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A
DISEASE
CALLED SEX

newscientist



SPECIAL BOOKS ISSUE

Nuclear war, nuclear peace



*There are whiskies
There are malts
And there's
Glenfiddich*

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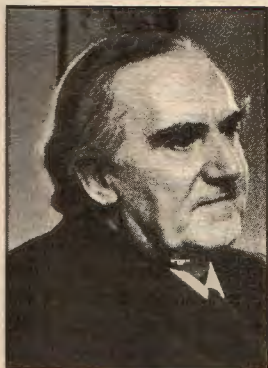
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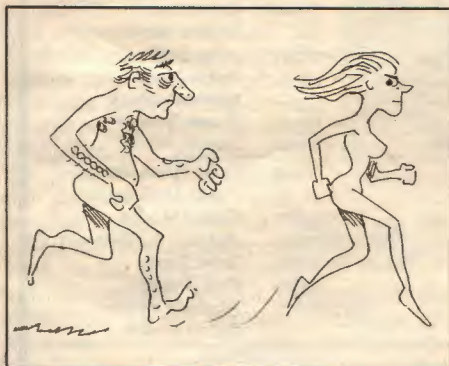


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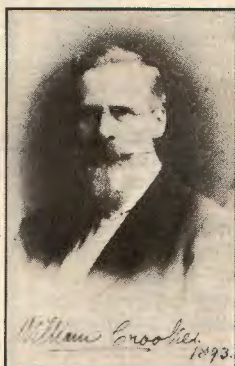


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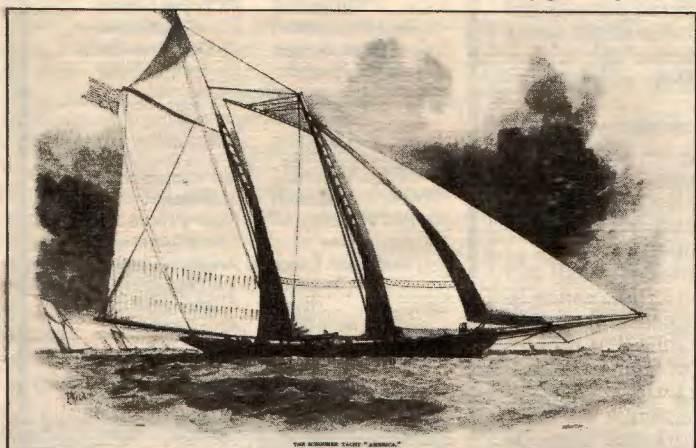


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NEXT WEEK

In colour

Eclipse in Java

or

How *New Scientist* went to the far ends of the Earth with astronomers from London and Cambridge to help to measure the diameter of the Sun

Russia's Hiroshima

The physics of God

John Parkinson

Gene-splicing brings hope of malaria vaccine

COLLABORATION between scientists in Australia and Papua New Guinea has resulted in a crucial breakthrough in the search for a vaccine against malaria. It could open the way to controlling many other parasitic diseases in the tropics.

Scientists from the Walter and Eliza Hall Institute of Medical Research in Melbourne and the Papua New Guinea Institute of Medical Research, at Goroka and Mandang, have developed a new technique which allows them to isolate human malaria antigens—the proteins that identify the parasite responsible for the disease—and provoke the immune system to produce antibodies against the parasite.

Several groups around the world are working on a malaria vaccine, but only one other has reported the isolation of antigens—and that was for a form of the disease affecting monkeys. The antipodeans devised a new application of



Malaria spraying on the way out?

Ann Westmore, Melbourne

recombinant-DNA technology in order to isolate all antigens in the blood stage of the malaria parasite, *Plasmodium falciparum*. This parasite is transmitted by mosquito bite and causes the potentially deadly *falciparum* variety of malaria. In this, red blood cells are invaded and destroyed, producing symptoms of severe chills, fever, sweating, anaemia and spleen enlargement. It may develop into respiratory failure, coma and death.

The new technique, published this week in the *Proceedings of the US National Academy of Science*, involves inserting fragments of DNA from *P. falciparum* parasites into *E. coli* bacteria. Culturing the bacteria resulted in a library of protein antigens, many of which have been tested against blood sera from people living in malaria-prone areas of Papua New Guinea.

The researchers believe the key to development of an effective vaccine lies with those sera which inhibit growth of the *P. falciparum* organisms and which come from people who are apparently resistant to malaria. The Hall Institute's head of

immunoparasitology, Dr Graham Mitchell, explains that these sera enable scientists to identify the specific bacteria that are producing the antigens capable of stimulating useful immune responses and thus protection against malaria.

During the next six months, the most promising of the 100 000 bacterial clones that have been produced will be grown in large vats by the Melbourne arm of the team. The resulting antigens will be tested by the World Health Organisation in monkeys (the only animal model of the human infection that is available).

Dr Mitchell says this should indicate whether malaria vaccines that would work around the world will need to contain "a cocktail of antigens".

Dr Mitchell adds: "The malaria parasite is particularly devious, with many trump cards to play in the fight against efforts to control it. And so it may be that the composition of the malaria vaccine will have to be altered every few years to cope with the subtle changes of the parasite."

While a vaccine will help control malaria and reduce its toll of death and illness among children in particular, Dr Mitchell doubts that malaria will ever be eradicated.

The implications of the latest advance go beyond malaria control. "Similar approaches to the identification of relevant antigens should be possible with other parasite systems such as schistosomiasis and trypanosomiasis which afflict hundreds of millions of people in tropical areas," says Dr Mitchell. "Until now, the single most important impediment to the development of parasite vaccines has been the scarcity of parasite protein antigens available for testing."

Ministers backtrack on lead

BRITISH ministers are backtracking on their commitment to eliminate lead from petrol as quickly as possible. They are bowing to pressure from the motor manufacturers who do not want to be forced to make cars that run on 92-octane lead-free petrol.

In April, the then environment secretary, Tom King, told parliament that the government "accepted" recommendations on lead in petrol made that day by the Royal Commission on Environmental Pollution. The commission, he reported, had said "from an early date all new vehicles should be required to use 92-octane lead-free petrol". This "represents the best possible route to achieve the earliest and most substantial reduction in petrol lead coupled with its eventual elimination". King said he would start talks with the motor and oil companies on a timetable for the change.

But, since those talks began, ministers seem to have changed their minds after the car makers complained that the oil companies could change their product to make higher-octane petrol free of lead. On Friday of last week (after the general election but

before King was replaced by Patrick Jenkin in the new administration) a spokesman at the Department of the Environment insisted to *New Scientist* that, despite King's April statement, no decisions had been taken. "We have never been committed to one side or the other. It is the Royal Commission that came down in favour of 92."

The row arises because low-octane lead-free petrol is easier for the oil companies to produce (they just leave out the lead). But it is harder for the motor manufacturers, who must redesign engines to cope efficiently with the new fuel. The Royal Commission said there was "no insuperable difficulty in making the transition".

High-octane lead-free petrol requires only minor modifications to existing high-compression engines. But it requires either more expensive refining of crude oil or the addition of octane-boosters like methanol or methyl tertiary-butylether, as a substitute for lead.

Meanwhile, the European Community's Council of Ministers meets today to consider the Europe-wide introduction of lead-free petrol by 1990. Europe's car-makers will be lobbying hard.



Jenkin's problem

Cottrell will head PWR safety panel

SIR ALAN Cottrell, who not long ago was a leading critic of pressurised-water reactors (PWR), is to become the official watchdog on their safety. The former chief scientist to the British government and a leading metallurgist has been appointed chairman of the advisory committee which will supervise the Inspection Validation Centre (IVC) for pressure-vessels to be built at Risley, Cheshire. The centre is a joint project by the Central Electricity Generating Board and the UK Atomic Energy Authority. It is designed to assuage once and for all fears about the stainless-steel vessel which will form the heart of the PWR power station intended for Sizewell in Suffolk.

The IVC is likely to cost more than £3 million to build. It will include laboratories and an inspection pit capable of handling steel sections weighing up to 200 tonnes. In addition to carrying out tests on the pressure-vessel's forgings, it will approve all the procedures, equipment and operators for the ultrasonic inspections that will be performed on the pressure vessel both during construction by the French firm Framatome and after hydrostatic pressure testing has been carried out. The IVC will also carry out automatic inspection of the pressure vessel using the equipment destined for ultimate inspection when the vessel is in service.

The CEGB hopes that the presence of Sir Alan will be able to satisfy the critical voices who have questioned the integrity of the vessel design and the ability of current tests to predict the behaviour of steel under



Pressure-vessel (top) and its watchdog

certain abnormal conditions.

For its past generations of gas-cooled reactors, Britain has used reinforced concrete containment vessels. But it has tested steel vessels. One critic of the board's PWR is Rodney Fordham, a former senior nuclear-safety scientist at the UKAEA who was forced to take early retirement from the authority last year. Fordham was for 17 years a principal engineer responsible for reactor safety. He is now safety consultant for the Town and Country Planning Association at the Sizewell

public inquiry. He recently brought to light an engineering test in 1966 which resulted in a steel pressure vessel failing "catastrophically" at high temperature well below its calculated strength. The results have never been published. Fordham says they raise questions about the behaviour of cracks in the steel vessel, suggesting that brittle, rather than ductile, cracking could take place at high temperatures.

The UKAEA says the test was instrumental in confirming that the integrity of a pressure vessel is properly assured by preventing a crack from running rather than relying on being able to stop running cracks. Asked to comment on the test, Sir Alan told Fordham: "It is an extremely artificial case, completely unrepresentative of practical conditions, in which catastrophic failure was forced upon a model pressure vessel. . . . These artificial conditions do not represent any realisable operational situation in a PWR pressure vessel".

Roger Milne

Shuttle will drop laboratory into space

THE NEXT trip into space of America's space shuttle, scheduled for lift-off this Saturday, will test a new concept in space science—a "free-floating" platform that is left in orbit laden with experiments. During the shuttle's six-day mission the vehicle will leave overboard a prototype platform made by engineers in West Germany. The hardware, called SPAS, will stay in orbit for several hours until the shuttle picks it up again for a safe return to Earth.

Ultimately, scientists think that such platforms could be left in space for months collecting data or acting as a test bed for experiments in materials processing. The European Space Agency is building a platform, based on SPAS and called Eureka (European Retrievable Carrier). It should fly in space in 1987.

Challenger, the second vehicle in NASA's shuttle fleet, is making its second flight. By 1985, NASA will operate a total of four orbiting craft. The mission will be the first on which astronauts use the shuttle's robot arm to position objects in outer space. With the arm, they will take out from the vehicle's cargo bay two commercial satellites for Canada and Indonesia. The arm will also figure in the manoeuvres involving SPAS.

Thirdly, Challenger's five-person crew will include Sally Ride, an astrophysicist who becomes the US's first woman astronaut. Also aboard is a physician, Norman Thagard, who will monitor the rest of the crew to discover what causes the motion sickness from which many astronauts suffer.

Peter Marsh

Dutch return to windmills

THE DUTCH government has given the go-ahead for the country's first windmill park. More than 20 turbines, with a total generating capacity of 10 000 kW will be built at Sexbierum on Holland's breezy North Sea coast. The Ministry for Economic Affairs has promised to contribute half of the estimated cost of £16 million. Work will begin in 1984.

Minerals threat to Antarctica

SIGNATORIES of the Antarctic Treaty are meeting in Bonn during 11-12 July to discuss a minerals regime for Antarctica. Central to the discussions will be a document drawn up by Chris Beeby, the chairman of an Antarctic minerals meeting held last January in Wellington, New Zealand. The Beeby document proposes "principles" to ensure that any mineral exploitation of the Southern continent should not cause "significant or irreversible changes in the distribution, abundance or productivity of living resources" or the environment.

The proposal argues against exploitation of protected areas such as sites of special biological or scientific importance. Without specifically defining the terms, the document outlines regimes for prospecting, exploration and development.

Greenpeace claims that "if this plan is agreed at the meeting in Bonn . . . then the way will be open for the systematic destruction of the most vulnerable parts of Antarctica—putting at risk a unique range of wild animals and birds, including penguins, whales and seals. It will be an irreparable loss for mankind."

World's top astronomy job

THE MOST important job in astronomy will go to the present director of the Institute for Astronomy in Hawaii, John T. Jefferies. He will direct America's new National Optical Astronomy Observatories, an amalgamation of three observatories and nearly 20 telescopes.

His fiefdom will include the Kitt Peak National Observatory in Arizona which has nine telescopes, and is the site for six more operated by other institutions—and, in the southern sky the Cerro Tololo Inter-American Observatory in Chile with eight telescopes. The third observatory in the new organisation will be the National Solar Observatory, itself a new amalgamation of the solar telescopes on Kitt Peak and those at Sacramento Peak in New Mexico. They include the world's largest telescope designed to study the Sun, the McMath telescope.

The amalgamation is partly to create an organisation to be responsible for America's plan to build, in the next few years, the world's largest optical telescope, with a mirror (or array of mirrors) 15 metres across.

List for power

PROFESSOR Reimar Lüst is the new head of the European Space Agency—one of the continent's top jobs in science administration. ESA's council approved the appointment on 8 June. Lüst is the current president of the Max Planck Institute. He will take over in May 1984.

By all accounts, Lüst had a tougher fight than expected. His elevation was delayed after he allegedly performed badly at an interview. Britain's Sir James Hamilton, his little-fancied civil-servant rival, did well.

In its formal statement, ESA's council felt it necessary to affirm its continued confidence in Erik Quistgaard, the outgoing chief, for his remaining year in office.



Lüst: takeover

Government 'misleading' on nuclear war casualties

A LEADING nuclear physicist, Professor Joseph Rotblat, has accused a top scientific adviser to the British government of misleading the public and "completely ignoring" evidence from the US in his estimate of the number of people likely to die in Britain during a nuclear war.

Rotblat, who once worked on the British bomb, criticises Professor John Martin, of Dundee University, in a letter in the summer issue of the *Journal of the Society for Radiological Protection*, published this week. Martin is the chairman of a Home Office working party on radiation hazards and his claims have been accepted by the Home Office for its civil defence plans. The bone of contention is the difficult problem of calculating the radiation dose that would kill 50 per cent of the population—the LD₅₀. Martin argues for an LD₅₀ value of 600 rads, measured at the skin's surface, whereas the figure widely quoted elsewhere, especially in the US, is 400-450 rads. A recent symposium in the US backed the figure of 400 rads.

Martin "bears a very heavy responsibility for ensuring that the public is given an objective picture of the radiation hazard in a nuclear war", writes Rotblat.

Martin has cited various cases to back his version of what the LD₅₀ is. One of these concerns four Algerian women who stole some radium and exposed themselves to between 1000 and 1400 rads over 38 days. All four survived. However, says Rotblat, Martin does not mention that they "had to be kept in isolation in plastic sterile chambers; they received major antibiotic and anti-mycotic treatment; repeated transfusions of multiple bags of red and white blood cells and platelets". Such treat-

ment would not be possible in the aftermath of a nuclear war, says Rotblat.

Martin, meanwhile, is preparing a reply to Rotblat's criticism. He told *New Scientist* last week that the American symposium produced "no new information". The figure of 400 rads had been estimated by polling radiologists and medical physicists. "It is up to Rotblat to say why he believes in this estimate," says Martin.

But Rotblat is even more critical of Martin's use of a formula to assess how the effects of progressive recovery from radiation by the body can be incorporated into the LD₅₀. The human body can recover from a short burst of low-intensity radiation as new cells are made and old, damaged cells repair themselves. The Home Office, taking its cue from Martin, proposes a formula for assessing the operational equivalent dose (OED) which adjusts the total dose to take account

of this recovery. The OED is, therefore, the amount of radiation actually damaging the body and when it rises to the LD₅₀ then 50 per cent will die.

Philip Steadman, the director of the Centre for Con-figurational Studies at the Open University, points out that when the OED formula is used to modify Martin's LD₅₀ for short bursts of radiation, to account for the body's ability to recover, it raises the LD₅₀ to 800 rads for a day's exposure, and 900 rads for a week. "This last figure may be compared with the LD₅₀ for an exactly equivalent wartime one-week dose, quoted recently by the British Institute of Radiology, of 450 rads," says Steadman.

Raising the LD₅₀ to 800 rads for one day's exposure "perhaps explains the claim by the Home Office" writes Rotblat, "of a 70 per cent survival after an attack of nearly 200 megatons on this country, with radiation accounting for less than 6 per cent of the fatalities." □

Steve Connor



Rotblat: "misleading"

Canadian trial decides dioxin use

A TRIAL is under way in the Supreme Court of Nova Scotia, Canada, to decide whether herbicides containing the lethal impurity dioxin can be used near inhabited areas. Sixteen local residents, who have won a court order banning spraying until the case is heard, will have to pay C\$2 million in costs if it is found to be safe. The Swedish-owned company, Nova Scotia Forest Industries (NSFI), wants to

switch to aerial spraying of the herbicides 2,4-D and 2,4,5-T to kill young hardwoods in softwood plantations. Local unease reached a peak last June when Micmac Indians, whose reservation is downhill and downstream from the plantations, ripped up 1000 seedlings in protest.

Other pulp companies in the province, including the British-owned Bowater-Mersey, are helping with NSFI's costs. □

Two months on a floating ice-station

CANADIAN scientists are assessing data gathered during the country's longest and most ambitious recent expedition to the Arctic. The results could prove valuable in bolstering Canada's claims to sovereignty over parts of the Arctic. They will also create better maps, improve understanding of ice conditions, and lead to wider knowledge of a virtually uncharted underwater mountain range.

A team of 40 men and women, sponsored by the Federal Department of Energy, Mines and Resources, spent more than two months this spring aboard a floating ice-station, CESAR '83 (Canadian Expedition To Study The Alpha Ridge). They set up camp 400 kilometres south-west of the North Pole, and drifted an average 2 km a day on the ice, while they studied the Alpha Ridge—a chain of mountains 400 km wide, almost 1300 km long and up to 2.7 km high—under the Arctic Ocean.

One of the aims of the expedition was to take samples of the core of the earth's crust from the ocean bottom. If, as some oceanographers and geologists believe, the Alpha Ridge is connected to the Canadian land-



Adrift at the North Pole—Canada's luxury ice-station

mass at Ellesmere Island, Canada could claim the whole ridge area under the provisions of the Law of the Sea Treaty.

The group, under its chief scientist, Hans Weber, lived in Arctic tents in temperatures around -45°C. Among their 300 000 kg of supplies were micro-computers and a bulldozer to build a runway. Dining on steak, the group was a far cry from the first polar expedition—mounted by the British 100 years ago.

Researchers from Norway and the United States also took part in CESAR, Bathymetric surveys, to show ocean depths throughout the area and the major seafloor features, were followed by gravity studies providing data on the underlying crust.

One other highlight was a visit to NP-25, the Soviet ice station which has been drifting near the Pole for almost three years. Jim Tanner, director-general of the ministry's earth physics branch, says: "It seems they are doing little science at the site—they have satellite-receiving equipment, some

weather instruments, and appear to be doing some oceanography." He assumes that, "the Soviet scientists merely gather the basic data and send it off to Moscow and Leningrad" for analysis.

CESAR, like NP-25, did a lot of movement tracking: the station drifted east-south-east about 2 km each day, more than 6 km a day during the storm. The storm was welcomed by the mapping team as it drove them over a greater area of the Alpha Ridge than anticipated and contributed to their investigation of the Ridge's origins. □

Europe pitches for African communications satellite

THE BATTLE to provide a pan-African satellite telecommunications system is hotting up. European satellite suppliers seem to have stolen a march on Intelsat, a cooperative project that has become tied up in international red tape, and per-suaded a number of African nations to buy into their own satellites.

The Europeans—British, French, Italians and the European Space Agency—hope to sell a satellite for national and international communications. It will be operational by 1988. The French sowed the seeds some years ago but, to get aid from bodies such as the European Development



Nations set to sign

Fund (EDF), the project had to be more European. Now a consortium headed by Euro-space has widened African contacts to include English as well as French-speaking African nations.

At a meeting in Dakar at the end of last month, the Europeans launched the idea of setting up a group of customer-nations. They hope at least seven will become members by the end of the summer—making it an acceptable candidate for EDF aid.

Five nations are near to signing—Senegal, Congo, Sierra Leone, Ghana and Botswana. The British Department of

Industry, The Ministry for Cooperation in France and the Union of African Posts and Telecommunications are currently engaged in "door-to-door selling", according to one source.

If the satellite goes ahead, it will be specially modified to cope with a mass of low-volume signals coming in from all corners of the continent. The Europeans are arguing for a system designed to operate with low power and low-cost earth stations. This will be an advantage over what Intelsat could offer at the moment, the European suppliers believe.

The Europeans believe that satellite communications could have great advantages for Africa. Satellites are much less vulnerable to the frequent maintenance problems which plague African telecommunications. Ground-based microwave networks need only to have one relay station out of action for continent-wide communications to be affected.

However, the European suppliers are afraid that Intelsat will come up with a new service more tailored to African needs. In the meantime, they are looking for around £20 million in assistance from the EEC—enough to pay for the satellite. But the Africans will have to foot the bill of about £80 million for the ground stations.

Andrew Lloyd, Paris

Now, Euro-TV for breakfast

EUROPE'S TV broadcasters have come up with a plan for "Eurovision" breakfast TV. It is one of the highlights of a package of programmes that could be exchanged by satellite between the main broadcasting networks from next year. The broadcasters met last week in Munich, where they discussed a proposal to exchange at least three hours of programmes each day. These would either be broadcast immediately by the main networks of cable TV or could be recorded for later transmission. "Good morning Europe", a 6 am competitor to existing breakfast programmes received strong backing at the meeting.

Last year, 15 nations ran a series of programmes using an existing satellite. These were distributed by closed-circuit TV only. But, as a report due for publication in July will show, these experiments proved that there will be enough demand and production capacity to make such a service viable. "They were successful enough for us to think we will continue next year," says Neville Clarke, senior programme officer with Britain's IBA.

The broadcasters' plans are coordinated by the European Broadcasting Union. They follow yet another report by the EEC Commission that called for the development of something even more ambitious—a European TV channel. Amongst other things, the report complains of a lack of really "objective" European news coverage without national-list overtones. As the new technology of cable and satellites makes it feasible for homes to receive a huge variety of programmes, Europe's technocrats, politicians and broadcasters have decided that the time is ripe for a European channel. □

Killer plastic stalks the greenhouse

SCIENTISTS working for the British government believe they have nailed a mysterious plague that has been killing crops in greenhouses. The culprit seems to be a type of plastic glazing strip, which firms started fitting two years ago. The plastic has an unfortunate side-effect—it kills plants.

This week, scientists at the National Vegetable Research Station at Wellesbourne near Warwick are rebuilding one of the station's glasshouses to test the theory. They are replacing the glazing strips—the pieces of plastic that hold the glass—in part of a large greenhouse with strips made from a less volatile type of plastic. In a few weeks they should have some hard facts to back up their suspicions.

Some people who make a living growing glasshouse crops such as tomatoes already have the evidence they need in the form of damaged produce. For cabbages and radishes, the effect is even worse—the whole crop dies.

According to the ARC, symptoms of the

problem "include pale or dead patches on the margins of leaves and sometimes lead to the death of the leaf or even the whole plant".

Scientists working at the Agricultural Research Council (ARC), the agriculture ministry and Imperial College, believe they have traced the problem to a plasticiser called di-butyl phthalate, which turns hard PVC into a malleable substance. After a time it seems to give off a chemical—which no one has yet been able to detect—that arrests photosynthesis in certain plants. The ARC believes concentrations of the chemical are far too low to pose a threat to humans: "the amounts involved are parts per billion," said Dr Jeff Moorby.

British PVC makers had talks with the ARC last month. They have already changed the plasticiser that goes into glazing strips for a less volatile one. The greenhouse companies are anxious to keep the whole fiasco quiet: "If this gets out, there will be no British greenhouse industry in six months," one scientist said. □

Britain to sell reactor to Turkey's colonels

BRITAIN is set to make its first export of a nuclear reactor since the 1960s. At the weekend the National Nuclear Corporation confirmed that it is negotiating with Turkey for the sale of a 350 Megawatt Magnox reactor, one of the first generation of British nuclear reactors.

The NNC acts as the agent for the building of Britain's nuclear power stations and has been running short of work. Moves by the NNC to sell the Magnox to Bangladesh and Chile ran into political flak recently because of fears of nuclear proliferation. Magnox reactors are particularly efficient at producing plutonium suitable for weapons. It remains to be seen whether the Turkey deal founders because of the unstable nature of the present military regime in Turkey.

Meanwhile the Sizewell inquiry, now in session at Church House, Westminster, after its move from Suffolk, has been told of the Central Electricity Generating Board's medium-term capital investment plans. These include provision for a programme of eight nuclear power stations, including Sizewell B, over the next decade.



Will the military take the controls?

Details came to light during the cross-examination of John Baker, the board's chief witness, who was facing questions put by John Taylor QC, on behalf of the Council for the Protection of Rural England. The details of the board's investment proposals are contained in a hitherto-confidential memorandum submitted to the Department of Energy in February. The document shows that the board believes it would be prudent to ask the government for financial approval for a continuing nuclear programme.

The board says neither the CEB nor Whitehall is committed to the plan. □

Germany calls for curbs on Europe's pesticide exports

TODAY, West Germany and the Netherlands will call on their partners within the European Community to bring in controls on the export of dangerous pesticides to farmers in the Third World. Members of the EEC are responsible for two-thirds of the international trade in pesticides and West German chemical firms alone produce a quarter of the world's exports. Oxfam, the development charity, estimates that there are 375 000 cases of humans poisoned by pesticides every year in developing countries.

Some pesticides should only be sprayed by trained operators wearing heavy and expensive protective clothing. In practice, in the fields of the Third World, they are sprayed by half-naked farm labourers who know nothing of the risks that they run. West Germany will use its position as the current chairman of the EEC's Council of Environment Ministers at today's meeting to back a proposal for a directive that would give ministers the right and duty to control

Catherine Caufield



Germany accounts for a quarter of all pesticide trade



did agree to publish, by the end of this year, a list of all the products banned or restricted in individual countries.

The UN is also drawing up a code of conduct for the advertising, labelling and marketing of pesticides—similar to that drawn up for "infant formula" baby foods.

pesticides exports. Both West Germany and the Netherlands, which will propose the idea of a directive, have plans for similar domestic legislation. The directive would outlaw the export of any pesticide that is banned or severely restricted within the EEC, unless the importing countries still ask for the product after being told of the reasons for the restrictions.

The move follows extraordinary unanimity in a vote at the United Nations last December on the need to control pesticides. The General Assembly voted by 146 to 1 in favour of controlling the export of products, including pesticides, that cannot be sold in the country of manufacture. There were no abstentions. Only the United States voted against. This vote, unlike an EEC directive, is not binding. But the nations

The industrialised nations of the OECD have also prepared their own "guiding principals", according to which the governments of importing countries should be given information about hazardous chemicals. But these guidelines have not yet been adopted by the member states.

As a result of all this international activity, the manufacturers themselves are rushing to prepare their own codes in the hope of influencing the drafting of the UN code. A bizarre competition has developed between the American National Agricultural Chemicals Association (NACA) and the International Pesticide Industry Association (GIFAP) as to which will be the first to adopt guidelines. The Americans believe that whoever can claim to be following a formal code of conduct will win business, especially from governments, who are among the largest buyers of pesticides. □

Rat poison kills 18

EIGHTEEN people died in Indonesia earlier this year after eating rice treated with a rat poison made by ICI. Campaigners for controls on the export of hazardous products from Britain say that the deaths would not have occurred if ICI observed the same precautions on its exports as are required for pesticides sold in Britain.

ICI supplies the government of Indonesia with the rodenticide, brodifacoum, under the trade name Klerat. Klerat is a liquid and ICI mixes it with rice for use as rat bait. One of the many settlements in which it is used was Bajur Agung in Lampung Province, Sumatra. The people there knew the rice was poisoned but, because their harvest had failed and they were starving, they decided to eat it. They washed it thoroughly and one man volunteered to act as a human guinea pig. Because brodifacoum is a slow-acting poison, the man lived long enough for the others to decide to eat the poisoned rice. They all fell ill, and 18 of them died.

