

from P. V. E. McClintock

SUPERFLUID ^{4}He can be made to act as a tunable high-pass phonon filter, according to some recent experimental work at Nottingham University by Wyatt, Lockerbie and Sherlock (*Phys. Rev. Lett.*, **33**, 1425; 1974).

Their experiment was performed below 0.1 K, where liquid ^{4}He is an almost pure superfluid, that is, a fluid which can indulge in frictionless flow, or through which objects can move without any dissipation of their kinetic energy. The superfluid itself carries no entropy, but acts as the inert background or aether supporting a gas of phonons, which are the quanta of vibrational energy. These behave much like a collection of independent particles moving at the velocity of sound, and they carry all the thermal energy of the liquid.

The Nottingham experiment consisted, essentially, of injecting relatively small numbers of very high energy phonons into the superfluid at temperatures below 0.1 K, investigating how they propagated through the liquid and, in particular, deducing whether they were able to decay. (Strictly, of course, the term 'temperature' is not applicable once the high energy phonons have been injected, because there then exists a non-equilibrium situation.)

Considerable interest attaches to whether or not a phonon of given initial energy is able to decay into two phonons of lower energy, since this yields direct information about the shape of the dispersion curve, that is, the relationship between a phonon's energy ε and its momentum p. It was long believed that for small ε the dispersion curve was linear, of the form $\varepsilon=cp$ where c is the phonon velocity in the long wavelength limit, but that at higher ε the curve deviated below cp (negative dispersion), representing smaller phonon velocities. More recently, mounting evidence has apparently indicated that, although the dispersion curve is indeed linear at very small ε, there is an intermediate regime in which it deviates upwards (positive dispersion) before entering the negative dispersion region.

The precise shape of the dispersion curve is of considerable importance because of its profound influence on 3-phonon processes, that is, the decay of one phonon into two of lower energy or, conversely, the combination of two low energy phonons to create one high energy phonon. Such processes are of crucial importance in determining many of the properties of the liquid, such as the ultrasonic attenuation or the normal fluid viscosity, at temperatures near 1 K. It turns out that for 3-phonon processes it is only possible to satisfy simultaneously the conservation of energy and momentum in the presence of positive dispersion: the interactions cannot therefore occur at all where the dispersion is negative. Unfortunately, it is difficult to deduce the shape of the dispersion curve unambiguously from, for example, normal fluid viscosity measurements near 1 K. This is partly because phonons of a very wide range of energies are simultaneously present, but also because of complications arising from the existence at these relatively high temperatures of large numbers of rotons, which are another type of thermal excitation.

Hence the value of performing experiments at very much lower temperatures where the thermally excited 'background' phonons are so few that they can be neglected. The Nottingham group used a superconducting fluorescer to inject into the liquid pulses of phonons which all had energies larger than 2Δ (Δ being the energy gap of the superconductor), and detected