ICI does not sell brodifacoum in Britain, although another company, Sorex, does sell it in a pellet form. It may only be sold to "professional operators" for indoor use. The ready-to-use poisoned rice that ICI sells to Indonesia carries health warnings and first aid advice. But the label does not advise professional use only. "Since brodifacoum is sold in pellet form in the UK", asks David Bull of Oxfam's public affairs unit, "why does ICI sell it to Indonesia in liquid form, which is clearly more dangerous?"

Brian Cox of the company's plant protection division, says: "It's not for us to dictate to the Indonesians. They have made plain that we're not expected to take the blame or pay compensation." ICI refuses to say how much brodifacoum it sells to the government of Indonesia—"that's a commercial secret". The Consumers Union of Indonesia claims that since 1980 Klerat has killed 52 people in Indonesia alone.

Are the West's pollutants killing Thai fish?

PESTICIDES may be the cause of a mysterious disease that is killing millions of fish in Thailand, say Thai government scientists. Among the species affected are mudfish and snakehead—part of the staple diet of Thai peasants.

First reports that fresh-water fish were dying in large numbers came from the south of the country in November. One Bangkok resident reported that "the disease left ugly open wounds in the fish." Since then the epidemic has spread to more than half the provinces in Thailand. Fish worth \$10 million have died, prices of other protein sources have soared.

There is controversy over the cause of the epidemic. The head of the toxicology division of the Thai agriculture department, Dr Prayoon Deema, blames the pesticides. But Thai and British fish experts say the fish are dying from an aquatic fungus. This may or may not be linked to the presence of the pesticides.

Whatever the truth, Thai fish are in a bad way. Deema's staff have found Paraquat and other pesticides, such as dieldrin and heptachlor, in most samples of fish tissue they have examined since the outbreak of the disease. Paraquat contamination ranged up to 60 parts per

billion. River water samples contained "extremely high levels" of 2,4-D and 2,4,5-T. These biocides are widely used in Thailand to keep down weeds on rubber plantations and rice fields. 2,4-D levels reached 8.8 parts per billion in river water.

Paraquat is manufactured by ICI for sale in Europe and North America as well as in developing countries. The only published source of data on Paraquat's long-term toxicology is research by the US company, Industrial Bio-Test. The reliability of all IBT results has been thrown into doubt since its director and three chief scientists were indicted by a grand jury for fraud.

Thailand's National Inland Fisheries Institute says it does not know what is causing the epidemic or why it has spread so rapidly. Experts from the Institute of Aquaculture at Stirling University in Scotland were recently in Bangkok. But they were unable to make a positive identification. "The symptoms are of a severe chronic muscle infection caused by an aquatic fungus," said Dr Ronald Roberts, the Institute's director. "But it's a new one to us and we don't know what's causing it, or what effects it has. □

Ecology's law in search of a theory

Plant ecology, at the admission of its own protagonists, has produced only one respectable scientific law. But the basis of it is unexplained

Michael Hutchings

THE MORE closely plants are crowded together, the smaller each individual plant is liable to be. The more they are thinned, the bigger the surviving individuals can become, until they may ultimately reach the maximum size for the species concerned. So much is obvious; but what is remarkable is that the density of the surviving plants growing in an actively thinning population has a precise mathematical relationship with their average (mean) weight. Indeed, if one draws a graph, plotting the falling density of surviving plants at different points in time along the horizontal axis, and their increasing mean weight up the vertical axis, using a logarithmic scale in each case, a steeply sloping straight line will be produced when the points are joined together, as shown in Figures 1-3. As time passes, populations move from the bottom right-hand corners of these graphs (high densities of plants with low mean weights), up the slope towards the top left-hand corners of the graphs (low densities of plants with high mean weights). The slope of the lines, almost regardless of the species considered, will be close to $-3/2$, "minus three over two". This relationship is so widespread that, in the words of Professor John Harper of the University College of North Wales, Bangor, the so-called $-3/2$ power law is "the only generalisation worthy of the name of a law in plant ecology".

The relationship outlined above is a simple mathematical description of the way populations of plants develop. When a population of plants first starts to grow, each individual may have all the resources it needs to grow as fast as it is genetically capable of doing in the environment in which it finds itself. However, as time goes on, individuals may begin to compete for resources, and to interfere with each other's growth. Under competition the rate of growth of plants is reduced, and modifications of plant form, termed plastic responses, are often also seen. Such modifications may include, for example, production of fewer branches and flowers, or the characteristic elongation of stems (termed aetiolation) seen in plants receiving insufficient light.

However, there is a limit to the ability of plants to absorb the effects of competition by plastic responses; when the competition becomes too intense, some plants die. Of course, plants may die as a result of many causes, including the effects of frost, desiccation, disease, being eaten and so on. Being crowded out is only one possible fate, and this particular cause of death is termed density-dependent mortality.



Plants thin themselves so as to maximise their biomass whether they are mosses (top) or pine trees: though foresters may help the latter to obey nature's laws

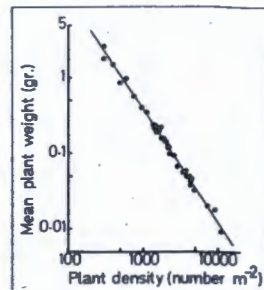


Figure 1 The relationship between density of surviving plants and their mean dry weight in species of plantain; as time passes populations move from the bottom right-hand side of the graph, up the $-3/2$ thinning line towards the top left-hand side of the graph. From K. Yoda, et al Journal of Biology, Osaka City University, vol 14, p 107

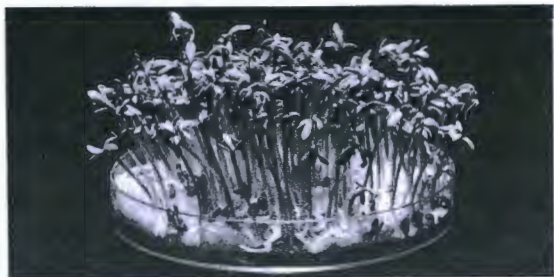
Density-dependent mortality is selective; inevitably, it tends first to affect the smallest members of the population. Thus, its first effect is to result in an increase in the mean weight of the survivors. In addition, within any one population, it

has the greatest influence in the areas where the plants are most crowded, and thus density-dependent mortality also leads to a more even distribution of plants on the ground. Subsequently, however, with competition reduced through the death of the smaller plants, and with survivors continuing to increase their mean weight, the total weight of the whole population increases as time goes on, despite the fall in plant density. When the surviving plants have grown to the greatest mean weight, that can be achieved at their new reduced density, density-dependent mortality may continue to take out the smallest ones. This leaves survivors with a greater mean weight, and allows them to grow still further.

Thus, with reference to the graphs, we can see that density-dependent mortality (or a thinning policy consciously adopted by a forester or gardener) is constantly tending to move the population towards the left along the horizontal axis, by reducing the density. However, as it does so, the mean weight of the survivors increases, and the population rises up the vertical axis. The net effect is to push the populations diagonally up the graph as time passes. Note that the total weight of all the plants in the population (the total biomass) is the product of their mean weight, multiplied by the density. Note too that the line is steeply sloped, to such an extent that a 10-fold reduction in density will, once the surviving plants have grown to fill the space available, be accompanied by roughly a 30-fold increase in mean weight, and roughly a three-fold increase in total biomass.

The line that the population follows on the graph is called the thinning line. It is a constraint upon plant growth in crowded populations—a boundary condition defining the maximum mean weight that plants can achieve (and hence the maximum biomass of species which can be grown) at a given density. In practice, of course, plants may well be below that maximum—for example, they may be small, and yet thinly spaced, as in a newly thinned patch of seedlings. In such a case, plotting density against mean weight would produce a point to the left of the line. On the other hand, density-dependent mortality always prevents the population from moving into the area of the graph to the right of the thinning line; this is effectively a “no-go area” for accumulation of plant biomass.

James White of University College, Dublin, and Eville Gorham of the University of Minnesota, have both recently published large sets of data showing that different species of plants ranging from mosses to forest trees, and including a wide variety of families and forms of growth, follow a thinning line of the kind shown in the graph—a straight line with a slope of $-3/2$. In Figure 2, results from different species are combined. Unsurprisingly, the trees, at the top of the graph, are individually large but must be spaced far apart, while the herbs, at the bottom, remain much smaller but need far less room. They all follow virtually the same slope of $-3/2$ and thus the same law applies to all of them. In addition, as the thinning lines for all species examined lie roughly along the same trajectory on the graph, it is obvious that they would virtually coincide, if appropriately extrapolated. Thus, we might surmise that if an individual daisy could grow so big that it occupied a whole square metre, it would be roughly the same weight as another species that occupied the same area. And so it turns out. The mean weight (or hypothetical weight) of a plant filling one square metre exactly is given by the term k ; and $\log k$, for virtually all species, has value between 3.5 and



Heather Angel

Below the thinning line; plants take time to reach optimum density

4-3. In practice, since k is expressed in logarithms, the consistency is not quite so great as it seems: the weight in grams might lie between about 3150 (if $\log k$ was 3.5) and about 19950 (if $\log k$ was 4.3). However, this range in values of $\log k$, representing roughly a six-fold range in mean plant weight at any density, is very small in comparison with 10^{10} -fold variations in mean plant weight values over which thinning lines have now been fitted. $\log k$ may well be a constant for any species. The range of values it takes from species to species may in fact be much smaller than that quoted above since, as James White has pointed out, $\log k$ is very sensitive to small changes in the slope of the thinning line, which itself will vary a little according to the data available.

Knowledge of the value of k is valuable since it enables us to predict limits to biomass production for a given species at any density. It is a term in the generalised equation that describes the thinning law. This equation takes the form $w = kd^{-3/2}$, or $\log_{10} w = \log_{10} k - 1.5 \log_{10} d$, where w is the mean weight of surviving plants, d is their density, and k is the constant as defined above.

James White's data show that this general equation applies to about 80 species of plant grown in mono-culture both in natural and managed stands, and it also applies to mixtures of species. In this last case it describes the behaviour of all of the plants, and not the fate of the individual species. However, I have found that the plants that seem to fail to follow the $-3/2$ thinning line most consistently are the perennial herbs that spread over the ground by clonal growth—that is, by producing facsimiles of themselves by asexual multiplication. These plants often occupy very large areas of ground with a network of shoots, many of which may remain physically connected to each other for several seasons. Growth and density of shoots in such clonal herbs are still constrained, however, by the thinning line. The growth strategy in such plants produces enough shoots each year to make it difficult for other plants to invade the space they occupy. In addition, as Lesley and Jon Lovett Doust described recently in *New Scientist* (vol 95, p 81) some of these plants distribute their shoots over the ground in such a way that they make the best possible use of available resources, but without causing enough competition between shoots to produce density-dependent mortality. (Adrian Bell in particular, at Bangor, has demonstrated predictable spatial organisation of shoots in a variety of species including the Indian cucumber and yellow wood sorrel.) Consequently, these plants increase their biomass very efficiently, because they are largely free, as other species generally are not, from the losses of biomass associated with density-dependent thinning. The populations grow until they encounter the constraint represented by the $-3/2$ power law, which, in many species, seems to coincide closely with their attainment of sexual maturity. Populations of shoots may remain near the thinning line for some time without moving along it, continuing to photosynthesise, both to maintain themselves and to build up storage organs that enable them to over-winter.

It is possible to alter the position of the thinning line—that is,

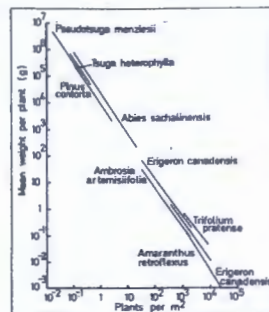


Figure 2 Relationships between mean dry weight and density for selected plant species, drawn to show the coincidence between thinning lines for plants of different sizes and forms growing at different densities. Those at the left of the graph are trees, those at the right are herbaceous. From J. White, in *Demography and Evolution in Plant Populations*, Blackwell

to increase or decrease the maximum mean weight achievable at a given density—but only by changing the intensity of light. If any other essential resource is altered, for example the availability of nutrients or water, or if herbivores or foresters harvest the biomass, then the rate at which the population progresses up the thinning line may be changed (the plants grow faster or slower) but the thinning line itself apparently stays in the same position. However, if the intensity of the available light is increased (provided nutrients and water are in sufficient supply) the position of the thinning line can be raised. In other words, plants achieve a greater mean weight before density-dependent mortality sets in. The opposite effect occurs when light intensity is lowered.

Light has this special effect on the thinning line because of the way in which it becomes available to plants. It enters a stand of plants from above, and is rapidly attenuated as it passes down through the leaf canopy. If light is of low intensity to begin with, then it will not pass far through the canopy before there is too little to support photosynthesis. Hence, with low light, the shorter plants begin to die at an earlier stage of growth and the total biomass which can be produced at a given density is reduced; in other words the thinning line is shifted to the left. Mark Lonsdale and Andrew Watkinson of the University of East Anglia have shown recently that the differences in the intensity of light in greenhouses between summer and winter can markedly alter the position of the thinning line (although, as already indicated, the value of $\log k$ does not exceed about 4.3 in most broadleaved species).

Because the position of the thinning line and the value of k depend in part on the ability of light to penetrate the leaf canopy, it seems that plants that allow deep penetration of light should have higher k values than those that do not. Evidence on this is scarce, but what there is seems to bear out



The light penetrates deep into Norway spruce (top) allowing high mass and high density. Iris (above) spreads to maximise mass without competing with itself

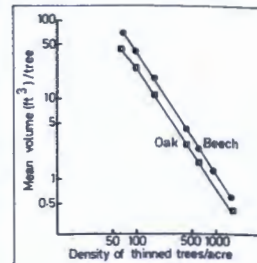


Figure 3 Relationships between density and mean volume per tree for beech and oak for full-stocked stands up to 150 years of age. Redrawn from J. L. Harper *The Population Biology of Plants*, Academic Press

this supposition: species with a conical shape and needle leaves, like coniferous trees, seem to have higher k values than broadleaved deciduous trees, with more spherical canopies: grasses, with their upright linear leaves, probably have the highest values of all. In perennial ryegrass $\log k$ may even exceed 5.0.

Ecologists have known of the $-3/2$ power law for about 20 years, but foresters, concerned with the optimum spacing of trees, intuitively grasped its significance much earlier. The Forestry Management Tables produced by R. T. Bradley, J. M. Christie and D. R. Johnston in 1966 show the most suitable thinning

regime to adopt in order to maximise the rate of increase in the girth of trunks and the volume of usable timber per unit area of ground, for different species on different soils. Plotting the logarithm of the mean volume per tree against the log of the density of survivors produces lines with gradients ranging from -1.72 to -1.82 , depending on the species and the growing conditions. These gradients are not greatly different from -1.5 , and such difference as there is may be caused by plotting mean volume rather than mean weight.

Despite the appealing mathematical simplicity of the $-3/2$ thinning law and its wide applicability to agriculture, horticulture and forestry as well as natural stands of vegetation, it has so far been demonstrated by the accumulation of evidence from experiments and other empirical data, but not satisfactorily derived from theory. The explanations originally proposed for the $-3/2$ term in the equation used arguments based on the dimensions of the plants, but despite the apparent logic of this approach, these explanations have been shown to be untenable. Thus, we can demonstrate the law in action but we cannot yet say why it works, or to quote Professor Harper once again, we have in the law “a crude statement of constraint whose underlying rationale remains elusive”.

Dr Michael Hutchings is in the School of Biological Sciences at the University of Sussex.

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PROVIDING A SCIENTIFIC EYE FOR DETAIL

Take a good look at the photograph below. Is it a gas nebula somewhere in the universe or a microcosm here on earth? Astronomy, metal physics, or human biology? Such are these scientific disciplines that if the yardstick by which they were measured were distance, they would literally lie worlds apart. Astronomy is the study of all objects within the universe; metal physics the properties governing solid state materials and biology the phenomena of life. Despite the divergent nature of these sciences, their individual development can be traced back to a single unifying source: the Galilean telescope invented in the early 17th century to examine the stars and planets. That same telescope, modified

and viewed through the other end, became the microscope - the key to the exploration of inner space. In the course of the last three centuries parallel development of optical telescope and optical microscopy has provided scientists with deeper and deeper insight into hitherto invisible worlds. However, the application of electronic and computer technologies as tools for scientific investigation has achieved a much greater impact in considerably less time.

The electromagnetic spectrum, like the optical properties of Galileo's telescope, has provided a fundamental basis for development of a wide and varied range of sophisticated investi-

gative instrumentation over the past three decades. Astronomy, metal physics and biology have benefited, of course. But the interdisciplinary nature of this development has given impetus to other fields of research such as Chemistry, Radiology, Geology, Meteorology, Telecommunications and Microelectronics.

As one of the world's leading research-based electronic enterprises, Philips has played an important role in this technological evolution. Notable achievements in electron microscopy start with selected-area diffraction aperturing and a 5-lens optical system in 1949, and continue with similarly innovative 'firsts' through to the recent introduction of a new family of transmission electron microscopes. Indeed, Philips global reputation for innovation in this field applies not only to electron optics, engineering and vacuum design but also to their application-oriented system concepts.

For medical investigations, Philips has developed advanced diagnostic systems for CT scanning, digital vascular imaging (DVI), ultrasonics and nuclear magnetic resonance (NMR). And you will find Philips providing a scientific eye for detail in space technology, too. In radio telescopes, in satellite earth stations and on board orbiting astronomical satellites.

For a closer examination, here are some fine details.

Outer space or inner space? Inner space, in fact. The bright spots represent the distribution of minute palladium catalyst particles 0.000004 mm in diameter on a thin substrate. The image was recorded using the conical dark field mode of the Philips EM 400T transmission electron microscope.



PHILIPS

NEW NMR SYSTEM FOR MILAN CLINIC

Measurement of the nuclear magnetic resonance (NMR) of hydrogen is a long established analytical procedure in chemistry and physics. Now Philips has applied this principle to develop the GYROSCAN - a NMR medical diagnostic system for visualizing internal organs and other tissues. NMR makes use of the property that hydrogen nuclei, which are present in all living tissue, can be made to emit radio signals. Using computer techniques, these signals can be processed to obtain an image of the tissue-of-interest. Good results have been achieved in the detection of brain oedema and the study of pathological processes such as necrosis, ischaemia and various types of neoplasm and degenerative disease.

The GYROSCAN has been ordered for the Radiology department of the Clinic Pio X in Milan, Italy, where a Philips TOMOSCAN 300 CT scanner has already been used for over 30,000 studies.



NEW TEM FOR APPLIED RESEARCH

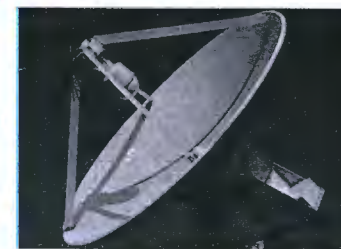
Philips universal transmission electron microscope, the EM 420, combines high performance imaging with extensive analytical systems capability. A unique feature of the patented Twin lens is that the excellent objective lens coefficients in TEM and STEM are identical and also allow small-probe TEM performance with high $\pm 60^\circ$ tilt and high resolution. The EM 420 can be extended with an extensive array of accessories to meet advanced specialistic needs in the area of X-ray, electron energy-loss and diffraction analysis. Specially developed for applied research, the EM 420 is part of a new family of transmission microscopes, the others being the EM 410 for life science investigations and the 300 kV EM 430 microscope for fundamental research.

These are just a few examples of Philips advanced technology. If you would like more information, contact your Philips organization or Philips Corporate Planning and Marketing Support, VOA-0217, 5600 MD Eindhoven, the Netherlands. Telex: 35000 PHTC NL. Please indicate in which of the above subjects you are interested:

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NEW GROUND STATION FOR METEOROLOGY

Signaal, Philips space-tech company, has developed a meteorological ground station that produces instantaneous images from orbiting and geo-stationary weather satellites. Employing sophisticated computer-tracking techniques, the station tracks low-orbiting satellites when they are in range and - when they go out of range - switches over to geo-stationary satellites. This dual-tracking capability enables meteorological agencies to widen their data base by comparing the high-resolution/limited area data from the TIROS-N satellite with synoptic data from the GOES and GMS satellites. The station's software-oriented layout permits a variety of system configurations to be achieved. One of these stations is already operational at the Royal Netherlands Meteorological Institute, KNMI.



SURE SIGN OF INNOVATION IN OBSERVATION



The J-class yacht *Rainbow*, 39 m long, defended the America's Cup successfully in 1934. But in the competition that year, Britain's challenger *Endeavour* won the first two races, the last time a British contender has won any of the races

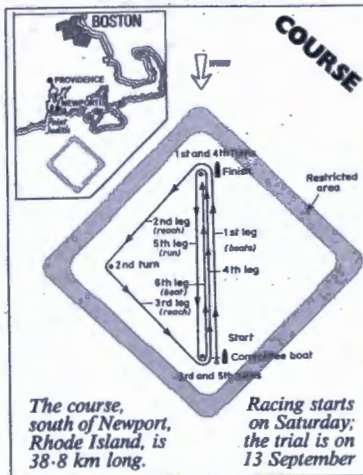
The America's Cup—Grand Prix yachting

Seven yachting syndicates from five nations will spend more than \$40 million on boats and advanced technology this summer to try and recover the America's Cup. Three more syndicates from the US have put up another \$10 million to stop them

John Stansell

CONSIDER this irony. Ten groups from developed nations have put up about \$50 000 000 to build, test, and sail a form of yacht first built in 1907, with the aim of winning a cup that America has successfully defended 24 times since 1851. While the technology that is being applied to challengers and defenders alike is space-age stuff, the hull form is bound by a rule that has changed little since it was first established in Europe in 1920 and which has not been modified since 1933.

Several designers of these boats, called "twelve metres", admit that despite all the tank testing, computerised hull design and construction techniques, any two with equivalent sails and crews would probably travel at the same speed. Races for the America's Cup are not necessarily about top speed, but about a combination of a boat's speed over a variety of wind directions and velocities, its manoeuvrability, sail quality and the preparation of equipment and crews. But even with all these, the winning boats in all the closely contested challenges have owed their success to something that technology cannot provide—sailing skill.



The course, south of Newport, Rhode Island, is 38.8 km long.

Racing starts on Saturday, the trial is on 13 September

The role of technology is to eliminate all the possible uncertainties that a challenger or defender faces. And it is in this context that the America's Cup challenge of 1983 becomes more than just a race between emotionally-fired rich men for a trophy of doubtful value. America's Cup boats have always been technologically advanced, but this year sees a new high in the use of materials, electronic instruments, design techniques and computers to evaluate performance of boats, sails and men. For those who need a "spin-off" from esoteric technological projects, the America's Cup leads to improvements in the performance, safety and cost of the small boats that sailors take to sea for recreation.

The America's Cup is like a Grand Prix motor race. The analogy is best seen at the waterfront in Newport, Rhode Island, where the races have been sailed since 1930. There, in a selection of wharves, each camp has its "pit", with several specially equipped "containers". Some are offices or workshops and others are compact meteorological stations. At all these "pits" is a hoist, that when connected to massive eye bolts in the keel can lift these 25 tonne-displacement boats

out of the water. In some cases the boats are lifted out every night, while in others, the keels are shrouded to conceal the secrets of their designers. Each syndicate has the use of a sail loft in town, and each has hired the services of their nation's best sailmakers, albeit most employed by one American manufacturer.

Security in each camp varies as to the syndicate's perception of its chances. For the so-called Freedom syndicate (inevitably the favourite as it contains the key people who retained the Cup in 1980) it borders on the hostile. For Britain's Victory syndicate it extends from the locked gate to the threat of instant dismissal for any employee who leaks information to the press. In the case of France and Italy, while language provides a natural security, the leading

shorter, he must reduce the weight and increase the sail area. Most designers opt for a length of about 20 m overall, with a waterline length of about 14 m, and a sail area of about 165 sq.m.

The precise hull shape is also governed by an official measurement of its girth at different positions. In general terms these must add up to a specific volume. The convention is to have the biggest girth roughly in the middle, with the weight in the ends of the boat being minimised. There is a specifically local reason for this. During the summer in Newport, the winds are often light but the sea is short and steep exacerbated by wash from spectator boats.

Any designer worth his salt will draw a boat that can cut through such waves and not suffer from speed-sapping pitch-

US—the Freedom syndicate

DENNIS CONNER, who successfully defended the America's Cup in 1980 is both skipper and boss. He has two boats in Newport, the new *Liberty* and last time's defender, *Freedom*.

Liberty is the result of trials with two boats built specifically to investigate extremes of design under the rating rule. One, *Magic*, was short and light; the other, *Spirit of America*, was long and heavy. Both turned in stunning speeds in light airs, but could not beat *Freedom* in strong winds. *Liberty*, in consequence, has elements from both unsuccessful trial boats, but is, at face value, a conventional twelve metre.

Conner is not a great believer in computers on boats, but his defender will have a Hewlett Packard computer, taking and storing data from selection of instruments from different manufacturers. Conner describes it as "a mix and match based on experience (defending the Cup) since 1974". The computer's chief role will be for navigation and tactics.

Sails are mostly by North (its chairman John Marshall is the mainsail trimmer) with some by another leading US firm,



Liberty, America's chief hope in 1983

Sobstad (its president Tom Whidden is Conner's tactician). Winches are by Lewmar of the UK (they are at least as good as anything else in the world, and are attractively priced, says Conner). The mast is by Sparcraft; the hydraulics by Navtech.

UK—the Victory syndicate

PETER DE SAVARY is the motive force behind Britain's best-presented challenge since 1934, the last time a British boat won any of the races. Like Conner, he has had two boats specially built: *Victory '82* (which was not fast enough) and *Victory '83*, which has not yet proved to be a winner either.

He also paid for Australia, said by Conner to be faster than *Freedom*, and *Lionheart*, Britain's challenger in 1980. *Victory '83* is designed by Ian Howlett, who also designed *Lionheart*. *Victory '82* has been severely modified as a back-up boat for this year's races.

The Australians, previously the undisputed leaders outside the US, have taught de Savary that a challenger must have enough money to spend on high technology. There is a \$1 million budget to buy sails for his syndicate and a tender to carry an ICL Perq computer behind the boats. The boats use the latest Ockam Instruments which have a microprocessor for each display. Up to 10 variables at a time can be transmitted from yacht to tender. Masts, rigging and hydraulics are from the same maker that the US challenger uses.

people are eager to publicise what they will do to try and wrest the Cup from their better heeled and more technologically-advanced competitors.

On the water, too, security is tight. Last summer in Newport, the British roused the anger of Dennis Conner, skipper of the Freedom syndicate, by filming the American boats during trials with video cameras. When the Americans sailed further out to sea, to make life difficult for the crew of the small tender the British were using, Peter de Savary, Britain's challenger, merely sent out a larger spy-boat.

The Americans spy too. During one series of British trials last summer, Britain's syndicate manager sent a tongue-in-cheek note to Conner, thanking him for providing a rescue boat. The acrimony that such activities built up has been resolved now with a British style compromise. Each syndicate has alternate days when it has the right to privacy, while anybody can follow its boats on the other days. The result is a dearth of objective information about any boat's performance. Experimental sails that show promise are aired on the private days; those that are average are on view to anyone nearby. The same applies to speedy boats. As Conner said: "If I had a breakthrough boat I'd let my conventional boats beat it when the press was around."

The key technological areas for twelve metres at this level of competition are hulls, sails, and electronics. But masts and rigging and sail trimming winches are important too.

The rule governing the design of a twelve-metre hull is highly restrictive. A designer can make a boat longer, but it must also be heavier and carry more sail; if he makes it

ing. If he can reduce wetted surface area he will cut drag, but again he is limited by the rule. He can reduce rudder size to this end but manoeuvrability is a key to a good match racing boat; the rudder must be of sufficient size and of suitable shape to control the boat while under the forces of a wide range of different sails acting under winds of different speeds and directions.

Most designers start with a known quantity—say a previous winner or a powerful challenger—and study its lines, rule book in hand, to see how the form can be improved. Then they draw the better shape and this is where computers and tank testing come in.

Computers aid in checking that the shape "looks" good when shown in a three-dimensional form. As Bruce Kirby, designer of Canada 1 says, "there is no excuse for an ugly boat". Apart from offending the eye, it is likely to be slow. Then the designer builds models to test in suitable tanks. Expertise in this area is what brought Ian Howlett into the limelight. He designed *Lionheart* for Britain's unsuccessful challenge in 1980 and *Victory '83*, the much better boat on which Britain's hopes are pinned this time. Howlett is a naval architect who specialised in tank testing at the Wolfson Unit at the Southampton College of Higher Education. Before *Lionheart*, he had "half built a twelve meter" before the commission was abruptly terminated. Learning from existing hulls and published data, he built models and tested them in towing tanks to experiment with variations. With *Lionheart*, he scored a partial success, creating a boat that some people have described as "the fastest twelve metre in

the world in a straight line". The opportunity to design Victory '83 gave him the chance to add cornering ability to speed. Only time will tell whether he learnt his lessons.

The hulls are made with lightweight but strong aluminium frames welded and glued into the structure, with sheets of aluminium laid over them. Any unevenness is filled with epoxy resins and boatyard workers endlessly sand them to the final, desired smoothness.

Hull design is still something of a gamble, even when the designer has had years of experience. Conner's new boat Liberty was designed by Johan Valentin, a Dutchman regarded as a whizz kid. He had considerable assistance from Conner and a veteran called Halsey Herresof (his grandfather designed many of the US's successful defenders of the 1930s). Yet rumour is now rife that Liberty is nowhere near as fast as Freedom, in which Conner won last time.

If the Cup is won by a non-American this year (or any year if it comes to that) the community of designers who follow the twelve metres will have to go back to their drawing boards. Conditions in Perth, Australia II's home, or Essex where de Savary hails from, are markedly different from Newport.

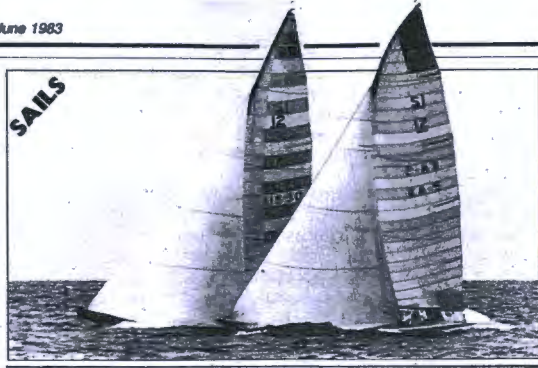
Everybody favours the "conventional" boat, on the basis of past experience. But they still all secretly hope for a real breakthrough. This year it is Australia II, designed by Ben Lexcen that is exciting most comment.

The finest hull is no use without good sails. And sails have shown the most advances in the recent past. The secret of a good sail is its shape. Designed around an ideal aerofoil, the fabric must change shape at different points of sailing. When sailing as close as possible towards the wind, it must be flatter in heavy airs than in a light breeze. When running away from the wind, it must be full to catch every drop of power.

When the wind comes from forward of a line at a right angle to the boat's direction (called the beam), most of the power comes from the lift given by the sail's aerofoil section. When the wind is behind the beam, some, but not all of the power comes from the "push" of the wind on the sail. When running directly down wind all of it comes from this force.

Twelve metres normally carry two sails at a time (although on occasion they can carry more). The mainsail is attached to the mast and to the boom. The other is called the genoa and is attached only at its forward edge to the forestay, a wire that holds up the mast. The mainsail is always carried and must be capable of being trimmed to a shape that suits the apparent wind—the wind as seen by the moving boat.

Materials are the key to a high-technology sail. Until recently Dacron (known as Terylene in Britain) was the



Top: The two finalists in 1980—Freedom (US30) and Australia. Australia's foresail has vertical panels to give more stretch-resistance. The dark and light patches on the back of Freedom's sail are made of Mylar/Kevlar, alternately reversed to help stitching. Above: North Sail's plotting/cutting table brings automation into the sailmaking loft

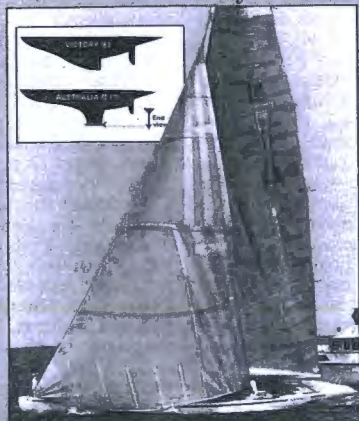
favourite; tightly woven into a fabric and "tempered" by heat treatment or coated with resin it stretches much less than traditional materials such as cotton or canvas. But it does stretch, so sailmakers turned to an extruded plastic sheet called Mylar. While Mylar is very tough, once it starts to tear, it goes in a flash. So sailmakers had to bond a woven material to it for tear strength.

Mylar hardly stretches at all compared with Dacron, but

SINCE Australia first challenged for the Cup in 1962, it has produced the greatest number of contenders (six to Britain's one) and the most technologically advanced. On two occasions, with Gretel in 1970 and Australia (the Victory syndicate uses her as its trial horse), the Americans acknowledged that the Australians had the fastest boats. They lost the races due to the American's superior local knowledge and helmsmanship.

In 1983, Australia II is reckoned to be the most feared contender. She was developed by a syndicate run by Alan Bond (a Perth property developer often described as having the same piratical nature as de Savary of Britain), and designed by Ben Lexcen (who was part designer of Australia). The boat is generally believed to have a novel hull shape. The keel and after sections are not exposed to the press or competitors, so nobody knows precisely what the novelty comprises. But it is generally believed that Lexcen has cut down the keel

The Australia II syndicate



area (to reduce wetted surface and improve manoeuvrability) and added the lost ballast in a bulb shape at the bottom of the keel. There are said to be fins (rather like wingtip "sails" seen on advanced aircraft) on the keel to reduce drag.

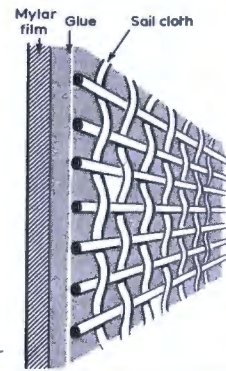
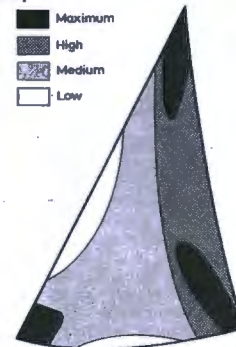
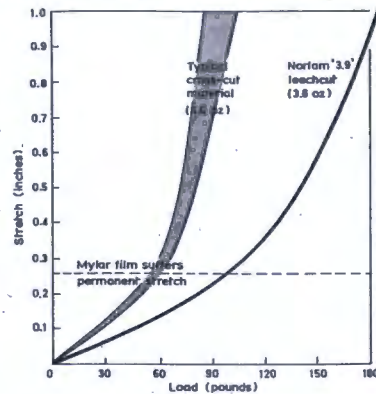
Australia II is said to be faster, both in straight lines and round corners, than the other Australian entry designed by Lexcen, Challenge, a "conventional" twelve metre. Lexcen is reported to have been so excited about tank tests on the new shape that he believes that if the full-scale yacht achieves anywhere near its theoretical potential, it will revolutionise hull design in sailing boats.

This will be Bond's fourth attempt at the Cup in nine years, so he has considerable experience; that means that sails, electronics, masts and so on will be at least as good as any other contender's. And in John Bertrand, he has what many people believe to be one of the top five helmsmen in the world in match racing. □

Right: Mylar/Kevlar with Kevlar fibres in the load bearing direction (the warp) give the laminated cloth more stretch resistance for the same weight.

Below right, a laminated sail has a Mylar sheet glued to a cloth; this bond must survive flogging of the sail as well as sun and salt water.

Below: the loads on a genoa are greatest at the corners, and at the back, explaining why sail-makers put more layers of cloth at such points



it gives enough to allow the sail to take up a satisfactory shape. Sometimes Dacron is bonded to it but in others a Kevlar cloth is chosen. Kevlar is a synthetic fibre which has a high strength to weight ratio. Sails of this pattern were first used for genoas in the America's Cup challenge in 1977, and for mainsails in 1980.

Sailmakers have tried different ways to cut the panels they stitch into sails. Traditionally they cut the panels horizontally with curved edges. When these curves are held straight and stitched, the sail takes up the curved aerodynamic shape intended. Until 1980, nobody could achieve a suitable shape with anything other than horizontal panels. But nature was not on their side for the vertical forces in a sail are greatest. If only they could sew panels vertically, for the same strength they could use a lighter material.

In a match race, where the first boat need only be one second ahead to win, a sail that can keep its shape in a wider range of wind speeds is an important advantage. You cannot afford the time to change a mainsail in such a competition; equally you cannot afford to break your sail.

This year's novelty is a material called "warp Kevlar". It is a ply of Mylar plus Kevlar woven in the warp, or load-bearing direction. The material is extremely expensive and until nine weeks ago did not exist in a form suitable for mainsails. In 1980, Australia started the final match with a genoa made of warp Kevlar cut in vertical panels. It contributed to the boat being faster than the US boat, Freedom, although it lost the series because Freedom's crew sailed better.

Last Autumn, the US sailmaker North Sails persuaded an American manufacturer of sail cloth to make a 5000 m long bolt of warp Kevlar, 1.4 m wide, using a fibre twice the

diameter of the 1980 material. It took some persuading because this simple roll of material cost \$100 000. Kevlar is extruded—squeezed from a die of the right diameter—and for a warp cloth must be produced in the length of the final roll. There are 35 fibres to the centimeter and at 1.4 m wide, that means nearly 5000 fibres, each 5000 m long. If any fibre breaks during extrusion, it is worthless. If any fibre breaks during the process of weaving the fibre into a cloth, that part of the cloth is no good.

After weaving, the fabric must be glued to the Mylar to form a laminate so perfect that it can withstand the flogging a sail experiences every time the boat "tacks" (turns so that the wind moves from one bow to the other). Add to that the natural dislike that laminates in general and Kevlar in particular have for sun and salt water, and you get some idea of why a twelve-metre mainsail can cost about \$15 000.

Most boats in the America's Cup have three such sails to cover the wind range in which the cup races can be sailed, from 5-25 knots at the start. Each syndicate will have built many such sails to get the perfect shape.

Traditionally (that is now in most sail lofts) a sailmaker creates templates for each panel. He draws a line on the material and cuts it by hand. Now North and other sail makers are using computers to handle this earlier stage of the design.

Once a designer defined the shape of a sail by drawing it and transferring key points into a table. Then he converted this into a set of instructions for the template maker. With the computer programs that North has had designed by Michael Richelson at Copenhagen University, and Peter Hepple at Cambridge in the UK, this part of the process becomes automated. The designer keys into the computer the co-ordinates that define the new sail. The program checks these for glaring errors and automatically converts them into the cutting instructions for each panel.

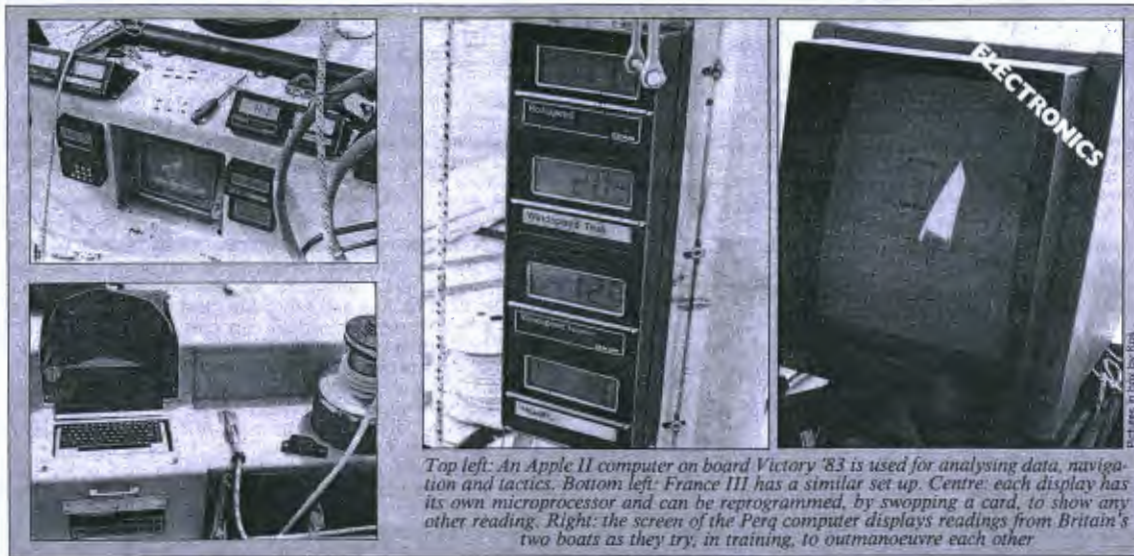
Sail makers at North's UK subsidiary, which the Victory syndicate is using almost exclusively, feed the co-ordinates into a computer at its loft in Fareham, Hants. They then lay cloth on a 25.5 m-long table and push buttons on a key pad. A carriage that runs on rails either side of the table then either marks the cloth to the desired shape, or cuts it with a "hot wheel". The key benefit is accurate sails.

Computers are also used by most syndicates to evaluate sails, as part of the whole operation of monitoring the performance of boat, crew and sails working together. The data for computers are measurements taken by sensors on the boat. They include such variables as true wind speed and direction, apparent wind speed and direction, boat speed and direction and speed made good to windward—the latter is a measure of how fast and close to the wind the boat sails.

Both the Victory syndicate and Australia II send data to mini computers on tenders that follow the yachts as they train. Italy plans to transmit its data to a computer ashore for analysis there. The three American boats have opted for computers on board that store data for analysis when the boats dock, as have the Canadians, the French, and the other two Australian syndicates.

Britain's boats send data to a large motorboat that follows them round. There they are loaded onto an ICL Perq computer and displayed instantly. In other words the operator, an electronics whizz kid called Graham Winn who is also a sailor, can watch the traces of each boat's speed, direction, the true and apparent winds they are experiencing and so on, as the boats are manoeuvring with each other.

He has programmed a number of floppy discs to cover the expected range of sea states—the height and frequency of the waves. He can use this information in a number of ways. One is to follow continuously what each boat does in relation to the other, pointing out to the shippers how they might sail faster, or manoeuvre more swiftly. Or he can identify whether a particular sail is driving a particular boat faster and under what conditions.



Top left: An Apple II computer on board Victory '83 is used for analysing data, navigation and tactics. Bottom left: France III has a similar set up. Centre: each display has its own microprocessor and can be reprogrammed, by swapping a card, to show any other reading. Right: the screen of the Perq computer displays readings from Britain's two boats as they try, in training, to outmanoeuvre each other

Hydraulics shapes the rigging

THE MAST and rigging of a twelve metre are akin to a fine musical instrument—unless tuned to perfection, they do not deliver their full potential. The main, or coarse, tuning is done before the boat goes to sea, but when sailing the crew will make continual adjustments to the rigging to pull and push the mast into a profile that suits the best shape of the sails for a particular course. They do this nowadays with hydraulics.

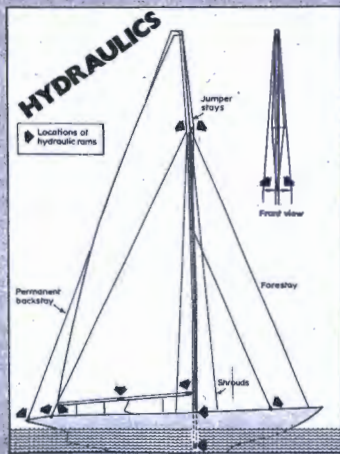
For example, a twelve metre's mast can take up any shape from looking like a long-bow, to dead straight, to the top third bending forward. Much of this control is through the backstay, which runs from the top of the mast to the stern of the boat. A hydraulic ram tightens or loosens the backstay with great power and precision. But many other rams, as many as 10 in some boats, govern the fine detail of the mast's curves. One at deck level pushes or pulls the mast to dictate its angle to the keel. Another forward of the mast (the inner forestay) "pulls" out the centre section to support the shape. Two so-called "running backstays" support the mast in the lateral direction to compensate for the forces of the sails at certain angles of the wind.

On Victory '83, Britain's chief hope, there are also four hydraulic rams in the mast. Two control the tension of the "jumper stays", wires

that run over horizontal rods projecting outwards at roughly 45° to the fore-and-aft line of the boat, down to roughly the middle of the mast. They support the top of the mast and govern the shape of the top half; the rams act outwards on the rods, or "spreaders". The other two rams act on the side stays (again through the spreaders) to tension them. Beneath the mast is yet another hydraulic jack, used before a race to tension the rigging. Finally, hydraulics is being used to control the shapes of sails.

Today, the pumps are oscillating types; pressure is increased by pumping a lever backwards and forwards; it is released by gently unscrewing a valve. But Navtech, the firm that has supplied hydraulics to virtually every boat in the competition is experimenting with rotary pumps.

Further in the future, there are suggestions that the massive rotary power of the winch systems may be harnessed to drive the hydraulic pumps. And the chains and gearboxes of this year's winches may be replaced by hydraulic links and gearboxes, which would save weight and increase efficiency. Perhaps that is what John Burton, chief executive of Lewmar, has in mind. Last week he finalised the purchase of Navtech, bringing two key areas of advanced yacht technology under one (British) company's control.



Grinders winch the sheets

IF THE sails of a twelve metre are equivalent to the engine of a Grand Prix motor race, then its winches are the controls the driver uses to get the most power from them" says Phil Atfield. He is the engineer who has installed a British design of winch on nine of the 12 America's Cup boats now in Newport. He works for Lewmar, a British firm that has so advanced its winch technology in the past five years that its equipment is the first choice of the leading contenders. And at £50 000 (\$75 000) per system that is good business.

But what is a winch? At first sight, it does not look like high technology. In essence, it is a concave drum, rotated in some way, around which you wind a rope that is connected to a sail, thereby allowing the crew to control its shape. But when the loads on those sails are enough to propel a 25 tonne boat through the water at 9 knots, and every fraction of a second counts when changing their shape, the winch must deliver high power and high speed. That calls for a marriage between brute force and precision engineering.

On twelve metres (as in all racing yachts) the power comes from men—known in the trade as grinders. There are two winch systems: one controls the mainsail (and for convenience is also used to power the bilge pump) and is driven by two men; the other controls the foresails—genoa and spinnakers—and can deliver the power of four grinders into one winch drum. Standing facing each other, pairs of men rotate handles on the ends of cranks to deliver rotary power to the winch drums through automatic gearboxes, chain drives and universal joints borrowed from helicopter rotor blades.

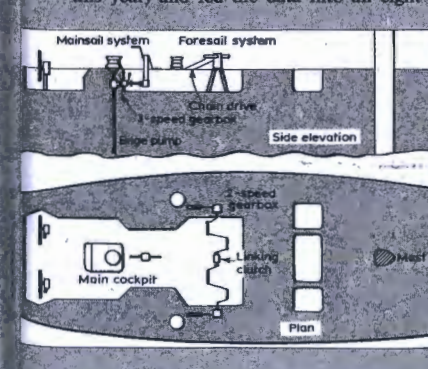
The gearboxes provide the grinders with up to six power ratios, semi-automatically, through a three-speed automatic gearbox

with a two range gear train. What happens is this. The sail trimmer winds a rope connected to the sail around a drum, and clips it into a cleat on the top that keeps the rope wound tightly round the winch. He pushes a button to select first gear and orders the grinders to wind; when the load becomes too great they reverse direction to select second gear, and reverse it again to select third. When that range has run out of power, the trimmer bangs over a lever, and hits the first gear button again; in less than a second the winch is fourth gear. Two further reverses of the direction give fifth and sixth. If for fine tuning, the trimmer wants to oscillate between any two gears he can lock them, so that each change of direction by the grinders gives one or the other ratio.

The materials used to build this humble man-powered machine would not disgrace a modern fighter plane. They include tempered alloys, special stainless steels, titanium and highly durable plastics. Bearings are for the most part needle roller types to minimise friction, with Delrin balls (a plastic) used to cope with side loads.

Before the mid 1970s, Lewmar had never made winches for twelve metres and a Californian firm called Barient was king. Then the British company was approached by a leading American sailmaker to equip his contender for the competition. But the sail loading data he supplied were based on estimates and were far too high; not surprisingly the first prototypes were too large and cumbersome.

So Lewmar's chief engineer, John Huggett, decided to measure the loads accurately. He fitted load cells to ropes, pulley blocks and winches aboard France III (a potential challenger in 1980 and again this year) and fed the data into an eight-channel chart recorder.



Armed with such data he designed a winch system that was 50 per cent lighter than the Barient equivalent, and which performed at least as well.

Ironically it was Dennis Conner who gave Lewmar its second chance to get into this esoteric end of the sport. In 1979, he ordered a winch system for his boat Freedom, with which he retained the Cup for the US in 1980.

Your problem

You are an electrical engineer, a surveyor or a professional person whose work involves long and involved mathematical calculations. Physics or chemistry may be your forte. Or, indeed, you are a statistician faced with the problem of calculating population variance over differing periods of time given the norms and the level of significance where the application of χ^2 -test is relevant.

Your program

```

P0
10 WC
20 PRINT "x":A+1:
INPUT X
30 A=A+1
40 N=N+X
50 P=P+X^2
60 GOTO 20

40 Q=Q+Y^2
50 GOTO 10

P2
10 C=(SQR((P-(N^2)/N)/(N-1)))^2
20 D=(SQR((Q-(O^2)/O)/(B-1)))
30 PRINT "P1=":A-1
40 PRINT "P2=":B-1
50 PRINT "F0=":C/D
INPUT Y
20 B=B+1
300=O+Y

P1
10 PRINT "y":B+1:
INPUT Y
20 B=B+1
300=O+Y
    
```

Your computer



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CASIO! MAGIC!

MONITOR

A radio supernova suggests more are overlooked

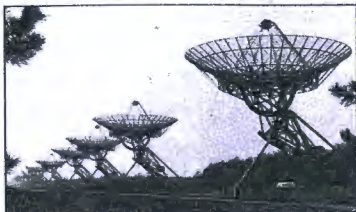
ASTRONOMERS from Jodrell Bank, Holland and Germany have found a supernova in another galaxy by its radio emission. This is the first time that a supernova has been discovered at wavelengths other than light, and it suggests that optical astronomers may have missed many supernovae in the past: Supernovae could occur twice as frequently as previous statistics indicate.

The team reporting the discovery (to be published in *Nature*) consists of Rod Davies and Alan Pedlar from Jodrell Bank, J. M. van der Hulst and G. D. van Albada from Holland, and E. Hummel from Bonn. The Dutch astronomers had mapped the radio emission from the spiral galaxy NGC 4258 with the Westerbork telescope in Holland and the Very Large Array in the US during 1974 and 1975. The galaxy was observed again at Westerbork in late 1982. Meanwhile, the team was using the Very Large Array to study a sample of 100 spiral galaxies, which included NGC 4258 in January 1982. They analysed the map of this galaxy a year later.

To their surprise, they found a bright, very small radio source in one of the galaxy's spiral arms. This source did not appear in the 1974-75 map. They then checked the map made at Westerbork later in 1982, eight months after the source was recorded with the Very Large Array, and found the source present, but only half as bright. This confirmed that the source was real, not just an artefact from the telescope, and also showed that it could be a supernova, fading after an earlier outburst.

Radio astronomers have detected radiation from only three other supernovae, all first discovered by optical astronomers. The new supernova has a similar radio output to these three (about 14 times

stronger than the most powerful source in our Galaxy, Cassiopeia A, the remains of a supernova explosion of 300 years ago). There are three main optical observatories regularly monitoring galaxies to look for supernovae—Palomar in the US, Asiago in



Westerbork telescope spots a supernova

Italy, and Zimmerwald in Switzerland. Paul Wild at Zimmerwald has studied his collection of photographs, and has indeed found a faint image of the supernova on a plate taken in November 1981. The strong radio emission several months after its appearance optically is typical of the previous three radio supernovae. But the optical image found by Wild is little more than a hundredth as bright as the supernova should have been. Its dimness was probably caused by its light being absorbed by the dense dust in that region of NGC 4258. Wild's photograph may have been taken after the supernova's maximum brightness and its maximum was missed because the supernova occurred close to a bright spiral arm whose image would have been "burnt out" on photographs.

Either way, the fact that optical astronomers missed this supernova means that

A clock that keeps time in the womb

ANIMALS have built-in "clocks" that regulate their bodies' activities according to the time of day. But does the clock start ticking at birth or before? Steven Reppert and William Schwartz of Harvard Medical School have found that the biological clocks of rats are working well before birth; they are synchronised by their mothers' experience of night and day (*Science*, vol 220, p 969).

Animals regulate their clocks—located in brain regions called the suprachiasmatic nuclei (SCN) of the hypothalamus—according to the periods of light and dark that make up their day. There is a direct link between the retina of the eye and the SCN. This system could hardly be working in the cosy but dark confines of a rat's uterus. Yet Reppert and Schwartz found that the SCN's of rat fetuses examined 24 or 36 hours before they were due were active in the daytime and quiet at night. They injected the mothers with a radioactively-labelled form of glucose called 2-deoxyglucose, which collects in active parts of the brains of both mother and fetuses, and marks

these areas clearly when slices of brain are subjected to a photographic technique called auto-radiography. If the mother was injected during the day, the SCN of the fetuses showed up as dark spots; if she was injected at night, they could not be seen at all.

When the researchers gradually changed the rats' "day" into "night" by turning the lights on and off at different times, both mother and babies adjusted their clocks to fit the new daily cycle. But if the mother was unable to see, neither she nor the fetuses reacted to the change. This was the first convincing evidence that the mother's experience of day and night determined the daily rhythms of the fetuses.

The authors conclude that "the mother acts as a transducer between the environment and the fetal brain", although they do not speculate on how she might achieve this. But they argue that without maternal guidance, physiological mechanisms that show daily rhythms might not be coordinated at the time of birth, thus endangering the survival of the young. □

Nigel Henbest

they may have missed many others in the spiral arms of galaxies—particularly those of Type II, the explosions of young massive stars which occur mainly in the arms.

If the supernova rate has been underestimated, it affects many branches of astrophysics. The shocks from supernova explosions are responsible for forming some of the stars in a galaxy—the proportion depending on the supernova rate. The shocks also accelerate cosmic ray particles, which produce the normal radio emission from spiral galaxies.

Perhaps most important, it helps to alleviate the "pulsar problem". Pulsars—rotating neutron stars—are thought to be the collapsed cores of Type II supernovae. The number of pulsars in our Galaxy indicates that a new pulsar must be born every 10 years; but the rate at which supernovae explode in spiral galaxies has seemed to be about one every 50 years. The higher rate implied by the new discovery goes some way to closing this gap. □

Bugs too hot to handle

AT 250°C, fats melt, proteins unravel and DNA falls apart. So when on the eve of 1 April this year, A.E. Walsby found on his desk at the University of Bristol a manuscript announcing the discovery of bacteria that can not only live but grow at that temperature, he at first toyed with the idea that he might be the victim of an elaborate piece of April foolery. But apparently not. The manuscript was sent from *Nature*, with a request for an editorial comment from Walsby. Both have now been published (*Nature*, vol 303, p 423, p 381).

John Baross and his colleagues at the State University of Oregon discovered the bacteria last year in the output of sulphurous hydrothermal vents deep in the floor of the east Pacific (*Nature*, vol 298, p 366).

Baross set out to grow the bugs in the laboratory in conditions as close as he could manage to their natural ones. At 250°C his bacteria were still growing. They beat by a comfortable margin the record of 105°C, set last November by a heat-loving strain discovered by K.O. Stetter of the University of Regensburg (*Nature*, vol 300, p 258).

Having abandoned the April Fool theory, Walsby has settled for speculating on how bacteria might manage this chemically implausible feat. A few more hydrogen bonds and salt bridges to stabilise their proteins, perhaps? Baross mentions five mysterious unidentified amino acids in their make up—perhaps they contribute. Perhaps life began with such thermophilic bacteria, much earlier in the Earth's cooling than we had supposed possible. Perhaps the molten core is even now seething with unimaginable life forms... □

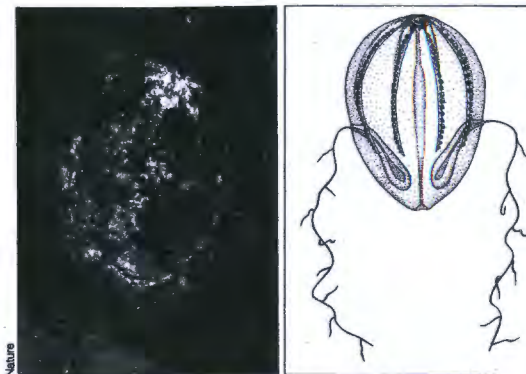


Comb jellies find their roots in the past

ALONE among animal phyla the comb jellies or ctenophores have had no fossil record. That is no longer so. A fossil ctenophore, about 400 million years old, has been found in the early Devonian Hunsrück Slate at Bundenbach in West Germany. It is described by George Stanley and Willem Stürmer, who name it *Paleoctenophora brasseli* (*Nature*, vol 303, p 518).

The oval-shaped, biradially symmetrical specimen, 13 mm high and 9 mm in diameter, is poorly preserved, which is only to be expected since ctenophores are delicate, jelly-like animals that live in the plankton of coastal waters and the open ocean. Luckily some of the details of the soft tissues of the ancient ctenophore were preserved by pyritisation (the conversion of organic sulphur compounds to iron sulphides).

These anatomical details have been revealed by X-ray techniques developed by



The first fossil ctenophore (right) and what it may have looked like alive in the Devonian seas

Stürmer for studying many other invertebrate fossils found in the Hunsrück Slate. *Paleoctenophora* shows all the main ctenophore characteristics—at the top lies a statocyst or balance organ from which radi-

ate the typical eight longitudinal rows of tiny ciliated comb plates used for swimming, and the paired, branched tentacles that would have been retracted into internal sheaths when the animal was not using them.

In appearance the fossil is most like the modern *Pleurobrachia*, which belongs to the simplest order of ctenophores, the cydippids or sea gooseberries. The cydippids are believed to represent the ancestral form and all ctenophores, whatever their adult appearance, pass through a cydippid-like, free-swimming larval stage.

Stanley and Stürmer believe that the similarity of *Paleoctenophora* to its living counterpart, *Pleurobrachia*, indicates the "antiquity of the basic ctenophore body plan" and that if ctenophores and coelenterates ever had a common origin this must have been further back in the Palaeozoic than the Devonian, perhaps even in the late Precambrian when the metazoans first appeared. □

Gene probes may spot genes missing from embryos

AN YOUNG **A**NYONE who has been following the AIDS story (and it has been pretty difficult to avoid) will know that haemophiliacs suffer from an inherited deficiency in blood clotting that can be corrected by extracts from other people's blood. Yet this replacement therapy does not always work: in rare cases, the haemophiliac produces antibodies against the blood-clotting factor he needs, and is forced to resort to less satisfactory forms of treatment. The reason for this rare complication, according to some recent research in Oxford, is almost certainly that the patients in question completely lack the gene for the clotting factor (*Nature*, vol 303, p 181). Since their immune systems have thus never seen it, they identify it as non-self and proceed to attack it.

This conclusion was based on an analysis

of six patients with a form of haemophilia known as Christmas disease, or haemophilia B. Christmas disease is actually a very uncommon form of haemophilia, due to a deficiency in clotting factor IX: the more usual form is haemophilia A, which is due to deficient factor VIII. The reason for choosing the rarer form to study was simple expedience: nobody has yet cloned the gene encoding factor VIII, but George Brownlee and his colleagues at the Dunn School of Pathology in Oxford have very recently succeeded in cloning the gene for factor IX (*Nature*, vol 299, p 178).

The Oxford scientists used a series of radiolabelled DNA probes corresponding to different parts of the factor IX gene to search the chromosomes of the six patients in the UK known to have anti-

bodies to factor IX, to see if any part of the gene was missing. Four of the six proved indeed to have gross deletions in the gene, and in two of those the Oxford researchers could find no factor IX DNA at all.

What about the other two? Their genes may contain mutations that distort their factor IX so much that it is not only useless but unrecognisable to the immune system as the same molecule as normal factor IX.

This research will probably not help patients with antibodies. But it may help potential parents of haemophiliacs with the difficult decision they have to face about having children. It is already possible to diagnose haemophilia before birth, but not until quite late in pregnancy when abortion is relatively traumatic and dangerous. Diagnosis with DNA probes is possible much earlier and much more safely, because doctors do not have to wait until the embryo is producing enough clotting factor to be reliably tested; and there is no need to remove blood from the embryo. All his cells will have the same defective gene and they can be sampled harmlessly from the amniotic fluid. In these circumstances, parents at risk of producing a child with the more severe forms of haemophilia, particularly if they are likely to be antibody-producers, might well prefer the option of an early abortion.

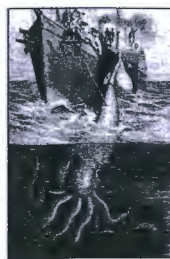
Eventually, of course, the cloning of clotting factor genes is aimed at the possibility of getting genetically engineered bacteria to produce the factors instead of blood donors. And although it seems likely that the danger of AIDS has been grotesquely exaggerated, it could well be that, given the choice, many haematologists would sooner give their patients clotting factors from a nice clean bacterium. □

Warmth kills a giant of the seas

VERY frustrated scientists study giant squids. These monsters of the deep can exceed twenty metres in length and may grow even bigger, but unfortunately, they are always discovered either as a rotting corpse on a beach, or dying in mid-ocean. So, any hard facts about them are few and far between. At last, a Norwegian zoologist has got to one before it has rotted away and lost all scientific value. He has shown that despite their size, giant squids die if the water temperature goes above 10°C. This is the reason why, when carried

inshore by warm currents, they are usually dead on arrival (*Nature*, vol 303, p 422).

Ole Brix of the University of Bergen took samples of blood from a squid, some 10 m long, netted off the coast of Norway. Squids have haemocyanin instead of haemoglobin in their blood, and Brix found that giant squids have two disabilities. Their haemocyanin levels are very low, and their blood carries four times less oxygen at 15°C, than at 6°C. All this indicates that these huge invertebrates do not have the capacity to move very quickly, or to tolerate changes in their environment; so they live in the depths of the ocean, lazily catching fish until they die—either in the jaws of a sperm whale or suffocated by a freak warm current. □



Mary Evans

Predicting rainfall—the answer may lie in the soil

RAINFALL patterns over the continental US and China seem to be affected by the temperature of the ground one or two metres below the surface. The effect is not a dominant influence on climate. But it could help to pinpoint agricultural regions at risk from drought if the results of studies at Colorado State University (CSU) stand up to further tests.

A research team headed by CSU's Elmar Reiter has found a significant correlation between the temperature pattern of deep soil in one season and regional precipitation in the following season. The inspiration for the work came from Chinese studies which have also shown that, for example, if the deep soil is unusually warm during the winter season (December to February) the following spring is likely to be wetter than average. After visiting China and learning of this work, Reiter decided to test the hypothesis using data from existing deep soil monitoring stations in the US, with the help of Maocang Tang, a Chinese scientist now visiting CSU.

Reiter stresses that his team is not yet in the forecasting business, and that their study is at the preliminary stage. They have used data from just 38 monitoring stations, and since they first get the data in a usable form some six months after the measurements have been made there is no hope of predicting weather trends. However, the records of daily temperature variations in the soil a few metres below ground go back for 20 years, and have now been analysed in terms of overall seasonal variations against which individual seasons can be compared. Typically, a significant anomaly is a deviation of $\pm 2^\circ\text{C}$ from the long term trend over a three month season.

Such a deviation does not produce a dominant influence in the weather of the next season. But by comparing years in which other things are equal, the CSU team has shown that droughts are more severe when preceded by low soil temperatures, while seasons that were going to be wet anyway, judging by the overall circulation

pattern, are even wetter where the soil has been unusually warm. The prospect is not one of predicting the weather, but rather, in a year when a drought is on the cards because of gross circulation patterns, of identifying the regions most at risk.

These are qualitative effects and cannot be translated into a forecast that a 1°C deviation implies so much difference in precipitation. But the correlation holds up even better in the US than in the Chinese records, perhaps, says Reiter, because "precipitation trends here are not as erratic". Such a technique would be very unlikely to reveal anything useful in the UK's notoriously erratic climate, but might be applicable to continental Europe. But to

provide reliable information for regional precipitation forecasts Reiter estimates that as many as 200 monitoring stations would be needed in a state the size of Colorado.

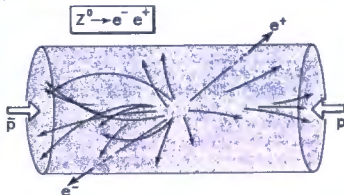
Although the research into this unsuspected correlation is only just beginning, there is no difficulty finding an explanation for it. Warm air rising from warm ground enhances convection and encourages shower and thunderstorm development; cool soil makes for less convection and therefore less precipitation locally. So the effect is likely to be distorted by urban heat islands, but to be clearest in the open countryside, exactly where the agricultural benefits of improved forecasting will be most strongly felt. □

Straight tracks point to the Z particle

EXPERIMENTERS at CERN, Europe's centre for research in particle physics, now have evidence for five Z^0 particles, thus confirming the first tentative pronouncements made last month (*New Scientist*, 12 May, p 355). The Z^0 plays an important role in the electroweak theory, which links electromagnetic phenomena with the weak nuclear force responsible for many kinds of radioactivity.

The team that has observed the Z particles consists of over 100 scientists from Europe and the US. The experiment, code-named UA1, detects the debris from collisions between protons and antiprotons in CERN's largest particle accelerator, the Super Proton Synchrotron. In this recent data analysis the researchers have scoured over two million collisions

out of a total of three billion or so, in search of the Z^0 . Out of this sample they find four occasions, like the one shown here, in which an energetic electron-positron pair are created and fly away back-to-back. The pairs are consistent with their having been produced in the decay of a Z particle. On a fifth occasion a pair of muons—"heavy" electrons—are observed, also apparently from a decaying Z .



A decaying Z particle betrays its presence in the straight back-to-back tracks due to an energetic electron-positron pair (e^-e^+). The tracks are picked up in the gas-filled central detector which observes the collisions of high-energy protons (p) and antiprotons (\bar{p})

From these five "events" the researchers calculate a mass of 95 GeV (roughly 95 proton masses) for the Z^0 , in line with the predictions of the electroweak theory, but subject to a possible change of ± 5 GeV after the apparatus is calibrated at the end of the present bout of data collection in July. Experimenters may then have more Z particles to strengthen the theory's case. □

Galaxy redshifts still pose puzzles for cosmologists

QUASARS and galaxies continue to be identified in associations which pose puzzles for cosmologists. One new piece of evidence reveals that there is a tendency for galaxies to cluster around quasars; another survey shows a consistent tendency for the fainter galaxy in pairs of spiral galaxies that are physically associated to have the larger redshift. But nobody is clear what either discovery is actually telling us about the Universe.

Interest in associations between galaxies and quasars, and in the redshifts of companions to galaxies, was revived recently by Jack Sulentic's confirmation that the pair NGC 4319 and Mk 205 is physically connected even though they have very different redshifts (*New Scientist*, 21 April 1983, p 148). Redshifts are usually interpreted as a measure of the distances to extragalactic objects, but if two objects in the same place have different redshifts this simple relation breaks down. Now, Sulentic, working with Halton Arp, or Mount Wilson and Las Campanas Obser-

vatories, E. Giraud and J. P. Vigier, of the Institut Henri-Poincaré in Paris, has conducted a survey of pairs of spiral galaxies which shows up the same sort of discrepancy.

The study by the joint French-American team is especially interesting because by choosing pairs in which both objects are members of the same class—in this case, spiral galaxies—they ought to have eliminated differences in their physical properties, except those which depend on size. Yet they find that in sample of 63 pairs in 73 per cent of the cases the fainter member of the pair has the higher redshift (*Astronomy and Astrophysics*, vol 121, p 26). Faint galaxies might appear dim because they are younger and have less mass; could it be that younger galaxies are composed of material that has a higher intrinsic redshift?

Meanwhile, Howard French, of the University of Oklahoma, and James Gunn, of Princeton University, have been looking at the distribution of galaxies near relatively low redshift quasars. In a sample of

25 quasars with redshifts less than 0.36 (which places them relatively nearby on the conventional interpretation of redshifts as distance indicators) they found a significant tendency for faint galaxies to cluster around the quasars (*Astrophysical Journal*, vol 269, p 29).

Although the redshifts of these cluster galaxies have not been measured, they are faint objects which look about the right brightness to be at the distances indicated by the quasar redshifts. This is a quite different pattern from the classic examples of "discrepant" redshifts, like the one Sulentic described recently, where a bright galaxy has a much smaller redshift than its faint quasar companion.

The only "obvious" conclusion from this study is that, perhaps, quasars only occur in galaxies that have companions. But the obvious implication of all these studies taken together is that no one simple model can "explain" all the observed features of extragalactic redshifts, and that is a far more interesting, and profound, discovery. □

Aromatics on the edge of stability

A newly synthesised porphyrin analogue provides a test for one of organic chemistry's most treasured theories

Lionel Milgrom

A NEW larger analogue of the porphyrins—arguably nature's most important class of biomolecule—has been synthesised. Christened pentaphyrin by its creators, Albert Gossauer and Hans Rexhausen of Berlin's Technical University, its increased size underlines a central theoretical concept in organic chemistry known as aromaticity. This is the increased stability bestowed on certain flat cyclic molecules that contain just the right number of alternating carbon-carbon double bonds.

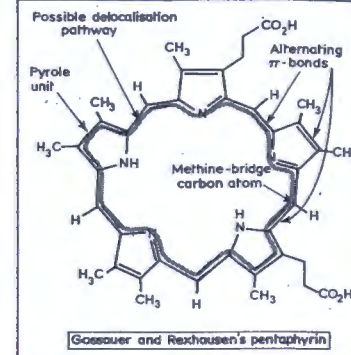
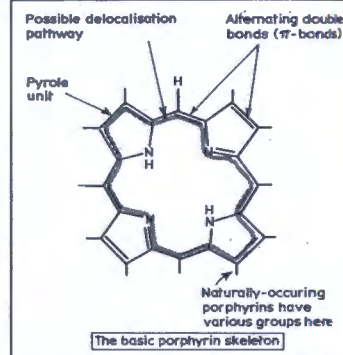
Porphyrins play a vital part in several natural processes. They are the haem in haemoglobin, the red, iron-containing protein that transports oxygen in the blood. With a few modifications, the same basic molecule serves as chlorophyll, the green light-collecting pigment that drives photosynthesis. Yet, structurally, porphyrins are simple. Four rings, each consisting of four carbon atoms and one nitrogen atom (called pyrrole) are connected into a larger ring or macrocycle. Each pyrrole unit is joined to its neighbour via a carbon atom known as a methine bridge (see Figure). This arrangement creates a hole in the middle rather like a well-known mint, which can be filled by a variety of metal atoms. In haem, the metal is iron; in chlorophyll, it is magnesium.

Another consequence of this arrangement depends on the sequence of double bonds (or π -bonds) shown in the figure. They alternate in a special way, leading to a stabilising effect chemists call aromaticity (after the first compounds in which this effect was discovered, the sweet-smelling benzene and toluene).

π -bonds in a molecule make it chemically reactive. They are the reason why ethylene can polymerise to form polythene, and why margarine spreads straight from the fridge. In molecules with many π -bonds, this reactivity is multiplied as long as the π -bonds are isolated from another. When they alternate, however, something strange happens. Somehow, the alternating π -bonds interact with each other and stabilise the molecule. In cyclic molecules with alternating π -bonds (called cyclic polyenes), this stabilisation is much more pronounced, but only if there are the right number of them.

The classic example is benzene. It has three alternating π -bonds contained in a hexagon of carbon atoms, yet the molecule is exceptionally stable. Why is this? Kekulé dreamed the beginnings of the answer back in 1865, but it wasn't until the early part of this century, with the advent of Erwin Schrödinger's wave mechanics, that the problem was solved. The answer lies in the quantum mechanics. π -bonds are not lines on paper. They are the result of the overlap of electron-clouds.

In the benzene ring, each carbon atom uses three electrons, two to bond to its neighbours and one to a hydrogen atom. This leaves one electron per carbon atom



with nothing to do. It exists as a "charge-cloud" above and below the plane defined by the hexagonal carbon skeleton. The six charge clouds merge together to form, as it were, two "doughnut" rings, sandwiching the hexagon. The six electrons are now said to be delocalised over the benzene ring. This arrangement stabilises the π -electrons (reduces their energy) and similar stabilisation occurs with other numbers of electrons. The German theoretical chemist, Erich Hückel, showed that, in general, cyclic polyene with $4n+2$ π -electrons ($n=0, 1, 2, \dots$ etc) would be similarly stabilised. This is known as Hückel's rule and for benzene, $n=1$ (so that $4n+2=6$).

Hückel's rule is born out in practice. Molecules with 2, 6, 10, 14 and 18 π -electrons exist and are stable. They are said to be aromatic. Conversely, molecules with 4, 8, 12, and 16 π -electrons are either unstable or impossible to synthesise. They are called anti-aromatic. The magic $4n+2$ formula does not go on forever, though. It is thought to break down after $n=5$.

The aromaticity of a molecule can easily be detected using nuclear magnetic resonance spectroscopy (NMR). Here, a molecule is placed in a uniform magnetic field, and a changing radio-frequency signal is beamed in. The signal causes the nuclear spins of the molecule's hydrogen atoms to "flip" or resonate. The frequency at which a hydrogen nucleus will resonate is intimately connected with its atomic environment. Different surrounding groups produce changes in this resonance frequency which, in turn reveals what groups they are. The NMR technique is therefore a powerful diagnostic tool for determining the structure of organic molecules.

Under the influence of NMR's external magnetic field, the electrons in an aromatic molecule's ring "doughnuts" rotate. This ring current generates a magnetic field in opposition to the external one. In other words, it is diamagnetic. Because of this, hydrogen atoms sited on an aromatic cyclic polyene experience a large shift in

their NMR resonance frequency—the diamagnetic ring current opposes the external magnetic field so that an aromatic hydrogen atom actually experiences less magnetic field than if the ring current were absent. This called diamagnetic shielding and all aromatic molecules show it.

From the theoretician's point of view, porphyrins are interesting because they obey Hückel's rule and so should show a diamagnetic ring current in the NMR. Normally they contain 22 π -electrons ($n=5$) but only 18, ($n=4$) are ever delocalised at any one time. The hydrogen atoms sited on the methine bridges (see Figure) have a large NMR shift, so that 18 π -electrons produce a diamagnetic ring current and porphyrins are aromatic. Would a pyrrole macrocycle with more than 18 delocalisable π -electrons still be aromatic or would the predicted breakdown of Hückel's rule begin to take effect?

Gossauer and Rexhausen synthesised the pentaphyrin macrocycle from two fragments, one containing two pyrrole units and the other, three. This wasn't an easy task because chemically-linked pyrroles are structurally and energetically prone to form porphyrins if four or more are involved in a macrocycle-forming reaction. The judicious use of functional groups, however, neatly overcame this problem, with the result that the German chemists obtained pentaphyrin in over 31 per cent yield. Pentaphyrin contains a total of 28 π -electrons so if they were all delocalised, the system would be anti-aromatic and unstable (if $4n+2=28$, then $n=6$ which is not a whole number). A delocalisation scheme can be envisaged, however, where only 22 π -electrons are delocalised. Even so, $n=5$ here in Hückel's $4n+2$ rule. So would it still be aromatic?

Sure enough, the methine-bridge hydrogen atoms (see Figure) show a large NMR shift like those in the porphyrins. Pentaphyrin has a diamagnetic ring current and is therefore aromatic, in line with theoretical expectations. (*JCS Chemical Communications* (1983), 275). □

TECHNOLOGY

Navy puts more punch in its Harriers

THE PERFORMANCE of the Royal Navy's Sea Harrier fighters during the Falklands war has convinced the Ministry of Defence that the aircraft has a big future. The ministry (MoD) has speeded up plans to improve the Sea Harrier's ability to find and destroy enemy aircraft and ships, and to protect itself from attack. The ministry claimed after the Falklands that the V/STOL (vertical/short take-off and landing) plane, flying from comparatively small aircraft carriers, was as effective as the Phantoms and Buccaneers that used to operate from the much bigger Ark Royal. The Royal Navy's top brass now seems to have overcome its initial scepticism, and agrees that this is the case.

The navy will soon arm its Sea Harriers with British Aerospace's new Sea Eagle anti-ship missile. Sea Eagle is much more advanced than the French Exocet in many areas. It has a jet engine rather than a solid-propellant rocket motor, giving it a range of 100 km: twice that of Exocet. The British weapon's radar homing head contains advanced computers which work out the most valuable target to attack in a group of ships. Exocet's seeker selects the first target that it detects.

The MoD has recently decided that the Sea Harrier, rather than the Royal Air Force's fighter version of the Tornado bomber, should be the first British aircraft to carry the new American AMRAAM missile. Hughes Aircraft is developing AMRAAM, which stands for Advanced medium-range air-to-air missile, to replace the 1950s-vintage Sparrow. AMRAAM is much smaller than Sparrow, and it has its own active radar seeker in the nose (which, like the homing head in Exocet or Sea Eagle, guides the weapon to a direct hit).

Sea Harriers in the Falklands achieved their high success rate despite carrying only two Sidewinder missiles, which home in to infrared radiation from an enemy aircraft.

The Royal Navy has since doubled the number to four per aircraft. From 1988,



Sea Harrier has convinced the sceptics

when the first Sea Harriers with AMRAAM join the fleet, each aircraft will have four of the much longer-range radar missiles as well as two Sidewinders.

When the navy decided what sort of equipment it wanted on Sea Harrier, it specified a radar with comparatively low performance. This proved inadequate in the Falklands, and the MoD gave radar companies only five weeks in which to come up with a better idea. Three firms put in bids on 12 April, and the ministry hoped to announce a winner on 18 May. Now the election is over, a decision is imminent. Marconi Avionics, Ferranti and Thorn-EMI are competing for the order. Thorn-EMI at least, and probably Ferranti, have turned to America to help supply it.

The other main areas of improvement are the engine and equipment for electronic warfare. Rolls-Royce is developing a new version of the Pegasus turbofan powerplant

which gives the Harrier its unique hovering ability. The new Pegasus Mk 105 for the improved Sea Harrier will produce more thrust but burn less fuel (helping to prevent embarrassing incidents such as having to land on Spanish merchant ships).

Another lesson from the Falklands was the vulnerability of modern aircraft to rapid-fire guns that use radar to control them. The navy plans to fit its Sea Harriers with electronic equipment to detect these radars, work out what type they are and send out a high-power signal to jam them.

These improvements will make the Sea Harrier a potent fighting machine. The irony is that, having struggled for years to sell the aircraft to an unimpressed world, the British are now about to be overtaken by the McDonnell Douglas AV-8B—a Harrier lookalike with an American nameplate and all the clout of the Pentagon behind its sales campaign. □

EEC hits European video consortium

BUREAUCRATS at the European Community have unwittingly helped to kill a dream of a pan-European electronics industry to do battle with the Japanese. The import restrictions that Brussels imposed on Japanese video recorders in an attempt to give European firms such as Philips and Grundig a better chance of selling their ailing V2000 system, has cost the jobs of European workers employed to assemble Japanese machines in the EEC. Now Thomson of France has abandoned a plan to link up with Philips and Grundig. Instead it will make parts for the European assemblers of Japan's JVC.

In 1978, Thorn in Britain and Telefunken in Germany spurned the video formats that Philips and Grundig proposed for Europe. Instead they signed with JVC to back the Japanese VHS system, which now has two thirds of the world market. In March last year, Thorn, Telefunken and

JVC formed a joint venture called J2T to assemble from kits VHS recorders in Berlin and Newhaven.

Thomson was due to have joined in with a third assembly factory in France. But when the company was nationalised, Philips suggested that it make European V2000 machines instead. Nothing daunted, the J2T factory in Berlin took on 450 West German workers to assemble 300 000 machines a year, and Newhaven employed 220 Britons to make 200 000.

But in January this year, after the two plants had gone on stream, Brussels made a secret deal with the Japanese government to keep Philips and Grundig happy. The deal limits to 600 000 a year the total number of kits that Europe can import. With Matsushita, Sony, Hitachi, Mitsubishi and Sanyo already assembling or planning to assemble Japanese recorders in Europe, the quota is nowhere near large

enough. So J2T is having to hold its total production down to 400 000 recorders a year. The plant in Berlin now has only three out of four production lines working and Newhaven has one of its three lines lying idle.

The stumbling block is that although the assembly work is complex, the plants import almost every raw component from Japan. Only the recorder's fuses and aerial wires are made in Europe! To break the deadlock, Thomson has bought a 75 per cent share in Telefunken, and signed a five-year rolling contract with JVC to make the high-precision video tape mechanisms in France for both the J2T factories. Kits with the main part coming from within the EEC would avoid the restrictions that are crippling J2T. So largely thanks to meddling by Brussels, Philips and Grundig have now lost all chance of persuading Thomson to back the V2000 video systems. □

Heat pumps tap geothermals

TWO PROJECTS in Scandinavia suggest that geothermal energy will provide a boost to the already growing interest in large heat pump installations. Swedish engineers have completed an exploratory drilling programme linked to exploiting geothermal energy with heat pumps, while in Denmark engineers are putting the finishing touches to that country's first geothermal-linked project.

Sweden is well advanced in applying multi-megawatt, heating-only, heat pumps in cities and industry. The extraction of low-grade heat from sewage and lakes is already a proven option to expensive imported oil.

The exploratory drilling programme, near the town of Lund in the south of Sweden, involved the local utility Lund Energiverk and manufacturer Stal-Laval.

Water extracted from the sandstone formations 700 metres beneath Lund reached the surface at 25°C. The engineers hope that a heat pump will be able to raise water temperatures at its condenser side sufficiently to provide energy for municipal district heating. Later this year, the partners will decide whether to proceed with a trial 5 MW installation plumbed into the town's district heating system.

Mindful of the increased business that could result from more widely available subterranean heat sources, Stal-Laval is to fund some test drilling into granite near Finspong. According to managing director Göran Lundberg, high water tables in the region make the study of underground water as of much interest as a possible heat source as do the deeper geothermal sources.

Swedish interest in large heat pumps stems from the country's lack of indigenous fossil fuels. Cheap electricity based on substantial hydro-electric resources and (arguably) from a high proportion of nuclear power plant, has combined with laws that prevent industry from fitting new oil-fired boilers to replace worn-out units.

Two notable applications are the 36 MW installation which serves the town of Uppsala's district heating system by extracting heat from citizens' waste water, and the 12 MW unit that supplies heat to the

Ludvika works of the electrical company ASEA. In this case the nearby Lake Väsman is the heat source.

In Denmark, tenders are out for a heat pump that will draw geothermal water and feed heat into the district heating network in the Jutland town of Thisted (population 20000).

This is Denmark's first attempt to couple heat pumps with underground hot water, and three electrically-driven 3.4 MW pumps connected in series will be supplemented by heat from their associated diesel generators (totalling 4.2 MW).

The temperature of the saline brine being pumped to the surface at Thisted is, at 60°C, considerably above that extracted at Lund. Because of the energy requirements of the production and injection pumps in the geothermal circuit, heat will be recovered from motors and gears to maximise the efficiency of the system.

The consultants for the project, Steensen Varming, has put the heating capacity of the entire plant at 15 MW when raising the temperature of district heating water from 50°C to 80°C, and cooling geothermal water from 60°C to 20°C.

The state-owned Dansk Olie & Naturgas has been drilling down to geothermal reservoirs 3 km below the surface of Jutland since 1978. The present project is founded on this work, and complies with the company's remit to exploit any Danish geothermal energy.

At first, grid electricity supplies will power the heat pumps because the diesel generators are to be excluded from the first phase of the plant (which should be on stream late next year). If this part then operates successfully for 12 months, the diesels and associated heat recovery plant will be added. The consultants say that by taking waste heat from the generators as the last step in boosting the district heating water temperature, the heat pump can operate at a lower condensing temperature and consequently show a better coefficient of performance. In this design the condensing temperature goes down by 8°C, increasing the coefficient from 2.8 to 3.1. □

Holophonics hits the shops

THE RECORD company CBS has twice had to delay the release of its disc of sound effects recorded on Hugo Zuccarelli's "holophonic" system (*New Scientist*, vol 98, p 24). Technical problems with cutting the master discs have forced the company to delay the release, originally scheduled for May, until June or July.

CBS made the original recordings, of sound effects such as rattling matchboxes, exploding fireworks and spraying water, on a Sony digital audio tape recorder. Digital tape can handle a wide of dynamic range (a dramatic difference between loud and soft signals). But engineers find it hard to transfer the same range onto disc without distortion. And any background snap, crackle and pop from the disc's surface destroys the illusion of surround-sound through headphones.

Some journalists who eulogise over the holophonic effect have not realised the

significance of the fact the the inventor demonstrates it directly from wide-range digital audio tape. This partly explains the impressive effect the Zuccarelli has achieved with his new approach to the old idea of binaural or "dummy head" recording.

But after seven tries at making a master disc, CBS now thinks it can turn out good pressings. So in July, hi fi buffs should have a chance to hear holophonics for themselves. But the record will not be cheap. CBS plans to release a 30-cm, 45 rpm disc, with 10 minutes of sound effects on each side. Although there are no musicians or music royalties to pay, the record will cost around £3.

Even when CBS manages a clean pressing, one problem with holophonics remains. This is the lack of a clear frontal sound image—a characteristic of all binaural or dummy head recordings. □

Walkie-talkie

RESEARCHERS and industrialists plan to join forces to give Britain a new form of communications satellite. With the craft, people in vehicles would keep in contact with their offices.

According to workers at the Rutherford Appleton Laboratory of the Science and Engineering Research Council, the £20 million satellite could be launched in 1987. The craft would be in what is called a super-synchronous orbit; it would move around the Earth in an ellipse in such a way that the vehicle is overhead Britain for about eight hours a day.

The craft would be more useful to people in vehicles than are conventional communications satellites which hover 36 000 km above the Equator. Because Britain is so far north, such vehicles are always fairly low in the sky, so obstructions such as bridges and buildings can interfere with signals.

Later, fully-operational versions of the satellite could revolutionise mobile communications. People who move around and want to keep in touch with others would no longer need conventional radiochannels, which are becoming clogged.

Paint-a-chip

SCIENTISTS at California's Lawrence Livermore National Laboratory have taken up painting. They have developed a new way of making integrated circuits with a rapidly-flashing laser light working much like a paint brush.

The light, flashing millions of times every second, passes through gases to "paint" integrated circuits directly onto silicon wafers. The scientists call the technique laser pantography. By the end of the year the scientists hope to have a system that can paint 1000 transistors a second. The group makes bold claims about the system's potential: that it will lead to greater numbers of supercomputers, capable of working at much faster speeds.

One important feature of the process is that it is reversible enabling workers to correct mistakes. □

Hip strain

A HIP bone, in the words of the song, is used to be connected to the thigh bone. But for some Swedes, their hip bones will soon be connected to a strain gauge as part of an experiment to measure the stress on artificial hips.

Middlesex Polytechnic has designed 14 miniature strain gauges, each 1 millimetre in diameter. They are due to be attached to a miniature radio transmitter and implanted into a hospital patient, along with his artificial hip joint. The experiment will take place in Stockholm later this year. The experiment is the brainchild of Dr Clive Lee, of Exeter University.

The gauges, fastened down the length of the steel spike of the joint which is cemented into the femur, will record the immense stresses imposed on hip joints during ordinary activities.

Within two years, so Lee believes, the data transmitted from the joints to receivers strapped to the patients' hips will provide enough information for the design of joints to be based, for the first time on proper engineering considerations. □

Molecular path to a new electronics

MOLECULAR conductors are an exciting new class of electronic materials. In theory they could open the way to new types of lightweight batteries or even to "molecular computers" which act as a single entity. But scientists working on them face a dilemma: should they concentrate on fundamental research, to understand fully the materials, or has the time come to seek out practical applications?

Earlier this year, Britain's Science and Engineering Research Council held a workshop for scientists to decide on this, and other questions about the new materials. The coordinator of the research council's programme, Professor John Lewis of Bangor University, sees a parallel between molecular conductors today and liquid crystals 25 years ago. At that time, liquid crystals were materials with unusual properties but with no obvious applications. A few years later, when their uses in electronics were discovered, they turned into big business. Now the Science and Engineering Research Council wants to ensure that Britain can take full advantage of equivalent developments in molecular conductors.

The new materials fall into many different types, from conducting polymers such as polyacetylene to crystalline salts of metals such as platinum. Conventional electronic materials, for example copper or silicon, are composed of atoms linked together by chemical bonds to form a three-dimensional lattice. In the new materials, the basic building blocks are *molecules*. The same chemical bonds hold together the atoms that make up each molecule, but the forces binding the molecules together are much weaker. Electrons that can move freely within each molecule cannot hop from one molecule to the next quite so easily. A typical molecular solid, such as paraffin wax, is an insulator.

But what scientists have discovered is that not *all* molecular solids are insulators. In special cases, where the electron orbitals in adjacent molecules overlap sufficiently, electrical conduction between molecules can occur.

The conduction can have some unusual

Paul Breeze

properties. For example, if the electrons on one molecule can hop onto adjacent molecules above or below it but not sideways, the material will favour conduction in one direction (anisotropy). Many of the new materials are one-direction conductors.

Conducting polymers form another group. In these, electrons move easily along the carbon atom backbone of a polymer molecule, and show some very unusual properties peculiar to one-dimensional conductors. Scientists are only beginning to explore the technological implications of this type of material.

Researchers have found materials with non-linear optical properties, conductivities that change with voltage and temperature, and in some cases, easily-stimulated changes in chemical composition which industry exploit to make batteries.

Applications are already appearing. In the US, the National Science Foundation has funded research on polyacetylene as a material for batteries. It offers a method of building a lightweight but powerful device for storing energy. A subsidiary of Allied Chemicals should make a prototype later this year. Elsewhere, IBM is interested in developing polypyrrole for batteries and electronic displays. Bell Labs, Xerox, the General Electric Co and Chevron are also working in the area.

There are other tantalising possibilities. How about a semiconducting polymer which can be processed at low temperatures, moulded to the correct shape, and is cheap enough to throw away after use? Scientists can dope polyacetylene to make it semiconducting, and they have



made diodes and solar cells from the material.

Unfortunately, the finished product is sensitive to air and so brittle that it cannot be moulded as a normal polymer can. Bob Feast, at Durham University, is trying to overcome this problem by making a material that has normal polymer properties but which turns into polyacetylene when heated.

Much of the research on the new materials started as a quest to find an organic superconductor that works at room temperature. (Conventional superconductors work only at very low temperatures.) So far, only one, low-temperature, superconductor has turned up, but the search continues.

Such a material could provide interconnections in microchips, and possibly transmission equipment for electrical power. Another interesting possibility would be to make a cable and its insulation from a single material, structured to form a conductor on the inside but an insulator on the outside.

These ideas are only scratching the surface: many more will arrive with time. This is where the scientists' dilemma lies. On one side is the fear that if they direct research toward practical goals already identified, they may miss even more important discoveries. But if researchers fail to keep their sights on exploitation they cannot expect to attract investors from businesses. □

Superchips destroy computer class barriers

ANEW generation of computers coming onto the market later this year will deal another blow to the old hierarchy of the business. In the past, machines fell fairly neatly into the categories of mainframes, minis or micros. Recently, however, "super minis"—computers the size of filing cabinets with the processing power of mainframes—have eroded one distinction. And the advent of "smart terminals", screens with their own processing power, has blurred the distinction between terminals and independent microcomputers.

Now an American "original equipment manufacturer", which supplies hardware to the household names of the computer world, plans to take the process a step forward by introducing a system that users can upgrade from a micro to a mainframe simply by adding more modules. The firm, Convergent Technologies, hopes that its

"MegaFrame" equipment will allow companies such as Gould, Burroughs and NCR to build computers that do just this.

At the heart of the system are filing-cabinet sized units based around 64 K very large-scale integrated circuits connected with a 32-bit high-speed system bus. Convergent says it has designed the architecture of the system so that doubling the number of processors doubles the amount of processing power.

The firm says the MegaFrame could grow to serve up to 128 terminals, with 24 megabytes of random-access memory and 21.6 gigabytes of memory in outside discs.

At the front end, programmable terminals, each with a 64 K random-access memory, will be able to handle operations such as word-processing and simple graphics without interrupting the main computer. □

One of Convergent's vice presidents, Ben Wegbreit, said last week that the arrival of desk-top computers had dealt traditional terminals a death-blow. "People will not tolerate delays when a personal computer can provide instant response... terminals that depend on the host computer for processing are becoming obsolete."

Wegbreit said that new chip technologies had already blurred the distinctions between different types of computer: "These machines are considered to be micros because the chips are small, but their processing power goes well into the mainframe range."

The next stage will come when manufacturers adopt the new 256 K chips. The barriers in the way have already changed from technical to financial ones. When they are overcome, the days of many mainframes could finally be numbered. □

Scientists and the supernormal

Many distinguished scientists have involved themselves in studies of the occult. Though they may be well-intentioned, they cannot always be relied upon

Ruth Brandon

THE NUMBERS and eminence of interested scientists has always been one of the strongest planks upon which psychical researchers base their claims that parascience is not only a serious subject worth investigating, but has been repeatedly, thoroughly and unexceptionably investigated. Thus Brian Inglis, in the introduction to a series of books published by the Society for Psychical Research to mark its centenary in 1982, writes: "If evidence were lacking for 'parascience'... it could be found in the composition of the society from its earliest beginnings."

He goes on to list the names of distinguished scientists and other savants connected with the society from its inception. The list is impressive; it includes Sir William Crookes, Sir Oliver Lodge, two Lord Rayleighs, Henri Bergson, Hans Driesch, Gilbert Murray, William James, A. J. Balfour, Charles Richet, the Curies, and many others. Nobel laureates abounded and still abound. The list is remarkable not only for its philosophers and psychologists but also for its physicists, chemists and biologists—groups of scientists used to dealing with "hard" evidence. And these numbers, this mix, was true not only 50, 60 and 70 years ago: it is still true today. Brian Josephson, Sir Fred Hoyle, Sir Alister Hardy, H. J. Eysenck, Professor John Hasted, the Stanford Research Institute, stud the pages of today's literature of psychical research.

The importance of these people to the credibility of what were once known as "psychical phenomena", today more often called "psi" or "parascience", is that in this region of the weird and the woolly they are neither woolly nor weird. They are hard-headed men and women used to hard-headed investigation. Their names and reputations are brought out like talismans. It is assumed and asserted, by themselves and others, that their motives and methods in this field are exactly those they bring to any other scientific investigation. This claim is of course essential to their credibility, and it is made (one may reasonably assume) in utter good faith. But is it true?

One of the most significant and influential of these scientific investigators of the supernatural was also one of the earliest: Sir William Crookes. A brilliant and innovative chemist and physicist, Crookes was a self-made man who went on to become, in old age, president of the Royal Society. But his investigations into the supernatural took place many years before that, in the early 1870s, while he was still in his forties. In this capacity he conducted experiments with the famous medium Daniel Dunglas Home, and attested to



Sir William Crookes, one of the earliest and most influential investigators of the paranormal, photographed with the materialisation of Katie King

the veracity of the ghost Katie King, materialised by a charming young lady medium, Miss Florence Cook.

The Katie King materialisations may today be reasonably discounted. Although they still have, or had, their adherents, it seems fairly plain that Crookes, a susceptible man, was the lover of the delectable Florrie Cook, and—being also married with a large family—was in no position to destroy her reputation even had he wished to do so. But his experiments with Home are not so easily dismissed. They are quoted to this day—perhaps most recently by Eysenck and Carl Sargent in their book *Explaining The Unexplained*—as evidence for the existence of supernormal powers.

D. D. Home was the most famous medium of his day, perhaps the most famous ever. His reputation rests on the fact that, uniquely among mediums, he was never discredited or dis-

covered in fraud, even though he was rigorously examined by no less a figure than Crookes.

Home was renowned for his capacity to produce "physical phenomena". (In distinction to, say, Mrs Leonora Piper, the medium who convinced William James of the truth of spiritualism, and who specialised in seemingly inexplicable clairvoyant descriptions of the past life and family relations of her subjects.) Home's repertoire included all the usual spiritualist mysteries such as raps, touchings by disembodied hands, messages from the dead, table-liftings: but he also boasted some much more amazing specialties, unique to himself. These included elongations of his body and levitations.

Perhaps the most spectacular of these feats was the occasion when he floated out of a third-floor window in Victoria and in at the window of the adjoining room. This was at a house belonging to Lord Dunraven, in Ashley Place, and was witnessed and attested to by Dunraven's son, Lord Adare; his cousin, Captain Charles Wynne; and a young Scottish peer, the Master of Lindsay.

Their descriptions of the occasion conflict in details, but all were convinced at the time that they had witnessed a miracle. (The accuracy of their observation is perhaps exemplified by Lindsay's estimate of the windows as being 85 feet above the ground. Three stories could not be more than 40 feet up; Houdini, who was preparing to emulate the feat, remarks on the predilection of these gentlemen for tall stories.)

Of the three, perhaps the least sure of the miraculous nature of the occasion was Captain Wynne—the only one of the three who was not previously well acquainted with Home.

Both Adare and Lindsay had known Home well for some time, and both had witnessed similar, if less spectacular, performances on his part several times before. It seems clear from the accounts of the incident that Wynne was an unexpected guest on this occasion, and one not altogether welcomed by Home, who nevertheless, for once, made the best of things. For an important part of his technique was the hand-picking of his subjects. Only certain people were permitted to witness his more extraordinary feats.

Cynics would say that the rationale for this is clear enough: some people are more prone than others to believe what they are told they see. A clear case in point is that of one of Home's most celebrated and discussed seances: the one in which both Robert and Elizabeth Browning participated. This led, in Elizabeth's case, to an implicit belief in Home's miraculous powers, and in Robert's, to the disgust which led him eventually to write the damning anti-spiritualist poem *Mr Sludge "The Medium"*.

Where she saw miraculous disembodied hands rising from the very table's surface, he saw crude puppetry; where she was touched by ghosts, he was patted by some arrangement of sticks and stuffed hands, emanating from Home's "inordinate sleeves". Before this seance began, five would-be participants had been summarily dismissed by the medium. Browning concluded that Home would no doubt have liked to send him away, too: but there was no having Elizabeth without Robert, and Mrs Browning's recommendation was one which Home, then at the start of his European career, was anxious to receive.

Home's usual way of dealing with awkward customers like Robert Browning was to admit them, amiably enough, to a seance at which nothing, or very little, happened: the power to work miracles cannot, after all, be summoned up to order. Vague promises of future, more successful occasions would come to nothing. Only those suitably inclined witnessed Home in full flight.

Where, in all this, does William Crookes fit? On the face of it, there could have been few men in England less suggestible and more suitable to provide a real test of what he was to term Home's "psychic force". In an introductory article in the *Quarterly Journal of Science*, of which he was the editor, Crookes set out his position: "The spiritualist tells of manifestations of power, which would be equivalent to many thousands of 'foot-pounds', taking place without known agency. The man of science, believing firmly in the conservation of force and that it is never produced without a corresponding exhaustion of something to replace it, asks for some such exhibition of power to be manifested in his laboratory, where he can weigh, measure, and submit it to the proper tests."

Home readily agreed to be tested by Crookes, and these experiments have become the linchpin upon which his reputation has since rested. They were conducted in the presence of Dr William Huggins, a fellow FRS; Serjeant Cox, a lawyer and enthusiast for spiritualistic manifestations; Crookes's wife and daughter; his laboratory assistant; and a Mrs Humphrey.

The seances were not quite as coldly clinical as the ambience of laboratory experiments might suggest. At first there was a number of what might fairly be termed routine spiritualist effects—raps and knocks, currents of cold air, disembodied touches. An accordion, locked in a cage, played *Home Sweet Home* and *The Last Rose of Summer*. Although he was distinctly impressed, these were not the experiments in which Crookes was most interested. They could not be satisfactorily tested in scientific terms. He had, however, set up one which could.

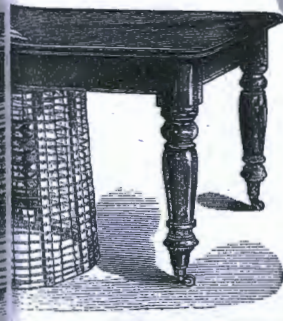
This consisted of a long mahogany board, one end of which rested on a table, while



Mary Evans



D. D. Home is "tested" by Crookes, though the cartoonist remains sceptical



The great Harry Houdini was furious to think that anyone should suppose he achieved his effects by paranormal means



Mary Evans

the other end was supported on a spring balance fastened to a strong tripod stand. Home placed the tips of his fingers lightly on that extreme end of the board which rested on the support while Huggins and Crookes, one each side, watched closely for any effect which might be produced. Almost immediately, they saw the pointer of the balance descend, then rise again; the end of the board oscillated slowly up and down.

Home now took a matchbox and a small handbell and placed one under each hand to satisfy Crookes and Huggins that he was not producing the downward pressure. The slow oscillation became more marked, and Huggins, watching the index, said he saw it descend to 6½ pounds. The normal weight of the board was 3 lb, so this meant that there was 3½ lb of additional downward pull. At one point in the experiment, the index descended as low as 9 lb.

Crookes wrote up this experiment, and various others which he subsequently conducted, in his *Quarterly Journal of Science*. He also sent substantially the same paper to the Royal Society, which, much to his mortification, rejected it. Crookes was particularly indignant at this rebuff because (he asserted) the reason for it lay purely in the subject of the experiments, not in their quality or interest (a grievance frequently voiced by experimenters in the supernormal). And up to a point, he was right.

In the early 1870s, when Crookes was conducting these experiments and publishing them, the scientific debate between Darwinists and fundamentalists, hard-line rationalists and those who found it impossible to envisage or accept a world devoid of soul or design, still raged furiously. Spiritualism was (and parapsychology still remains) allied with the Lamarckist camp and the vitalist philosophy of a purposive life-force.

Crookes was vitriolically attacked for such allegiances and attitudes in an article entitled "Some recent converts to spiritualism", which was written by Professor W. B. Carpenter and published in the *Quarterly Review*. Crookes's reaction, not surprisingly, was to mount his scientific high horse. "Have I ever shown haste in

forming an opinion? Have I ever admitted a new fact in science on insufficient testimony?" he demanded of a colleague. And in reply to Carpenter he wrote: "Now, let me ask what authority has the reviewer for designating me a recent convert to spiritualism?"

In the face of this indignation, two questions immediately present themselves. One: was his interest in the subject of the "new force" as dispassionate as he was at pains to have everyone believe? And two: if Home fooled him, how did he do it?

The second question is of course much more straightforward, and—especially given a will to believe on Crookes's part—not all that hard to answer. Home was probably an expert illusionist, and it has been pointed out that Crookes was very short-sighted (which may or may not be relevant to the case). There are various ways in which Home could have moved the end of the spring balance.

One, and possibly the most likely, is by distracting the attention of Crookes and Huggins, allowing time for a quick pressure of the fingers. (Other techniques which have been suggested include the use of a loop of hair or black cotton to depress the plank, perhaps looped round Home's knee, or a working knowledge of the power of static electricity.) At any rate, if we suppose that Home's was no new force but plain old physical movement, possible means abound. Crookes and Huggins may have been expert scientific investigators, but they were not, as Home almost certainly was, expert conjurers.

Conjurers who claim they can replicate the most inexplicable of mediums' feats abound in the history of the paranormal. They range from J. N. Maskelyne and Harry Houdini to James Randi, possibly the most prominent such figure in the field at present. A common reaction of those who have been fooled, as Houdini found to his fury, is to insist that the illusionists have psychic powers but are simply not admitting it. It would clearly not be difficult for such a person to set up most successfully as a psychical wonder worker. But the puzzle remains. Crookes was an experimenter of the first rank, and he knew exactly what he was looking for, and looking out for. Was it really possible that he could have been duped?

This, of course, is always the key question, and the answer generally accords with the predilections of the respondent. The position of a Brian Inglis is founded upon the assumption that the answer to such a question must be no. This position is stubbornly maintained against the batterings of assorted sceptics, and most particularly those magicians who have interested themselves in psychic questions and who are only too willing to demonstrate at every opportunity that, on the contrary, the answer is almost certainly yes. So the battle of words goes on. The satisfaction of a convert is rarely accorded to either side.

But a more fruitful line of investigation is perhaps to look at the actions and behaviour of the scientists themselves. Partisans may argue; what, meanwhile, do the facts of the case indicate?

In almost every case I have looked into, the facts turn out to be singularly revealing. Time and again they present a curious dichotomy between the publicly proclaimed spirit of pure scientific inquiry in which the investigations in question were undertaken, and the underlying emotional motivation which prompted those investigations in the first place.

Thus the founders of the Society for Psychical Research (SPR) went to great lengths to distance themselves from the trivial vulgarities of spiritualism. In the case of this Cambridge elite, it was probably as much for reasons of intellectual snobbery as any scientifically discrediting effect it might have had. And once the SPR had got into the full swing of its investigations, spiritualists certainly regarded members of the SPR as dispassionately intellectual to a fault and actively antipathetic to the movement. But a reading of the diaries and letters of Henry Sidgwick and F. W. H. Myers, the SPR's founding fathers, shows that each originally approached the subject through spiritualism and in that mood of religious yearning so common among those mid-19th century intellectuals who, 50 years earlier, would probably have taken orders as a matter of course, but who, post-Darwin, needed proof to bolster their faith.

The hidden agenda

There are other, much more extreme, cases. J. W. Dunne is best known for his famous book *An Experiment with Time*, an account of a series of prophetic dreams he experienced. This is written up in a highly scientific and philosophical style. Mathematics, quantum theory and relativity are adduced in Dunne's explanation of his dreams, much as the strange behaviour of sub-atomic particles is quoted by explorers of the paranormal today. Spiritualism is certainly never allowed to raise its unintellectual head. But the book appears in a very different light if it is read in conjunction with Dunne's autobiography, *Intrusions*, which he wrote just before his death in 1954. Here he reveals that he began his interest in such things as spiritualism, and was indeed for a time a medium—this book providing, incidentally, one of the very rare objective analyses of mediumistic possession as experienced from the inside. The omitted framework of the dreams that make up *An Experiment With Time* is fascinating; but even more fascinating is the fact that Dunne chose to leave it out of his original account. This was presumably because he judged, correctly, that it would affect the way that account was received.

An even more revealing instance of significant omission is that of Dr J. B. Rhine. Almost everyone, of course, has heard of Rhine. He was the founder of the famous Parapsychology Laboratory at Duke University, the first person to establish the paranormal as a subject for university research. Nothing could have been less outré or more banal than his own researches in this field.

Rhine was the king of card-guessing, a statistical exercise of monumental boredom using the Zener pack of cards bearing five different symbols. Others, notably the English mathematician S. G. Soal, took up this line of investigation and achieved amazing results, later to be discredited by the discovery of manifold cheating. Rhine's reputation has suffered no such slur: his integrity is as spotless as his results were uninteresting. Rhine did, at first, get results. But as he improved his experimental design, so his subjects' paranormal powers declined. Scientifically, he was unexceptionable. The contrast, however, between his techniques and findings and the motivation behind them, could not be more bizarre.

Rhine began scientific life as a Harvard botanist. While there he met Dr William McDougall, a noted psychical researcher and, like Rhine, a vitalist who believed that life could not be explained mechanistically. Vitalism was not propitious to a budding biological career, and when McDougall moved to Duke University, Rhine moved with him. The vitalist link is, of course, significant; but many excellent scientists have been vitalists. Much more extraordinary is the extreme motivation Rhine reveals towards the end of his book *The New World of the Mind*, published in 1954.

In the religious war between capitalism and communism, Rhine saw his researches as a crucial weapon. He proposed, in so many words, to co-opt God as an experimental partner in this fight. "There is a belief... that a divine personal

agency exists to which prayer is directed. The cooperation of this agency could in all sincerity and propriety quite well be included in the research plan. In fact, the older world religions were supposedly founded with the aid of miracles, that is, cooperative demonstrations by divine agencies."

Rhine was in no doubt that tangible proof of the existence of God is the real aim of all research into the supernatural. Only so will communism be defeated. "Most thinking people know that blind faith in dogmatic revelationistic religion cannot counter the claims and promises of communism. It may force a realisation of the need to push research on the spiritual armament against communism to its logical scientific limits... Think of all the good man-hours of prayer spent through all the centuries by all the billions around the globe, with no one throughout these ages taking the obviously sensible precaution of checking up!" Rhine clearly believed he had done the final and conclusive check-up. If President Reagan shared his belief, the world might be a safer place today.

Where, in all this, does William Crookes fit? Was there in his background, too, some unadmitted reason which might make him so eagerly desire to obtain the findings he did in fact obtain, that the habit of scientific method and objectivity was no match for it? Was he, in fact, in control of the sessions with Home as his written reports of them lead us to assume?

The very fact that Home agreed to be tested by Crookes argues, judging by his invariable practice, that as far as Home was concerned the sessions were being run by himself, not Crookes. And this is borne out by Crookes's notes of what went on during the seances, and his letters—as opposed to his published articles. Most importantly, one might reasonably infer from the articles that the sessions discussed represent all, or virtually all, the occasions on which Crookes conducted his experiments with Home. But the notes and letters reveal that there were a great many other occasions, unrecorded in the articles, on which nothing of any note took place at all. Thus, Crookes wrote to Huggins: "I want you to come and attend another seance which is appointed for next Thursday week... when Home has promised to come, and we are going to get the same party and if possible the same conditions. You must, however, prepare for the chance of a failure. Home is the most uncertain of mediums, and it is quite as likely that the next time absolutely nothing will take place."

This certainly accords with Home's habit of not attempting anything unless all the conditions were right, including a sympathetic audience and correct lighting, placing of persons and so on. And the notes show that Home dictated when the company was to stand and when to sit, to move away from the table or towards it, and other such very germane details.

Why should Crookes have suffered himself to be imposed upon in this way? Because—contrary to his declarations—he wanted to believe. A few years earlier, in 1867, he had suffered one of the great griefs of his life. His beloved brother Philip died at the age of 21 while acting as engineer during a cable-laying expedition to Havana. Ever since then, Crookes had been making eager and (he felt) successful efforts to contact him through spiritualism. So he had compelling emotional reasons to wish that the phenomena of spiritualism could be tested and proved on a sound and unarguable scientific basis. When Carpenter designated him "a recent convert to spiritualism", this was in fact no more than the truth.

What are we to infer from all this? Obviously not all parapsychologists conceal their motives from themselves, the public, or both, any more than all "hard" scientists are dispassionate about their work. But the fact of concealment, where it occurs, is interesting and relevant in itself. And given the cases where it can be shown to occur—after all, among the most important in the history of the subject—it is clear that the background of those scientists interested in the paranormal is as fair a subject for scrutiny as their results. □

Ruth Brandon's book *The Spiritualists: The Passion for the Occult in the Nineteenth and Twentieth Centuries* is published on 23 June by Weldenfeld.

Parasitic DNA—the origin of species and sex

Some sequences of DNA perform no function in the organism and yet spread through populations. The discovery of these transposable elements—"parasitic DNA"—has led to new ideas about the origin of species and the evolution of sex

Michael Rose and Ford Doolittle

A NEW view of DNA is emerging. Particular DNA sequences may be neutral, irrelevant, disposable or even parasitic. This parasitic DNA does the organism no good, and may even be harmful, yet it can persist and spread. In effect, the genome of the cell, its repository of genetic material, has become a kind of ecosystem: many selfish replicators engage in a mêlée of evolution within the genome. This view new of DNA has opened up some of the most taxing problems of evolutionary biology, including the ways in which new species emerge, and the origins of sex. Sex, indeed, might reasonably be seen as a form of disease that animals and plants have learned to live with.

Parasitic sequences of DNA can be thought of as viruses inside genomes. Unlike viruses, however, they do not spread by infecting a cell, reproducing within and then escaping from the cell. Rather they engage in what is called "duplicative transposition"—newly synthesised, "free-floating" copies are made from a copy located on a chromosome and then deposited at a new chromosomal site without loss of the original sequence. Mathematical theory for this process shows that such a "transposable element" will usually spread throughout a population unless its effects are extremely detrimental. Many different transposable elements are known throughout the living world. Indeed, some genomes may consist almost entirely of transposable elements or their inactive descendants.

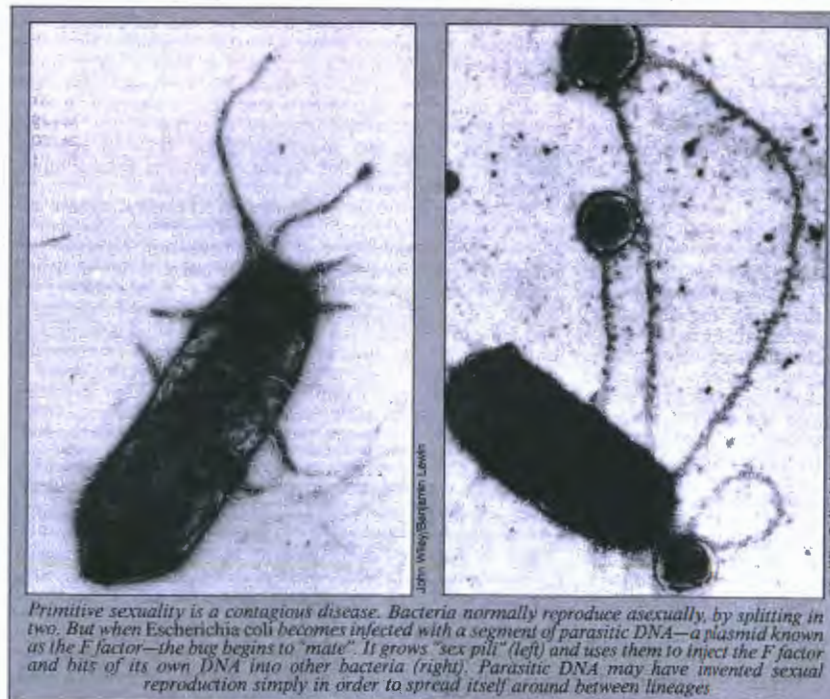
Transposable elements appear to come in three basic models. The first kind have molecular structures that resemble the DNA of retroviruses that have become integrated into the chromosomes of cells. Retroviruses are viruses that contain only RNA but they convert this into DNA and then insert themselves into the DNA of the host. Some transposable elements appear to move themselves around the genome in a similar way; they first form RNA copies of the integrated DNA, then convert these RNA copies into DNA copies, and finally reinsert this DNA at new sites on the chromosomes. Since retroviruses also go through all these steps when they reproduce inside a cell, such elements may be degenerate viruses. On the other hand, the viruses may be parasitic segments of DNA that have acquired the ability to spread "horizontally" by infection as well as "vertically" by inheritance from generation to generation. Howard Temin of the University of Wisconsin favours the second evolutionary scheme, but the question remains unresolved.

The second sort of transposable element also appears to propagate itself by going from DNA to RNA and back to DNA. But unlike the retroviral-like element, this kind of transposable element does not itself encode the enzyme necessary for the second (RNA to DNA) step of that "life cycle". Just how the second step is carried out remains uncertain. These elements seem to be fragments of parasitic DNA that arose within genomes, since all DNA is able to form

copies of itself in RNA. Our own chromosomes are burdened with between 300 000 and one million copies of a family of such elements, the "Alu" family, studied extensively by Warren Jelinek, Carl Schmid and their collaborators. These "genes" have no function; they do not direct the production of any protein.

The third sort of transposable element does not generate free RNA intermediates; it transposes itself by replicating straight into DNA and integrating the new DNA into chromosomes. Although there are bacterial viruses which employ these same processes, a viral origin for such elements seems unlikely. These viruses themselves are probably derived from such elements, having acquired the additional DNA that codes for the protein that coats the viral genome.

In spite of differences in mechanism of transposition, the integrated copies of all three elements are struc-



Primitive sexuality is a contagious disease. Bacteria normally reproduce asexually, by splitting in two. But when *Escherichia coli* becomes infected with a segment of parasitic DNA—a plasmid known as the F factor—the bug begins to "mate". It grows "sex pili" (left) and uses them to inject the F factor and bits of its own DNA into other bacteria (right). Parasitic DNA may have invented sexual reproduction simply in order to spread itself around between lineages.



New species may be created by "genomic disease." Two strains of fruitfly (P and M) may possess different transposable elements. Normally these mobile bits of DNA are quiescent. But when two strains mate, the newly-mixed elements become active and cause havoc as they move about the genome. As a result the hybrid offspring are sterile. Thus a breeding barrier is formed between the two strains, leading to a new species.

of Margaret Kidwell at Brown University, William Engels at the University of Wisconsin, and Gerald Rubin and Philip Bingham at the Carnegie Institution of Washington we now have a fairly complete understanding of a phenomenon, involving parasitic DNA, which seems to have all the makings of a mechanism of speciation.

turally similar. We do not know whether these similarities represent traits retained from a primitive common ancestor, or reflect constraints on the ways in which a transposable element can be made.

All transposable elements can cause mutations near sites at which new copies are inserted. It has been fashionable to see this ability to cause mutations as "a good thing". By causing mutations, such elements increase genetic variability within a population, and it is genetic variability upon which a population must draw when challenged to meet some new environmental threat to its survival. But this account is unsatisfactory for two reasons. Firstly, most mutations are deleterious. So this explanation requires that individuals maintain genetic components which are, on average, harmful, simply because the population as a whole may thus remain more adaptable. But selection does not usually favour characters that are fostered by such group selection, while simultaneously opposed by individual selection.

Secondly, the explanation is actually unnecessary. Duplicative transposition alone can maintain such transposable elements, and evolution operating within the genome, independently of any benefits for the organism, can create them. Some very specialised transposable elements may be maintained by individual selection: for instance, those which appear to generate variation in some parasitic protozoa that enables them to circumvent the immune defences of the host. But there seems no reason not to regard the vast majority of transposable elements as genomic parasites.

The concept of genomic parasites throws light upon one of the most elusive problems in biology: that of speciation, the formation of new species. Thanks to the work

The phenomenon, known as P-M hybrid dysgenesis, arises in certain crosses of laboratory stocks of fruitflies (*Drosophila melanogaster*) when males from "P" strains, recently caught in the wild, are crossed with females from "M" strains that were derived from wild populations more than 30 years ago. The offspring suffer a high rate of mutation, frequent rearrangements of chromosomes in their sex cells. Sometimes the offspring are also sterile. The cause of these pathologies in the hybrid is a transposable element that contains 2907 base-pairs of DNA. This particular transposable element, known



as the "P element" seems to have originated in the western hemisphere, and since 1950 it has swept through wild populations of *D. melanogaster*. When females from populations without P elements receive them, the P elements appear to be activated: they move around the DNA in germ-line tissue (the sex cells) and thereby disrupt the production of gametes.

Two sequences in the DNA of the P element that apparently code for proteins are responsible for these unusual properties. One seems to encode a transposase, an enzyme that enables P elements to move about the genome. The other sequence seems to encode a repressor gene-product, that acts to reduce the rate of transposition. If P elements have been present in the population for some time, a balance between promoter and repressor is achieved: its two gene products are present at levels that allow germ-line cells to replicate normally. In hybrids, this regulatory system breaks down, producing dysgenesis.

The biology of hybrid dysgenesis led Kidwell, Bingham and others to formulate the "genomic disease" mechanism of speciation, although the term is our invention. Suppose that isolated populations of a species acquire different transposable elements such as P, such that each population has two or three transposable elements not present in the other. Populations of one type will then lack what amounts to immunity to a genomic disease, caused by the transposable elements present in the other type. Thus all hybrids could be completely sterile, as a result of the de-repressed proliferation of different transposable elements. This would establish a breeding barrier between these populations, making them distinct species.

Speciation by genomic disease

"Genomic disease" could have created some of the species of *Drosophila* alive today. The defective gonads of P-M dysgenic hybrids bear a striking resemblance to those of hybrids between *D. melanogaster* and *D. simulans*. *D. melanogaster* also possesses other stretches of DNA that cause dysgenesis in hybrids, such as that of the I-R system in another pair of strains studied by J. C. Bregliano and his colleagues in France. The pathologies of these hybrids are much like those of the hybrid progeny of species closely related to *D. pseudoobscura*. There appear to be no biological

constraints preventing several transposable elements operating to produce dysgenesis in a given hybrid. Two such transposable elements seem to have spread through *D. melanogaster* in the past 50 years alone. At present, there is evidence for the possible action of genomic disease in speciation only within species of *Drosophila*—probably because it is easier to work with *Drosophila*; its genetics are well-known and large stocks have been collected over the years.

The evolution of sex is one of the major concerns of



modern evolutionary biology. It is the subject of books by the leading figures in the field such as John Maynard Smith of the University of Sussex and George Williams of the State University of New York at Stony Brook. The problem is that it is difficult to explain the origin and maintenance of sex in terms of any benefit to fitness. Indeed, it is possible to argue that there should be strong selection pressure favouring the abandonment of sex by females, and the adoption of asexual reproduction instead.

Traditional evolutionary explanations for sex and related aspects of the genetic system, such as the benefits of recombination (the shuffling of genes as gametes are formed and fuse) have revolved around the advantage that accrues from producing offspring with a variety of genotypes, as opposed to a number of identical copies of the parental genotype. This idea was first put forward by H. J. Muller and R. A. Fisher in the context of group selection: sexual species would eliminate asexual species, because the former would evolve more rapidly than the latter.

But such arguments depend upon group selection: an overall advantage to populations. Evolutionary biologists tend to regard such arguments as measures of last resort. They would prefer to identify selection mechanisms couched in terms of the reproductive success of individual organisms. They concentrated mainly on cases involving unpredictable environments, either in space or in time. But mathematical analysis has led Maynard Smith to disavow "any idea that selection in an unpredictable environment necessarily or easily confers an advantage on sex".

The new ideas in evolutionary molecular biology suggest an alternative explanation. If some DNA sequences appear to evolve for no other end than ensuring their vertical transmission from generation to generation, could there not also be parasitic DNA sequences which foster their transmission horizontally, between lineages? In a sense, viruses do just this, though they have a life-cycle stage outside of any host cell. Parasitic DNA could engineer its horizontal transmission by establishing genetic exchange between host organisms; the DNA could infect new hosts as a result of the genetic exchange. Sex thus becomes a means of genetic contagion for these parasitic DNA sequences.

As pointed out by Donal Hickey of the University of Ottawa, this whole idea would seem quite outrageous were it not for the fact that there are DNA sequences which do just this. Consider the F factor, a large circular piece of DNA, or "plasmid", which is present in some cells of the bacterium

Escherichia coli. The F factor encodes at least 11 genes, eight of which make *E. coli* cells extrude long appendages, known as "pili". When cells with these pili contact cells lacking the F factor, the pili acts as a genetic syringe, sending a copy of the F factor into the contacted cell. Sometimes normal host genes are also transferred in this way, making it a plausible starting point for primitive sexuality. The parasitic nature of the F factor is evident because cells with F pili are more susceptible to viral infection. So there is circumstantial evidence that sex originated as a result of selection acting on parasitic DNA to foster its horizontal transmission between host cells.

With this view of the origin of sex, the maintenance of sex can also be seen in a different light. If sex is something that organisms were burdened with by parasitic DNA, then it seems reasonable to go on thinking of sex as something that happens to organisms, whether it enhances their fitness or not. It is difficult to explain how females benefit evolutionarily by their fertilisation by males, so perhaps they normally do not benefit. Instead, sex may be maintained because it is difficult for females to escape mating, evolutionarily. In this context, males can be seen as parasitic DNA made manifest at the organismal level. While males may occasionally benefit females, as indeed plasmids sometimes bear genes that benefit the host, nonetheless sex, like speciation, may be best conceived of in terms of evolutionary misfortune, rather than adaptation. □

Further reading

For more about parasitic DNA see W. F. Doolittle, C. Sapienza, *Nature*, vol 284, p 601 and L. E. Orgel and F. H. C. Crick, *Nature*, vol 284, p 604. For speciation, see M. R. Rose, and W. F. Doolittle, *Science*, vol 220, p 157. For sex, see M. R. Rose, *Journal of Theoretical Biology*, vol 101, p 137.

Michael R. Rose is assistant professor in Biology and W. Ford Doolittle is professor of Biochemistry at Dalhousie University, in Halifax, Nova Scotia, Canada.

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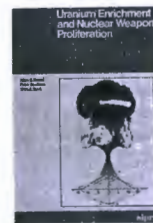
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The Alternative Defence Commission was set up to consider the possible defence policies for a Britain that had said 'No' to the bomb. The Commission looked at the immediate difficulties and consequences of becoming non-nuclear and goes on to put forward suggestions for the defence of the country, ranging from the maintenance of strong conventional forces to radical proposals for defence by civil resistance.

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Scientists, the Arms Race and Disarmament



Edited by J. Rotblat
A joint Taylor & Francis/
Unesco Publication
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£9.50 0 85066 234 6

Not only through their work in laboratories, but in their capacity as senior advisers in governments, scientists face dilemmas of a moral and material nature in devoting their talents to war purposes in times of peace. It is hoped that by drawing attention to these problems, a valid contribution can be made to the ultimate goal of international disarmament.

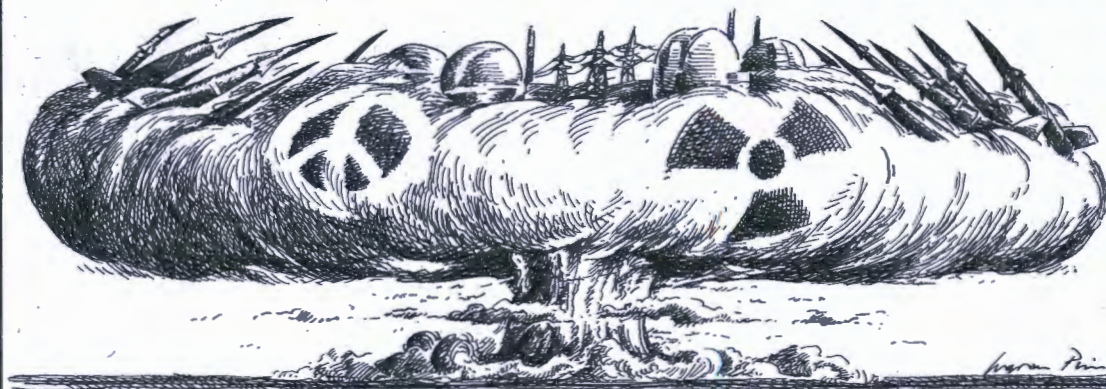


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NUCLEAR DEBATE



The truth for John and Jane Citizen

Living with nuclear weapons
by Harvard Nuclear Study Group, Harvard UP, pp 268, £9.95

Fred Dainton

ALMOST 38 years ago, when the atomic bomb was dropped on Hiroshima, I was in hospital recovering from surgery necessitated by the effects of a more conventional explosion. The devoted, deeply shocked, staff nurse, unable to contain her horror and knowing that I was a scientist, declared that she could not give aid and comfort to *anyone* who had any connection, however remote, with this weapon of terror.

In vain from my disadvantageously inferior recumbent position, I suggested that there were other considerations; that to secure a Japanese surrender by conventional weaponry might cost many more lives, that a new era had now dawned in which global conflict might be less probable and that, in any case, nuclear fission might offer benefits to humans as, for example, by diminishing the need for coal mining and the incidence of emphysema, chronic bronchitis and accidents, often fatal, due to rock falls and fire-damp explosions. The last point made some impact because in the next bed was a "Bevin Boy" miner, victim of such an accident.

The real problem, I told her, was how humanity could come to terms with this newly-acquired power, become its master and not its slave, and that to succeed in this task in a democratic society moral indignation—even revulsion—was insufficient; the citizens must know all the facts. If these arguments had any influence on her thoughts the bomb which fell three days later destroyed that influence and much of Nagasaki. Her feelings were not unique. Even Otto Hahn, the

discoverer of nuclear fission, was so depressed that he spoke of suicide.

A year or so later the American Atomic Scientists Association was launched and one of its purposes was to put the facts in front of the public. In Britain some like-minded scientists took a similar line. Meetings were arranged and my memory is of minute audiences because the vast majority of the population was apathetic, unwilling to consider the terrifying possibilities accompanying the opening of this nuclear Pandora's box or simply grateful that, after six years of war, and with national coffers depleted, British soldiers could be brought home.

The grandchildren of those returned warriors and their contemporaries in the USSR and the US are now growing up to face the same problems except that the aggregate destructive power of nuclear weapons exceeds 10 billion, that is 10^{10} tonnes of conventional explosives. In the intervening years there have been two surges of public revulsion typified by the CND marches of the 1960s and the current Greenham Common type demonstrations triggered by the failure to ratify SALT II and, latterly, the decision to site Cruise in Europe and to proceed with MX.

But the public remains by and large confused, unable to discern where the truth lies between the extreme views of the unilateralists and those who feel that the only effective shield

for Western values is nuclear supremacy. The party manifestos issued for the election and the divergent views of those supposedly committed to them reflect this confusion. Much information is available to those who are prepared to quarry official publications but most of us have neither the skill nor the time and there is a primary, urgent need for a clear, authoritative, statement of the truth in a form comprehensible to John and Jane Citizen.

Living with Nuclear Weapons goes a very long way to meeting that need. It originated with the president of Harvard, Derek Bok, calling together some colleagues, already experienced and knowledgeable in the field of nuclear arms limitation, and inviting them to confer with the object of producing a lucid accurate account of nuclear weapons and their control presented in an easy-to-read style but without distortion. They have been conspicuously successful.

After a preview of five major questions, the book opens with an essay on the history of the politics of the balance of power in the pre-nuclear era and then describes how a nuclear war might begin and develop, emphasising the enormously compressed time-scale of decision. Historical facts about the various nuclear arsenals form part two, whilst the final part discusses weaponry alternatives, possible control mechanisms and agreements, prevention of proliferation and concludes with

a piece on moral and practical dilemmas faced by humanity in the nuclear age.

Throughout, it does not shirk real issues and reminds readers who crave for certainties on which to base their decisions that in principle these are often unattainable; for example, there is the paradox that as long as a deterrent policy works it must be impossible to know how much weaponry is enough. The authors suggest that for some time we have to endure a kind of "crisis stability" which to a physical chemist recalls certain metastable states of aggregation and perhaps we might take comfort from thermodynamically unstable glasses which have nevertheless persisted for thousands of years. The question is how to avoid initiating the catastrophic devitrification of global nuclear "peace" before war of any kind is abandoned as an instrument of national policy.

This book makes a real contribution to the management of this (probably prolonged) metastable balance until the ardently desired real peace arrives, because it communicates the facts and uncertainties so clearly and objectively to everyone who cares to open its pages. I recommend it without major reservations and congratulate Harvard University on its responsible, public spirited, attitude in producing it. Harvard's motto is *Veritas*. The Bomb produces heat and light; discussions about it generate more heat than light, an imbalance which this book attempts to correct. The book deserves the motto *Veritas Lux Est* and a wide circulation. □

IN THE all-important nuclear debate there is at least a common starting point. Everybody — from Ronald Reagan to Yuri Andropov, from Margaret Thatcher to the women at Greenham Common — agrees that a nuclear war would be the worst imaginable disaster that the human race can inflict upon itself. But when it comes to the steps to avoid this disaster, the views are diametrically opposite. The women at Greenham Common have a simple solution: if we want to avoid a nuclear war, we should get rid of nuclear weapons. Thatcher's solution is more sophisticated: she wants an increase in our nuclear potential (for example, Trident) presumably on the basis of the Roman dictum "Qui desiderat pacem, praeparet bellum".

Defended to Death makes out a strong case against reliance on nuclear weapons for defence, on the well-substantiated evidence that the on-going arms race has resulted in less security and a greater likelihood of nuclear war. It is ironic that the idea for the book should have come from an official in the Ministry of Defence who suggested "that the academic community can play a valuable part in ensuring that the debate is conducted on an informed basis". This was certainly proved by the Cambridge dons, but I doubt

Cambridge dons speak out on defence policy

Defended to death
edited by Gwyn Prins, Penguin, pp 387, pbk £3-50
Joseph Rotblat

whether the outcome will please the Ministry of Defence; in the book the nuclear defence policy of the government is analysed meticulously, and demolished point by point.

The account of the many aspects of the nuclear arms race is remarkably comprehensive; I have one or two reservations about it. Granted that complete nuclear disarmament should be the clear goal, need the authors be so deprecatory about the few measures achieved so far, such as the Partial Test Ban Treaty, the Non-Proliferation Treaty and SALT I? Can anyone be sure that without these brakes the arms race would not have already ended in a fatal collision? In a book which stresses the radiation hazards from military and civil nuclear uses, the likely effects on the health of people from continuous atmospheric testing deserve more weight. Similarly, without the Non-Proliferation Treaty the nuclear club might have already acquired a larger membership.

The progress of the arms race is depicted mainly as the history of the introduction and deploy-

ment of nuclear weapons by the United States. This is justified because there is hardly any direct information about corresponding developments in the Soviet Union. Indeed, this very secrecy—inherent in the regime—has considerably contributed to the arms race, as it enabled the military in the US to demand funds for new weapon systems, allegedly to match advances in the USSR which in almost every case turned out to be non-existent.

But is it necessary for Russia to follow automatically—with a lag of 3-5 years—every American step? The Soviet Union officially rejected the concept of a limited nuclear war, and surely its arsenals are already big enough to satisfy its defensive needs. There is insistence on equality, but what this really means is the capability to destroy the enemy, say, 25 times over, instead of 20 times.

All the same, there can be no doubt that the greatest danger at present arises from the decision of the Reagan administration to step up the arms race by the introduction of weapon systems which must be perceived by the

weapons will be more accurate and reliable, and have greater targeting flexibility, than the ones they replace. Moreover, the superpowers are energetically working on anti-submarine warfare, anti-ballistic missiles and anti-satellite warfare. These developments are destabilising the Soviet-American strategic balance. The more unstable the strategic system becomes, the greater the risk of unintentional nuclear war during an international crisis.

Daniel Frei and Christian Catrina describe the factors affecting strategic stability, particularly the nuclear arms race, the development of strategic doctrines and the spread of nuclear weapons to countries that do not have them. Their conclusion is that while the danger of accidental nuclear war should not be underestimated, it is much more likely that "an acute international crisis may act as a catalyst to trigger a nuclear war not in fact intended by the govern-



Peter Kennard

other side as preparation for a first strike. Coupled with the fervour of a crusade against an "evil" regime, it is bound to make Russia (and everybody else) extremely nervous, and induce it to adopt desperate measures, such as launch-on-warning.

While advocating a policy of renunciation of nuclear weapons, the authors are fully aware of the risks involved in such a policy, but they are convinced that these risks are outweighed by the risks involved in the possession of nuclear weapons. In the light of recent developments it is difficult not to agree with this conclusion. □

ments concerned".

The authors, it seems to me, underestimate the dangers of accidental nuclear war inherent in the deployment of new nuclear weapons. Pershing II missiles, for example, will be able to hit targets in the Soviet Union, from launch sites in West Germany, after flight times of less than 10 minutes. We know that the American computerised warning system takes, on average, longer than this to sort out false alarms. And we also know that the Soviet computer system is not so good as the American one. To deploy the Pershing II clearly increases the probability of accidental nuclear war, even in times when there is no serious international crisis.

Why, then, are such destabilising nuclear weapons being deployed? Political leaders may want a first-strike capability, for world domination or whatever. Or, the nuclear arms race may be out of political control. The answer you choose will affect your judgement of the risks of nuclear war, and of the ways in which the arms race can be stopped. But on this basic question, the authors of *Risks of Unintentional Nuclear War* are not forthcoming. □



Peter Kennard

Waiting for the trigger

Physicians practise preventive medicine

Medical effects of nuclear war
Report of the BMA, Wiley, pp 188, pbk £4-50

Last aid
by Eric Chivian et al, Freeman, pp 338, £15-80, pbk £7-40
John Humphrey

IN 1981, the Annual Representative Meeting of the British Medical Association asked its Board of Science and Education to review the medical effects of nuclear war and the value of civil defence in order that the BMA should form a policy.

Also in 1981, a group of eminent Boston physicians, who shared the doubts of a growing number of doctors in America about policies that relied on nuclear weapons, joined with Soviet doctors of equal eminence expressing similar feelings. This historic meeting, near Washington DC, was the first congress of the International Physicians for the Prevention of Nuclear War (IPPNW). It was attended by 72 prominent persons from 12 countries, and received wide publicity in the US and in the USSR.

IPPNW has now grown sufficiently to assume the role of coordinating throughout North and South America, Western and Eastern Europe (including the USSR) and Japan, the organisations of doctors and other health workers who regard avoiding nuclear war as the major challenge to preventive medicine. It relies upon and exemplifies the fact that medicine has common goals and a common ethic which transcend national boundaries and political systems.

So much for the credentials of the producers of *Last Aid* (based on the first congress of the IPPNW) and *The Medical Effects of Nuclear War* (the report of the BMA's working party). Both are impeccable, though they differ insofar as IPPNW started *parti pris* with the intention to influence readers, and the BMA working party with an open mind and the remit only to inform.

The books cover much common ground; the development of nuclear weapons, their physical effects, current estimates of the world's nuclear arsenals (based on available independent analyses which depict a rough balance in total lethality between those of the US and the USSR), descriptions of the predictable medical and psychological effects of nuclear weapons used in war, studies in more detail of possible scenarios involving attacks on the UK and the US, and some very gloomy

assessments of the aftermath and the possible effects of an all-out nuclear war upon global ecology.

Last Aid goes on to give the text of appeals to world leaders and to world physicians to eschew nuclear weapons, whereas the BMA report contents itself with a summary and conclusions. The conclusions are clear and very similar: no current or foreseeable civil defence measures could provide effective medical help against an attack with nuclear weapons, for which even the destruction of Hiroshima and Nagasaki cannot be regarded as valid precedents.

How could a bunch of doctors predict the form that a nuclear attack would take, or know about nuclear weapons to foretell the effects of such an attack on people and their environment? They cannot, and neither can the Home Office, but the BMA working party examined several scenarios, concluding that the National Health Service could not deal with the casualties which might be expected following the explosion of even a single 1 megatonne weapon over the UK, let alone those following a more commonly assumed attack with 150-200 megatonnes.

As regards the second question, there is sufficient published information derived from more than 1200 nuclear weapons tests, combined with civilian and wartime medical experience, to allow computer prediction of short-term casualties from a given weapon at a given place within a factor of two.

The BMA working party interviewed representatives from the Ministry of Defence, the Department of Health and Social Security and the Home Office about specific plans for civil defence in the UK. Part of the Home Office replies are given verbatim, and the text is reproduced of the currently operative (but under revision) DHSS 1977 circular "The preparation and organisation of the health services for war".

The working party is severely critical of the Home Office's replies to questions, and agrees (with a section to explain why) with calculations made by Scientists Against Nuclear Arms (SANA) which conclude that official estimates of expected casualties may be too low by a



Nagasaki victims on his way to medical help. But could medics cope in tomorrow's nuclear blast?

factor of two or more. The reaction of the Home Office was to state that SANA's estimates were exaggerated—but also to admit that its own predictions were being revised.

What conclusions the BMA as a whole will draw from its working party report remain to be seen. In the US, the prestigious American Association of Physicians as well as the American Medical Association itself have accepted the general theses of

Doctors' organisations constitute one the most powerful lobbies in the countries of the West, so some of this criticism may even filter through to higher government levels. There is no doubt that it is more likely to do so if the lay public reads and takes in the implications of the message of these books. Of the two, *Last Aid* has the more popular approach; the BMA report is the more dead-pan and technical, but is nevertheless surprisingly readable. □

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How to achieve peace

The causes of wars
by Michael Howard, Temple Smith, pp 248, £10

Roy Herbert



Loos in 1915: bombs and gas found their way on to the battle scene

OPINIONS on the causes of wars are, for the most part, simple; the human mind attempting to make some comprehensible judgement so that the colossal event of a war can be coped with. In our own time the cause of one war, according to some people, was the unbridled aggressiveness of Margaret Thatcher. Millions of Americans believe that the reason for a future war will be Communism. Wars have been blamed on the Jews, the Arabs, the Kaiser and the cutting off of Jenkins's ear.

It follows that removing the threat of war must be equally simple. Kill the Communists, or the Jews, or hang the Kaiser and all will be tranquil. The women of Greenham Common subscribe to the same simple view. Abolish nuclear weapons for Britain and peace will follow as the day the night, if not for the world, then for the UK.

Michael Howard's gracefully written book is a collection of his essays and lectures over the past 20 years or so. It deserves wide reading, for, in addition to the common urge to cling to a single idea of the reasons for wars, there is a reluctance to study their history. It seems to me that if you do not understand, at the least, that the causes of wars are complicated, you can never understand the complications of keeping the peace. The reluctance is as sensible as refusing to study the causes of crime when engaged in attempting to obviate it.

Attitudes to war have changed radically in this century. Pic-

tures of crowds outside official buildings in August 1914 are almost interchangeable: in London, Paris and Berlin, people are cheering, waving their hats. They enthusiastically accepted the war just declared. But what sympathetic note is struck in any contemporary breast by Rupert Brooke's, "Now God be thanked who hath matched us with this hour"? No such rejoicing marked the declaration of war with Germany in 1939. It had become obvious by the beginning of 1915 that technology had made war a different business, murderous, sucking in populations as well as armies.

Nowadays, with the advent of nuclear weapons, it encompasses the world itself. How are we to deal with this when the causes of the wars in history are just as powerful now as they were then?

In societies described as "bellicist" by Michael Howard, war was a normal, even respectable, method of settling differences or extending power. Wars are not, in spite of some extraordinary arguments I have heard, caused by weapons. They are caused by men, who calculate that they are on to a good thing, on balance. In other words, they conclude that they have more to gain than to lose,

Nuclear candies in the cupboard

Uranium enrichment and nuclear weapon proliferation
by Allan Krass, Peter Boskma, Boelie Elzen and Wim Smit,
SIPRI/Taylor & Francis, pp 295, £15

Ross Hesketh

of the purposes listed above; it is restricted to detection of theft. At best, the agency can cry, "I saw you!", but sometimes it cannot even do that. In the words of the IAEA, "... the level of assurance... depends... on the content of the safeguards agreement concluded with the state in question..." Under the agreement with the UK, the IAEA is unable to require the most significant piece of information, namely the isotopic quality of the plutonium which comes out of Britain's civil nuclear power stations. The IAEA is not even able to cry, "I saw you!"; it is not allowed to see.

The distinction between national and sub-national groups is not always clear. Israel is thought to have acquired 200 tonnes of uranium loaded on to a ship registered to a different purchaser. Perhaps the chief distinction is that sub-national groups acquire nuclear materials only now and then, whereas for nations—Israel, UK, France, India, US, Pakistan, USSR, China—temptation is always present; there is always a Mars bar in the cupboard.

The International Atomic Energy Agency's current system of safeguards does not attempt to fulfil the first, third or fourth

of "non-proliferation" which, for its own part, it does its best to evade. For example, in 1976 Brazil (not a signatory to the Non-Proliferation Treaty) announced a wish to buy enrichment services from Urenco, the British-Dutch-German consortium. In 1978 the Dutch parliament agreed to sell, but only on conditions. These conditions were circumvented in 1981: Urenco announced that shipments to Brazil would take place from Britain. Yet Britain has insufficient enrichment capacity for her own needs.

The book amply maintains SIPRI's reputation for distinguished and dispassionate scholarship. The first part looks at the technicalities of uranium enrichment, the several motives for enrichment, and the

wrong though they so often have been. It is hard to see how the most bellicist of governments could calculate that starting a war in the nuclear age could lead to more advantage than the opposite.

In his essay on the use and abuse of military history, Howard is at his best. He deals with professional historians, but I know of no better case for the amateur reading of the history of what, after all, has been a constant occupation of mankind up to our day. All military history, or, at any rate, good military history, takes into account the political, social and economic context of the outbreak of war and its progress. If we cannot bear to study these things, we are hardly in a good position to recognise those that could bring war about and still less well-placed to avoid them.

In my youth, I heard over and over again that all wars were economic in origin and vaguely ascribed that apophthegm to Marx. The war that I took part in did not, as far as I could see, fit that pattern. Neither did it seem to me to be sensible to blame it on Charles Darwin, a belief that a Czech interpreter harangued me with in Germany at its end. Wars are not the result of simple causes, though they may be fought for them.

Theodore Roosevelt's recipe for keeping the peace was, "Speak softly and carry a big stick." I prefer the words of Liddell Hart, quoted by Professor Howard, "if you want peace, understand war." □

technical and institutional means of control. It is not easy reading, but it is very worthwhile for the dedicated layman.

The second and largest part treats in detail the principles of enrichment and all the hardware, both actual and putative. The authors continue to address the layman (as in the first and third parts of the book) but in fact they have produced a treatise for the scientific community. Only the person who is building a plasma centrifuge or a laser isotope will need to look elsewhere.

The authors are perhaps slightly backward looking in their emphasis on uranium. Plutonium is now preferred for weapons and in the coming decade a major risk in proliferation will be enrichment of the large stocks of plutonium derived from reactors of all types. Already one of the favoured methods is three years ahead of schedule. Soon there will be even more Mars bars in the cupboard. □

WHAT are the prospects for nuclear power? The promise of electricity "too cheap to meter" is lost in history, while that of the fast reactor is vanishing into the future. France apart, the nuclear suppliers are starved of orders in their domestic markets and are competing vigorously for a share of the export market, with perhaps profound implications for nuclear proliferation.

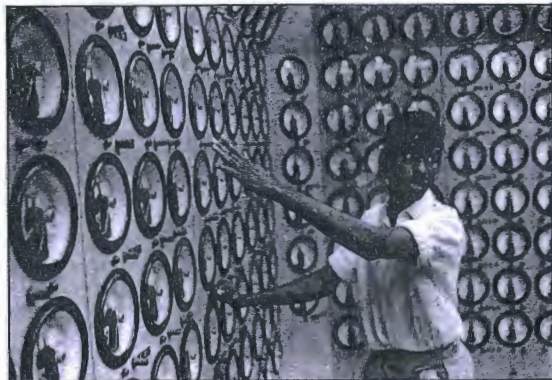
There has been much interest in the possibility that exports to developing countries might sustain the major nuclear suppliers until the hoped-for day when domestic orders pick up again. In this context, the books by David Hart and Dharendra Sharma are timely reminders that some developing countries do not wish to become over-dependent on the industrialised nations for nuclear technology.

India's nuclear estate (Lancaster, pp 195, Rs115) offers Sharma's highly personal and personalised account of the politics of nuclear energy in India. Such an approach is perhaps inevitable for a country where nuclear politics have turned so much on a handful of individuals, though it has its dangers.

Lancaster Publishers, PO 4325, New Delhi 110048, India.

From developed to developing

by Philip Gummert



India has one of the most advanced programmes of nuclear development in the Third World

Sharma is highly critical of what he regards as the costs of India's quest for nuclear independence, in terms of foregone energy options, the drain of specialist personnel, radiation hazards, corruption in high places, threats to democracy, the disbenefits of the 1974 explosion and, of course, finance. The Department of Atomic Energy

is sometimes renamed the Department of Added Estimates, though this hardly reflects a uniquely Indian problem.

In contrast, Hart analyses Indian nuclear policy more from the viewpoints of the technology involved and, as he sees it, its lack of energy-policy rationale. There is little political analysis in Nuclear power in India (Allen & Unwin, pp 159, £12) and only a brief appendix on the 1974 explosion. Hart does, however, present a lot of information and he makes some interesting points.

For instance, the difficulty with basing more of India's energy policy on coal lies not with the coalfields in inconvenient locations or unpredictable production, but with the inefficiencies of the railway system. There is a summary of the nuclear activities of 16 other developing countries, though Hart draws no overall conclusions: indeed, the book ends with startling abruptness.

Nuclear power in the developing world (Allen & Unwin, pp 254, £14.95) is more analytical, with its exploration of why developing countries choose the nuclear policies that they do. Daniel Poneman distinguishes between countries that seek independent nuclear development, those that rank speed of access above independence and so are willing to depend indefinitely on a supplier, and those that so far have mounted no serious nuclear power programme. He examines explanations for nuclear policies in terms of national security and economic objectives, and as the result of domestic political battles (which may produce

policies inconsistent with a government's stated objectives) or foreign influence.

His conclusion is that security and economic objectives have more influence upon the technology chosen than bureaucratic or international political processes, and that the technology chosen, therefore, is the best indicator of real intentions. Considerable political capital has to be invested to offset the heavy costs of nuclear power, and this price is obviously not thought worth paying by most leaders of developing countries.

While most books on international nuclear affairs concentrate upon governmental decision-making, William Walker and Måns Lönnroth develop a more original approach in Nuclear power struggles (Allen & Unwin, pp 204, £13.95). Their extremely well-informed and subtle analysis focuses on the struggle for supremacy and survival that is taking place among the leading nuclear manufacturers.

France and West Germany is challenging the US's supremacy, they suggest, with Japan poised to enter the ring. They examine the implications of the differing states of these countries' domestic markets and export prospects for the shape of the international nuclear system over the next 10 years. In particular, the authors foresee a growing separation of the centres of geopolitical authority (the US and USSR), upon which the non-proliferation regime has largely rested so far, from the new centres of nuclear trade.

Walker and Lönnroth expect France (a non-signatory of the Non-Proliferation Treaty) to assume a crucial role in the maintenance of the non-proliferation regime. Not only is France likely to dominate nuclear trade in the near future, but its overall foreign policy, with its strong emphasis on relations with Third World countries and with the Western alliance, places it well to mediate between North and South, and the US, West Germany and Japan. However, as the French domestic nuclear market declines in the late 1980s (a consequence, they predict, of earlier over-investment in nuclear plant), and pressure builds up for exports at almost any price, they foresee an intense political struggle over the priorities to give to industrial welfare, trade relations and international security. It would seem, then, that the survival of the non-proliferation regime in the 1990s may depend in large part upon an economic, if not a nuclear, boom in France. □

Israel's awkward option

Israeli nuclear deterrence: a strategy for the 1980s
by Shai Feldman, Columbia UP, pp 310, \$32.50, pbk \$13

Lawrence Freedman

ISRAEL'S nuclear capability is one of the worst-kept international secrets. It may not yet have actual weapons. It may have only a sort of quick-assembly kit. But it certainly has an advanced option. Top-secret briefings from the CIA describing this capability, usually putting it at up to 20 bombs, reach the press at such regular intervals that it can seem as if there is almost a deliberate policy of disclosure to accustom the world to this awkward truth.

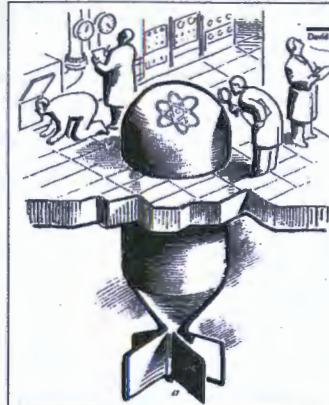
The truth is awkward for everyone: the Israelis want to preserve the option while not jeopardising relations with the United States by admitting to a nuclear status; the Arabs do not want to have to accept the limits on their plans that a nuclear Israel imposes; the Americans do not want to be asked to choose between its nuclear proliferation policy and a favoured friend; the Soviet Union does not want to have to provide nuclear guarantees to its unruly Arab clients. So it is in everyone's interests to keep the secret.

Shai Feldman wants Israel to come out of the nuclear closet and declare itself. But he refrains

from actually providing the evidence on Israel's capability on the grounds that it is all quite speculative. This is a curious omission in an otherwise thorough book. There is far more evidence on Arab nuclear programmes than on Israel's, details of which only emerge in descriptions of what other nations think Israel is up to. So the reader has to assume no smoke without fire and that Dr Feldman would not bother to write a book on the subject if Israel lacked the option.

What the author does is to draw on the vast literature on the concept of deterrence to demonstrate that a nuclear Israel might not be such a bad thing after all. He does this successfully—to an alarming extent.

The argument is based on the premise that the introduction of nuclear weapons so greatly raises the risks of confrontation that confrontation is therefore less likely to take place. Established nuclear powers are always embarrassed when other countries start to take seriously arguments—and the associated capabilities—that have served them so well. Nuclear weapons



David Suter's cartoon in War Heads (Sphere, pp 96, £2.50). Since Hiroshima, artists have used the bomb as a symbol of our fears on warfare. Steven Heller has collected works from over 60 cartoonists (including Steadman, Scarfe, Tupor and Feiffer) exposing "the lunacy and peril of an arms build-up". This is not a book to invoke smiles; rather it is a macabre collection of gloom and despair. But so is the subject.

do sober the reckless and restrain the adventurous. But there is a nagging doubt that they might just not sober and restrain enough.

These doubts grow in a politically unstable environment. Feldman recognises that a nuclear deterrent is not so much a substitute foreign policy but a way of bolstering the security of a state that wants nothing more than to live within its own boundaries. So his argument is conditional on Israel accepting a radical peace package that takes it back to something approximating the 1967 boundaries.

Shai Feldman is quite clear that the consequences of an

overt Israeli "bomb" and the current foreign policy could be disastrous but this must be countered the most likely combination. Moreover, if something along the lines of UN Resolution 242 could still be approved then it is not necessarily the case that the accompanying diplomatic and conventional military safeguards would not be sufficient. In these circumstances an announcement on nuclear deterrence could disrupt the new-founded harmony.

In the end, therefore, a case not proven but a carefully reasoned and rigorous case nevertheless, unafraid of a disturbing set of conclusions. □

The future with nuclear power

Taming the atom
by Ian Blair, Hilger, pp 248, £15, pbk £6.50

William Walker

IAN BLAIR has set out to provide our old friend, the intelligent layman, with an "authoritative and readable" assessment of nuclear power. The outcome is a lively and sensitively-written book, although most New Scientist readers will quickly detect the partiality of one who works for the Atomic Energy Authority's public relations department. As always, the infallible litmus test is the fast reactor. Blair expects it to be the preferred reactor design by the end of the century, warranting an early decision in favour of a British demonstration plant.

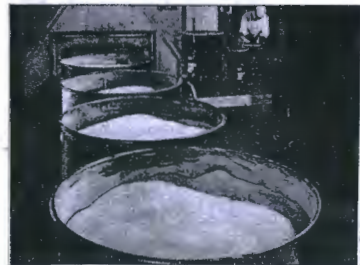
The book can be divided roughly into three parts. The first contains useful, although hardly novel, descriptions of nuclear reactors and the fuel cycle, and a rather coy discussion of the British nuclear industry. The second presents the case for a stronger commitment to nuclear power, arguing

that it is economic, has distinct advantages over other energy options (including conservation) and is relatively safe.

At this point, our intelligent layman may begin to wonder what all the hullabaloo has been about. If the cards are stacked so high in favour of nuclear power, why the persistent whiff of tear-gas in the air? In the third part, Blair essentially argues that

nuclear power and its architects are not themselves to blame—they have fallen victim to society's general disillusionment with the industrial way of life. Resolve that problem and the resistance to nuclear power will also die away. "I would even be so bold as to say that for all practical purposes the nuclear debate is over. However, the more general and important debate on the future development of our society is just about to begin." These are the author's closing sentences in this book.

In my view Ian Blair is wrong on both counts. Opposition to nuclear power is undoubtedly a complicated social phenomenon (as is nuclear advocacy), embracing many grievances and conflicts. But concern over nuclear power today has become more focused and more focused on the specific attributes of nuclear technology and practice. Questions of safety, economics and military



Uranium is transported to users in a relatively safe form as an oxide, or "yellowcake"

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Facing the Future with Nuclear Power

Ian Blair (AERE, Harwell)

A highly readable account of the nuclear energy scene for readers without a technical knowledge, which dispels many of the myths surrounding this emotive subject.

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The hard truths of energy policy

The war against the atom
by Samuel McCracken, *Basic*, pp 206, \$18.50

Michael Kenward

THERE HAVE been a handful of nuclear books, many more anti-nuclear books, but precious few anti-anti-nuclear books. Indeed, this is only the second of the third genre that I have seen. Although Samuel McCracken may not be a brilliant writer, and his own indignation sometimes gets in the way, he goes through the anti-nuclear arguments and dismisses them convincingly enough. But he is at his best when dismantling the individuals who lead the anti-nuclear campaign.

A scientifically-educated audience will not need to be told of the technical shortcomings of the case against nuclear power. But it does put things into perspective when you learn that "replacement power generated from fossil fuels, primarily coal, to replace the damaged TMI-2 [power plant] is killing four people a month". It also puts things into perspective when you learn that "The anti-nuclear lobby delights to quote cost overruns, but it rarely notes the influence on these delays that it works to cause. These costs too are borne by consumers and are cruelly regressive upon the poor."

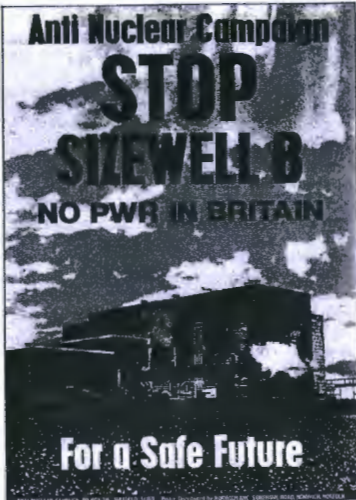
Throughout his book, McCracken raises the issue of the social inequities inherent in the anti-nuclear campaign. He presents opposition to the nuclear power as a middle-class activity for those who can afford to be against it. And there is no denying that the alternatives to nuclear power are spectacularly expensive. For example, a solar hot-water system "costs ten times what a conventional one

does, and because a large proportion of its cost is labour, the price is not likely to ever come down". The solar lobby presents solar energy's labour intensity as an advantage because it creates employment. Yes, it does, but it will be dangerous manual labour for people who will have to clamber over the roofs of the rich who can afford luxuries such as expensive solar heaters.

McCracken takes apart one solar energy scheme produced by Barry Commoner who seems to believe that streetlights could be replaced with solar collectors and batteries. Maybe, but "the visual quality of the [Commoner Patent Streetlight], whatever its economic problems, is a hideous one, a bizarre regression to the days when utility poles carrying hundreds of lines blotted out the urban skyline. One wonders what on earth Commoner can be thinking of."

McCracken goes on to investigate Commoner and the other "commanders" of what he calls the "warriors against the atom". He says of Commoner that his work "is studded with passages that make one wonder why anyone takes him seriously". "Commoner's views are the sort that it is possible to hold only in an extraordinarily rich country, where a glut of everything masks the system that produces it. He really resembles that bygone figure of gentle fun, the foolish professor. It is unfortunate that such a figure should be taken seriously on one of the most crucial issues facing the world today."

Amory Lovins comes in for similar treatment. He is branded as "extremely inconsistent" and



"plagued by inaccuracy"; and McCracken gives chapter and verse to support these allegations.

McCracken sums up his position: "There are some hard truths in this area, truths that must be carefully observed in the public interest. The first of these is that in energy policy it does not matter, if one gets the facts seriously wrong, how committed, how passionate, or indeed how virtuous one is. One must first of all know what one is talking about and then go on the crusade."

There are doubts about nuclear power. And the anti-

nuclear movement has, over the past decade, done much to unmask the nuclear establishment. Gone are the days when that establishment could disregard anyone who so much as suggested that the industry was less than perfect. To a certain extent the establishment was right in its assessment of the safety of nuclear power, but it did little to convince the public. There is little point in having a perfect technology if you are too arrogant to explain it to the consumers who have to foot the bill for that technology.

The anti-nuclear movement is now a tired operation. Its criticisms have been rebutted one after another, and the leading protagonists in the movement do not have the intellectual honesty to admit that they were wrong—something that the nuclear establishment has been forced to do many times over the years. We still see the same tired old arguments trotted out, with no embellishment, and certainly with no new science.

Perhaps that is why the focus has moved to nuclear weapons, a more meaningful target for protest, depending as it does on political choices rather than technical decisions. □

The energy of protesters

The CND story
edited by John Minnion and Philip Bolsover
Allison & Busby, pp 158, £5.95, pbk £1.95

Anti-nuclear protest

by Alain Touraine et al, *Cambridge UP*, pp 202, £19.50

Nigel Calder

AFTER THEY have lynched any generals and physicists they come across, survivors of a nuclear war will have plenty to chat about over the radioactive herbal tea. Why did the most creative civilisation of all time condone its own destruction? How come that, among 10 000 pages of learned prose composed and published every second of every day, no paragraph persuaded the arms racers to let up?

The early warning system worked well enough. Albert Einstein's last public act before he died in 1955 was to sign Bertrand Russell's manifesto that said bluntly: "There lies before you the risk of universal death." The bent white cross of

the Campaign for Nuclear Disarmament, invented by Gerald Holtom of Twickenham in 1958, became a symbol of anti-military protest, worldwide. But the war gamers built public unrest into their scenarios and decided they could live with it.

The two books under review help unwittingly to show why the Reagans, Thatchers and Mitterrands (to mention incumbents only) are allowed to go on conniving with the Andropovs in keeping the nuclear arms race going. *The CND Story* is a collection of reminiscences and comments on the first 25 years of a relatively vigorous campaign against nuclear weapons, which surged in the early 1960s and again in the early

The other side of the debate

Keeping the peace
edited by Lynne Jones, *Women's Press*, pp 162, pbk £3.60
Over our dead bodies
edited by Dorothy Thompson, *Virago*, pp 253, pbk £2.95

Sheena Phillips

ALTHOUGH both of these books are collections of writings by women, they are very different contributions to the peace movement. The aim of *Keeping the Peace* is to provide "an inspiration and in some cases a practical guide to further action by others". It is a series of very direct personal accounts, well broken up with pictures and headings, of how various groups of women have organised themselves and taken action on "peace" issues. The examples range from small groups of Japanese women in their 50s and 60s disrupting military exercises, to Oxford Mothers for Nuclear Disarmament organising a walk into town.

There are also about 50 pages of practical notes on taking action, obviously built on hard-won experience: "Most partici-pants in the blockade had done no previous training and did not come in groups. Expect this. Arrange emergency training."

The unconventional political style of many women's peace groups comes across strongly. On an organisational level, for instance, these groups aim to involve as many women as possible actively—whether in

decision-making, demonstrating or running an office. Consensus is widely preferred to voting. Responsibilities are devolved. And there may be "severe growing pains".

Actions such as the encirclement of The Pentagon by women expressing Mourning, Rage, Empowerment and Defiance emphasise the emotional and physical aspects of politics. Both at The Pentagon and at Greenham, women have demonstrated that the military is inaccessible to them physically and emotionally as well as politically. A woman at Greenham said: "That action meant directly confronting these people with our bodies... with the comprehension of what violence and power mean in human terms."

"Direct actions" like these are protests about violence in general, not just about nuclear weapons. The aim of *Over our Dead Bodies* on the other hand, like CND, is to convince people on the single issue of nuclear disarmament. It is written "with a sense of urgency", and a feeling of concern pervades the book. Many of the chapters cover topics found widely elsewhere—the effects of a nuclear bombardment, civil defence, the

1980s. It is well written and even hearty in style. *Anti-Nuclear Protest*, on the other hand, is the minutes of an inquiry by "interventionist" sociologists from Paris into the unsuccessful movement of the late 1970s, which was directed against the civil nuclear power programme in France.

Most people in the industrialised world are deeply scared about nuclear war, so the task of CND is apparently simple: to translate that fear into a strident demand for nuclear disarmament. The trouble is that those who organise such movements are too self-conscious, like a man wondering what colour of tie he should wear in the lifeboat. As a result, they do not take the threat of Armageddon with the unequivocal seriousness it deserves.

They also believe they can be politically astute. CND became preoccupied with capturing the Labour Party, and succeeded three times with results less than nil. The Conservatives, who delivered the partial Test-Ban

Treaty in 1963, were subsequently able to treat the anti-nuclear vote with disdain reserved for declared opponents. "Getting boxed into the left of the Labour Party," is how Nigel Young describes the outcome.

Repeated confusion of issues—Greek democracy, Vietnam—was another symptom of self-consciousness. In the Cuba missile crisis of 1962, opinions on the merits of Fidel Castro's regime obtruded incredibly into CND's discussions, on the very brink of all-out nuclear war. More wilful has been the confusion between nuclear weapons and nuclear power programmes. John Fremlin's dismay on this score, in *The CND Story*, is labelled "an alternative view". It suits the arms racers to see anxiety about nuclear war, and the energy of protesters, diffused in opposition to power stations.

The book from France reads like a Lewis Carroll parody of self-consciousness. I shall leave to social scientists the question of whether Alain Touraine's



The voice of women campaigning for peace at Greenham Common connection between nuclear power and nuclear weapons, for example.

However, it also offers some fresh angles on the subject and, unlike many political publications, some beautiful poetry. It stresses the importance of involving non-experts in the defence debate, though the style is rather wordy for a general audience.

The authors address themselves to women in particular. Kate Soper, for instance, appeals to women on the basis of "the starkness of contrast between the event of conception and the event which irradiates the womb". But many women in the peace movement place nuclear weapons in the wider context of the military as a whole. For them, the military is

the epitome of a male institution. In fact, the unconventional practices described in *Keeping the Peace* have grown out of the women's movement as much as the peace movement: they demonstrate alternatives to the male practices established in mainstream politics as well as in the military.

Of course, women's peace groups do not speak for all women. As Hilary Wainwright observes in *Over our Dead Bodies*, women express "both extremes of patriotism and of humanitarian revulsion from war". However, *Keeping the Peace* clearly suggests that the response of the peace groups is appropriate. *Over our Dead Bodies*, in contrast, isolates the nuclear debate and gives the wider issues a lower profile. □

techniques are sound. Self-styled "agitators" create "intervention groups" of militants, urge them to recognise the "highest possible meaning" of their action, and guide them to a programme of "permanent sociology". The protest against civil nuclear power in France broke like so many waves on the rocks of Cap de la Hague, while French officials made their country the most comprehensively nuclear nation on Earth.

Touraine's conclusion? "If the anti-nuclear struggle is not yet a socio-political force, it is because it is more: the double movement of a change of culture and a transformation of the social struggles." Such rhubarb provokes sympathy for Pierre Samuel, president of the French Friends of the Earth, who declared, "I accuse Alain Touraine and his team of having driven a score of unfortunate ecologists up the wall and round the bend..."

Tragicomic pages describe the shock when one of the militants draws the distinction

between civilian and military uses of nuclear energy. A trade unionist from the plutonium separation plant at La Hague remarks that there was much more job satisfaction in the good old days when the plant was working for the Army. It turns out that some of the French militants opposed to civil nuclear power are fatalistic about nuclear weapons, or even in favour of them.

Future historians in the South Pacific may conclude that nuclear war was an inevitable consequence of the existence of nation-states, like flags and inflation. They may also judge that the few decades after the discovery of nuclear fusion gave precious little time for dismantling the nation-states, beyond the token declarations of nuclear-free zones by many cities and towns. But if these two books survive in an Auckland library, they will not contradict any Polynesian inference that the European protesters, like the generals and their political masters, were just playing games. □

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Rationality and irrationality in deterrence

The prisoners of insecurity
by Bruce Russett, *Freeman*, pp 204, £12.95, pbk £6.50
Nuclear war and nuclear peace
by G. Segal, E. Moreton, L. Freedman and J. Baylis,
Macmillan, pp 162, £17.50, pbk £5.95

James O'Connell

THREE assumptions are built into Western-Soviet nuclear deterrence. First, that rationality will prevail on both sides—or, at worst, one side will back away from the perceived irrationality of the other. Secondly, the Western alliance and the Soviet Union are locked in unremitting enmity. The third is that the existing balance of terror can continue indefinitely.

J. Baylis suggests in *Nuclear War and Nuclear Peace* that a value of the British deterrent is that the Soviets would back away before perceived British irrationality. The irrationality in this case would need to be serious indeed because Britain could use its strategic weapons only in accepting to be, or in being, destroyed. One may well shudder over the fragility of an assumption of rationality in politics, for the Falklands episode alone is a reminder of how lacking in rationality two governments were under pressure. How much rationality would prevail in a mishandled crisis when governments have for over a generation portrayed and seen one another as treacherous and advantage-taking adversaries?

One may well shudder also over the lack of historical sense in an assumption of continuing enmity. Europe and the United States have seen enough changes of alliances during the past 150 years to suggest that it seems a folly to risk global or European incineration for an inevitably temporary set of alliances—which is not to say that one must advocate immediate disarmament on one side or the other or both sides, or that a proper measure of defence is not sensible during even a temporary period of confrontation.

As to the assumption that the existing balance in deterrence will prevail, Segal *et al* especially strike me as insensitive in *Nuclear War and Nuclear Peace* to the de-stabilising effects of increasing technological change and to the search by both superpowers for first-strike capacity, not to mention proposals for fighting and winning wars.

The Prisoners of Insecurity is a readable introduction to the nuclear deterrence policies of the two superpowers. Bruce Russett sees both countries as



David Buckland

"prisoners of insecurity". He tries to see how they might escape from their prisons of fear, and he uses "the prisoners dilemma" (recently used to good effect by P. O. Bennett and M. R. Dando—*New Scientist*, 17 February, p 432). The weakness of the book is that while he deals with the pathology of confrontation, he analyses rather less well its historical context and politics.

Russett scarcely mentions the British deterrent which is after all a marginal issue for Americans, and Russett is American. On the other hand, Segal *et al* are heavily concerned with British policy and suggest that their views offer a way between "extremist positions". Much of their "argument... is with the anti-nuclear movement". They sometimes present anti-nuclear positions in forms that seem distorted and oversimplified and that neglect crucial distinctions made by others who oppose British nuclear weapons policy.

It is hard to believe their view of themselves as defending a middle way for Britain when one considers the views they hold. They favour staying in NATO as a nuclear alliance, American bases remaining, retaining Polaris and intermediate range missiles; they support bringing along Cruise and Pershing II, and they will have Trident if they have to.

They argue for stronger conventional NATO forces with a nuclear back-up—as if such forces could not spark off a nuclear intervention earlier or, even if they postponed this intervention, the end result might not be the same a little later. In the case of Europe, it surely makes sense to argue that the best policy is to maintain strong conventional forces and accept the limitations inherent

in the policy, knowing that any other policy may only defend us more surely to death.

The American author portrays the Soviet Union as a danger rather than an enemy. The British authors seem to suggest rather ineffectively that the Soviet Union is an enemy to Britain. They broadly base their case on differences of ideology and the clashes of national interest between East and West. Ideology, however, would hardly explain the long series of Soviet-Chinese tensions. They write glibly about Finland but only barely mention Yugoslavia.

They are obsessed with the danger to political stability and the Western alliance from a non-nuclear Britain. This rather overestimates the role of Britain. But they also say that a crucial reason for the British deterrent is "the retention of some capability just in case the US umbrella is ever removed". They appear at one stage to reject Lawrence Freedman's earlier published position that the best argument for British deterrent is the uncertainty of the future, but they state eventually that, even if NATO moved towards stronger conventional defence, "Britain would still require some kind of nuclear capability as an insurance against unforeseen contingencies". One could say many things about this flimsy argument for our deterrent. At least one may comment that the deterrent itself is a powerful factor in creating a more uncertain future for this island.

Segal *et al* rightly keep reminding us that nuclear weapons cannot be disinvented. For that reason, besides the threat of global destruction from the superpowers, there is another threat, proliferation—whether the spread of weapons to desperate or irresponsible governments or the acquisition of increasingly miniaturised and widely-distributed weapons by terrorist groups.

Proliferation can be coped with only through some form of global policing, which is currently impeded by the *immobilism* of the superpowers. Both these books deal weakly with proliferation and scarcely notice it. Finally, there is nothing of substance in either book on how we might take political initiatives to transcend an East-West military confrontation that is politically anachronistic and economically unreal. □

IF THERE is a single consoling thought about the prospect of nuclear war it is that the people most likely to survive it are precisely the ones who caused it. And serve them right. There could be no more fitting punishment for the military and politicians in their bunkers than to be given time to appreciate the results of their mad policies.

It is to these miscreants that John Burton's letter "*Dear Survivors...*" is addressed. Now that they've had their Third World War, what will they do next? After they have cleared up the mess (assuming, unwarrantedly, that there is anything or anyone to clear up, or that it is a mess that can be cleaned up) how will they arrange society and nations in a way that will not lead inexorably to a Fourth World War?

Dr Burton is well qualified to put such questions. During and after the Second World War he was Permanent Head of Australia's Foreign Office. He is director of the Centre for the Analysis of Conflict at the University of Kent, and has written books on

After the Third World War

Dear Survivors
by John Burton, *Pinter*, pp 137, £9, pbk £3.50

Richard Boston

international relations, conflict, terrorism and war.

He argues that the post-war reconstruction of 1945 was a failure because it aimed to return the system to "normality", the business-as-usual of the pre-war world. He says that in effect we set about to re-create the very conditions that had led to that war, and to the war of 1914-18. In doing so we inevitably, and blindly, created the conditions that must lead to the Third World War.

The questions Burton raises are of life-and-death importance to everyone. Unfortunately he conducts the discussion on a level of abstraction that makes it almost impossible to concentrate on what he is saying. His avoidance of concrete examples is almost wilful.

For example, he refers at one point to the "community means

of handling deviance as developed, for example, in Ohio (see *Time* magazine, 1980)". But Burton tells us no more about Ohio and the handling of deviance there, so his argument is advanced not at all. Unless, of course, the obedient reader works his way through a whole year's worth of *Time* magazine in the hope of finding the article Burton is thinking of. What we have here is merely another example of academics putting in bibliographical references not for enlightenment but for what they consider to look like academic respectability. And if *Time* magazine has become academically respectable, then we have come to a pretty pass. "The fact," says Dr Burton, "that universal human needs include non-material goals that are in infinite supply, opens up means of resolving apparent

zero-sum conflicts of interest, including problems of change by positive-sum outcomes and, therefore, without violence or coercion."

This either means nothing at all or something so obvious that only a social scientist would say it. If a book like this is going to have any effect it must be by being understood by non-specialists. As a fully qualified non-specialist I have tried, and as far as I can make out what Dr Burton is saying in an extremely complicated, roundabout way, is that to avoid nuclear war we must all behave more sensibly and be much nicer to one another. Somehow I feel that I knew this already. □



The nuclear debate that wasn't

these incisive shafts. Discussion then lapsed into agreeable banter about whether he watched *Yes Minister* on TV.

Curiouser still was the debate about the authority itself, which began with another critic, Professor Roger Williams, presenting a short video tape covering the AEA's 30-year history in terms almost indistinguishable from those of Hirsch's opening video tape. The two even contained one identical shot, of Sir Peter walking across a well-kept lawn at Harwell. This was followed by a plea from Williams that the authority should embrace customer-contractor principles as a spur to more rigorous criticism



Bernard Dixon

of its expenditure. To which Chief Executive Arnold Allen replied that, "we have our own very rigorous internal scrutineers". Sir Peter added further assurance ("all our programmes are looked at extremely carefully") and that was the end of that.

Even an anticipated disputation over waste handling fell terribly flat. Dr Tony Gloyne argued that the Nuclear Industry Radioactive Waste Executive should have been set up earlier—without indicating precisely the point of this criticism. He also observed that some members of the Institute of Geological Sciences were unhappy about some aspects of waste dis-

posal—again without any further details. Summarising the authority's need to locate dumping sites and dispel local apprehensions, Hirsch then concluded: "One will have to work at this slowly and gradually."

Nearly an hour of this major national debate had elapsed before anyone raised the key issue of public apprehension over nuclear power. It was independent assessor Professor Ian Fells, rather than any of the three "informed critics", who did so. Amazing. And just as extraordinary were Sir Monty Finniston's efforts to stir up his critical trio. "Come on now, don't let them off the hook," he said to Gloyne at one point. But the tactic didn't work.

There were other weaknesses in this programme—a repeated failure to explain basic science, and a use of prerecorded videos resembling the most mediocre public information films of the 1950s. But given such a rare opportunity to scrutinise an organisation employing 3000 technocrats in work of great importance and sensitivity, the major defect was a lack of spunk. The nuclear debate is not lacking in individuals who combine a command of their subject with a keenness to engage opponents in real dialogue. Why were they not represented?

To avoid the possibility of people raising their voices? If so, Channel 4 chiefs should take that tiny risk next time. This bland and polite affair was really no debate at all. □

This week's contributors

Sir Frederick Dainton FRS is chairman of the National Radiological Protection Board.

Joseph Rotblat was founder of the Pugwash Conference on Science and World Affairs.

Frank Barnaby is former director of SIPRI and guest professor of peace studies at the Free University of Amsterdam.

John Humphrey is chairman of the Medical Campaign Against Nuclear Weapons.

Ross Hesketh is a physicist with an interest in isotopic separation in solids and gases.

Philip Gummatt lectures on the politics and technology of nuclear weapons in the Department of Liberal Studies in Science, Manchester.

Lawrence Freedman is professor of war studies at King's College, London.

William Walker is with the Science Policy Research Unit at Sussex University.

Nigel Calder, author of *Nuclear Nightmares*, was editor of *New Scientist* 1962-66. He was press officer of the Aldermaston Marches, 1959-62.

Sheena Phillips is a member of the Armament and Disarmament Information Unit at SPRU, Sussex.

James O'Connell is pro-vice-chancellor and professor of peace studies at University of Bradford.

Richard Boston is editor of *Quarto* and edited *The Vole* until 1980.

FORUM

When is a scientist most productive?

Tony Jones has been thinking about the age of science

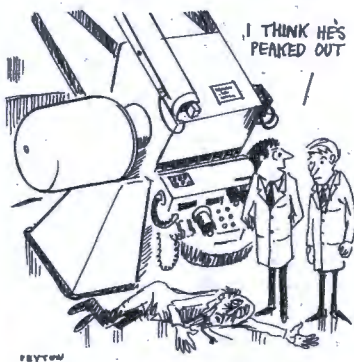
HAVE you passed your peak? Is your brief blossoming of youthful brilliance giving way to a sad slide into intellectual torpor? In short, are you over 30? If so, listen to Helmut Abt, the managing editor of the *Astrophysical Journal*. The most productive years of an astronomer's life may be in middle and old age, he says, and he has hard evidence to back him up (*Publications of the Astronomical Society of the Pacific*, vol 95, p 113).

But first, how can one measure the productivity of a scientist? Not by the hours he works, certainly, nor even by the number of papers he writes. Abt's unit of productivity is the "citation". In their published work, scientists conventionally make references (citations) to the papers of other scientists whose work is relevant to their own. The more citations a paper receives in the literature, the more useful it has been to other scientists. On this restricted definition, the most productive scientists are those who receive the most citations.

Abt selected 22 "outstanding" American astronomers who had retired by 1970, and examined the number of citations made during the years 1970-1979 to their life's work. His source was the *Science Citation Index*, a voluminous index to scientific papers cross-referenced with their citations. In those 10 years the 22 astronomers were cited on 9400 occasions. Abt grouped these citations according to the age of the astronomer when the cited paper was published, and applied a statistical correction to allow for the fall-off in citation rate since publication. (In an earlier study Abt found that papers received fewer and fewer citations as they became older. On average, a highly-cited paper has a

Popular Maths

PERSPECTIVE and probability are the two topics the London Mathematical Society has chosen to present to the public this year. This august body, whose lectures are usually aimed at a select group of professional mathematicians, is for the second year running offering a more tempting mathematical menu to a public that seems ravenous for more. The society hopes the "Evening of popular lectures" will become an annual event, "contributing directly to the culture of this country" in the words of Susan Oakes, the society's administrative assistant. The lectures are free and are being held on Friday, 8 July at 7.30 pm in the Mechanical Engineering Lecture Theatre at Imperial College, London. Anyone wishing to listen to Professor D. Williams from Swansea expound on the mathematics of probability ("Hopping mad"), and Professor E. C. Zeeman from Warwick discuss the discovery of perspective in the Renaissance, should write for tickets to Susan Oakes, London Mathematical Society, Burlington House, Piccadilly, London W1V 0NL. □



"half-life" of somewhere in the region of 24 years.)

Abt's findings are surprising. Work published between the ages of 30 and 75 is cited the most and accounts for 94 per cent of all citations, while the years 40-70 account for 70 per cent. An average "outstanding American astronomer" is in his early fifties before he is half-way through his productive career.

Why should this be so? One notes that this study excludes the "truly revolutionary

scientist", because there are too few for statistical analysis. (Abt doubts whether the United States has produced even one such astronomer this century.) Nevertheless, says Abt, brilliant intuitive leaps are only one way of advancing astronomy. Others include the painstaking collection of data for statistical analysis, the chance discovery of new objects, the securing of measurements at the limits of our technical ability, and the synthesis of new hypotheses from diverse observations. Few of these are the prerogative of the young. In particular, increasing age brings increasing job security (or it used to), and astronomers then have the time and resources to embark on major, long-term projects which are likely to yield important results. Also, older scientists tend to write review papers which summarise work done by others over a broad field, and which attract many citations.

Of course, not everyone agrees that a scientist's work can be fairly evaluated in this way (especially one's own work). Much has been said here and elsewhere on this and now is not the right time to "re-cite" the rights and wrongs of citation analysis. Life is short, and there is science to be done! □

Dr Tony Jones is in the Astronomy Department at Manchester University.

Candidates on the couch

Daniel S. Greenberg examines some presidential symptoms

THE TROUBLE with the recurring suggestion of psychiatric examinations for presidential candidates is that the types who traditionally pursue the presidency are not likely to fare too well by the standards of Freud and Rorschach.

Perhaps that is all to the good, and a shrink barrier should be added to the many others that guard the road to the White House, as Dr Marvin Greenblatt, a psychiatrist from the University of California at Los Angeles, recently proposed to the American Psychiatric Association. But if the idea is put into practice, we might be left with an insoluble problem: Where to find candidates who can pass psychiatric muster?

Consider, for example, that anyone seriously committed to becoming president must necessarily feel an enthusiasm for being the most powerful and important person in the world. Colossal egotism, even megalomania, are as integral to the pursuit of the presidency as feigned enthusiasm for the local grub and surrounding countryside and for plunging into crushing crowds to shake as may hands as possible. That is the nature of modern presidential campaigning, and anyone too delicate for the course had better settle for other work. But behind the double doors of psychiatric suites, any candidate who honestly discusses the obsessively sought after goal

and the required means for reaching it is going to inspire rapid scribbling in the doctor's notebook.

The presidential examiners might also see suspicious symptoms in several complaints common to all White House aspirants, and many officially certified psychiatric patients. Thus, anyone who repeatedly insists that he is the victim of lies and that his words are constantly and deliberately twisted by conspiring enemies would instantly set off psychiatric alarms. But all presidential candidates insist that they are the victims of lies and misrepresentations. It is a rare candidate in this era who does not at one time or another proclaim something along the lines of, "Even if my opponent stops lying about me, I'll continue to tell the truth about him."

Psychiatric tests for a president seeking re-election would present special problems, because there is nothing like a term in the White House for inciting paranoia. At about the two-year mark, the incumbent becomes persuaded that his precious secrets are being pilfered, usually by henchmen of known enemies, but sometimes by trusted friends. Feeling abused and desperate—symptoms of interest in psychiatric diagnosis—he lashes out at these unseen betrayers, and even demands lie-detector tests to find the culprits. The press invariably

responds with infuriating ridicule.

The incumbent also gets the feeling that the mangle that the press inflicted on his words when he was a candidate is nothing compared with the systematic misrepresentation to which he has been subjected as president. And he finds the press picking on his wife, closest relatives, and oldest

friends—people who ordinarily could not get into the papers with the aid of the costliest public relations counsel, but who suddenly acquire wicked celebrity because of their link to the president. Psychiatric tests for presidential candidates? It is a Catch 22 situation: The kind of people who run for the office could never pass. □

Laser weapons misses the point

Jeff Hecht believes an American press campaign is off-target

NEWSPAPER articles in the United States have alleged that physicist Edward Teller may have used information he learned as an advisor to President Ronald Reagan to help manipulate the price of the stock of a small Californian company involved in laser development. The reports, which first appeared in the *New York Times*, seem off target in charging Teller with the manipulation of stock dealings. They also fail to notice a larger trend of which Teller is only a part: the growing number of prominent scientists lending their names to corporations by serving as directors, but who have only minimal involvement in the company's activities.

Teller is alleged to have had advance knowledge of President Reagan's advocacy of ballistic missile defence in his speech of 23 March (*New Scientist*, 31 March, p 871), and to have used that knowledge to influence the price of the stock of Helionetics Inc. Teller was summoned from the West Coast to the White House for the speech. He says he did not know the planned content of the speech until two hours before it was given. He owns stock in Helionetics and is a director of the company, but he says that he purchased it during the company's formative years

Other side of the Wall

OUR MAN at a recent international geological meeting in Berlin claims that his most endearing recollection of the event was when delegates were given the afternoon off in East Berlin. Getting through Check Point Charlie with a band of Americans, most of whom had German-sounding names, our man says... was memorable enough—it set the frontier guards a jitter, treble-checking everything. But that aside, the great moment came at the famous Pergamon Museum where the delegates were confronted by the splendid Altar of Zeus, rescued by an earlier generation of German archaeologists. Well, our man was facing it, but the workshop geologists were on their hands and knees before the Altar, exploring some excellent red Devonian marble flagstones rich in fossils. □



Teller—father of the "Super Bomb"

communicate with submerged submarines, not to zap Soviet intercontinental ballistic missiles. Helionetics, according to its annual report, is also working on techniques to produce "high-energy X-rays for

when Jimmy Carter was president. Teller vehemently denies having bought or sold Helionetics stock since then, or that the stock was payment for him to use his influence in Washington.

Any suggestion of a connection between Helionetics and the development of laser defence against ballistic missiles seems rather fanciful. The company does build lasers, and is working on a military contract to build a new type of laser for use in space. But that type of laser would be used to

communicate with submerged submarines, not to zap Soviet intercontinental ballistic missiles. Helionetics, according to its annual report, is also working on techniques to produce "high-energy X-rays for

Pithy gag competition

What scientists and engineers think of each other

WE ASKED for witty gags about scientists and engineers in which they give away their professions through their responses to "everyday situations" (*Forum*, 28 April, p 239).

The prize for the best-known joke goes to David Poyner of Harlow in Essex (three other readers sent in versions of the same story but Poyner's was the most pithy):

● Three scientists were travelling together from London to attend a conference in Edinburgh. Shortly after crossing the border, they saw a black sheep.

"How interesting," the astronomer remarked. "All sheep in Scotland are black."

"An unwarranted inference," the physicist replied. "We can conclude only that some sheep in Scotland are black."

"All we can be really sure of," the logician said, "is that at least one sheep in Scotland is black on at least one side."

Our next favourite came from R. Wood, who works in Wembley, Middlesex:

● A Texan tycoon became increasingly nervous of air travel. In this modern era of terrorism, he reasoned, it was only a matter of time before he, a regular passenger, boarded an aircraft which carried a bomb or a hijacker. Being a technocrat, however, he decided to collect further data. He summoned his chief engineer and strategic

research applications", but that is an idea far from the X-ray laser battle stations that Teller has advocated for missile defence (*New Scientist*, vol 96, p 728). Teller says there is no connection planned or in existence between Helionetics and the supersecret X-ray weapon programme at the Lawrence Livermore National Laboratory.

The connections between Helionetics and President Reagan's missile defence proposal appear to be the creation of fertile imaginations on Wall Street which noted Teller's connection with both. That seems to be part of a trend on Wall Street to look for the names of prominent scientists among directors of small new companies. The presence of a scientific "superstar" on a board of directors can multiply the amount of money a new high-technology company can raise on the stock market by a factor of four or five, claim authorities on industrial finance. Investors tend to be impressed by companies which can drop prominent scientific names.

That trend would be understandable if the big-name scientists were active in the companies, but often they retain their full-time academic jobs and serve only a nominal advisory role as a director. In some instances, the company's activities don't even lie in the superstar's primary field of expertise. Teller's relationship with Helionetics is a case in point; his main speciality is in nuclear physics, while the company is involved in laser development, solar cells, electronic power supplies, and sonar. Although nominally retired, Teller keeps busy with activities other than Helionetics. Jeffrey Levatter, president of the company's laser division, says that "Teller makes no technical contributions." □

IT'S EXTRAORDINARY - A FUNNY THING HAPPENED ON THE WAY TO THE LAB. TODAY.



planner. "What," he asked them, "are the odds of my stepping aboard a plane which also carries a bomb or a hijacker?"

Three days later they delivered their answer: 312 547 to 1.

"And what can I do to improve those odds?" he enquired further.

"Well, sir," explained the chief engineer, "we calculate that if you were to carry your own bomb aboard, the odds of there being another bomb or a hijacker on the same plane are in the neighbourhood of 28 million to one."

Paul Dawson of London (who also sent in a version of the black sheep gag), gave us a subtle insight into the minds of mathematicians:

● A physicist and a mathematician were each given an identical pair of problems. In the first, each was locked in a room with a burning wastepaper basket, an empty bucket and a tap. Both the mathematician and the physicist filled the bucket of water from the tap, and used this to put out the fire.

In the second problem each was locked in a room with a burning wastepaper basket, a tap, and a full bucket of water. The physicist poured the bucket of water over the burning wastepaper basket to extinguish the fire. The mathematician emptied the bucket of water on to the floor, thus reducing the problem to the previous one.

But our top scorer came from I. Snell of Bell Aerospace in Buffalo, New York State: ● "What is 2+2?"

An accountant will tell you that the answer is, of course, exactly four.

Scientists and engineers will explain that they have studied the problem carefully, and that there is good evidence to suggest that the answer lies between three and five.

On the other hand a psychologist, after studying you intently for a long period will respond: "Why are you asking these questions? Why do you want to know these things?"

While we enjoyed the stories, and not to detract from the glory of our winners, we were disappointed to hear so few original gags. In the vein of the scientists described by David Poyner, we are tempted to speculate that there is little humour in science and technology. But perhaps we won't because we aren't guess what the logician might make of it □

... and more jokes

STRANGE how some people enjoy Spoking fun at the rather sad prospect of having your research grant either turned down or cut. At the moment there seems to be a plethora of jokes about the subject.

At a recent meeting of the Association of Researchers in Medicine and Science, a pressure group to stop contract labour in universities, Sir Monty Finiston, who introduced himself as "a scientist by profession, a technologist by adoption and an industrialist by accident," related one such story. It was about someone called God who applied for a grant to create the Universe. Unfortunately he/she was turned down by the relevant research council on the grounds that the application was too old. He had not repeated the experiment before; and, moreover, a book had been written on the subject.

Not to be outdone, Dr J. B. Wyngaarden, from the National Institutes of Health in the US, compared the stringencies of the American grants system to a "big grizzly" chasing after a couple of academics who are on a hiking holiday. One of them stops to take off his hiking boots and put on his running shoes.

"Don't be silly," says the other, "you can't outrun a grizzly." "It's not the grizzly I'm outrunning," said the other, "it's you." □

A monument to mountain meteorology

Jim Barton and Marjory Roy have high hopes for this month's Scottish celebrations



A CENTURY

ago a small community began living on top of Britain's highest mountain, Ben Nevis. They manned a meteorological observatory that functioned for more than 20 years, building up hour by hour a picture of a climate at times as severe as anything recorded on much greater mountains elsewhere. In 1904, the lack of funds and an unsympathetic government forced the observatory to be closed. Nowadays the work of that pioneering observatory is to some extent continued by a purpose-built automatic weather station on top of Cairn Gorm, 50 miles east of Ben Nevis. This modern counterpart, designed and built by the Physics Department at Heriot-Watt University with funds from the Natural Environment Research Council, was installed in 1977.

Meteorology was still in its infancy in the 1880s, although inventions such as the electric telegraph were of crucial importance to forecasters in gathering observations together quickly. The forecasters would analyse weather data by drawing synoptic charts—such charts had been displayed in Britain for the first time at the Great Exhibition of 1851. The public soon became aware of a scientific, as opposed to a fatalistic, attitude of weather with the introduction of daily forecasts in national newspapers. The proposal to build a mountain-top observatory stemmed from scientific curiosity about the higher atmosphere, championed among others by Sir William Thomson, later Lord Kelvin, and also from a desire for Britain to keep up

with other countries: Europe and North America had already built several high-level stations. The observations from Ben Nevis and Cairn Gorm will fittingly be brought together this summer, when the Scottish Centre of the Royal Meteorological Society celebrates the centenary of the building of the Ben Nevis observatory with a two-day event in the Fort William area. After a series of talks on various aspects of mountain weather, those with enough energy and enthusiasm will rise before 5 am on 25 June and retrace the steps of the extraordinary Clement Wragge and his assistants. Wragge and his colleagues, had climbed Ben Nevis almost daily in the summers of 1881-83 to read his instruments before the observatory was built by the Scottish Meteorological Society.

An intriguing picture unfolds from the neatly written pages of the Ben Nevis logbooks. Not only did the hardy observers have the winter weather to contend with, but also a constant stream of tourists during the summer months. Only extreme events, such as fire caused by lightning (19 June, 1895), would interrupt the hourly observations of pressure, dry- and wet-bulb temperature, wind speed and direction, type and amount of both cloud and precipitation, and duration of sunshine. The observers had to put up with their hair hissing and glowing with St Elmo's fire during thundery conditions. It happened so frequently that they came to accept it as normal. Observations for comparison were made

at Fort William, only 5 miles away but close to sea level.

The main problem with mountain observations is the formation of ice on the instruments. Because Britain lies on the track of frontal depressions moving across the Atlantic, mountain tops are often shrouded in hill fog at temperatures around freezing point. Ice, or rime as it is properly called, can build up to several feet thick on exposed instruments. With the limited technology that the Victorians had, they were unable to record observations automatically in these conditions.

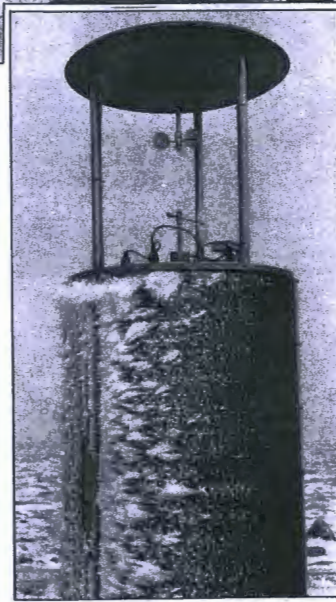
On Cairn Gorm a different solution had to be found. Although mains power was available at the summit in a hut built to house rescue radio equipment, this was insufficient to keep conventional automatic instruments free from ice by heating them electrically. The station run by Heriot-Watt University is therefore hidden away inside an insulated container except for a 3-minute period every half-hour, when the instrument platform is automatically opened. After 3 minutes, the readings of mean wind speed and gust, wind direction and temperatures are logged and the station closes until the next observation is due.

Over six years the automatic recording equipment has been opened and closed some 85 000 times and an archive of meteorological data has been built up. Cairn Gorm, like Ben Nevis, can produce extreme weather: on 17 January this year wind speed reached 124 mph (with gusts of

up to 141 mph) with an air temperature of -6°C.

The Royal Society of Edinburgh published the Ben Nevis observations and they provide a valuable and detailed record of mountain weather in the west of Scotland. The observatory staff, Alexander Buchan, the distinguished Secretary of the Scottish Meteorological Society, and others analysed the data in an attempt to determine weather patterns. However, the Meteorological Office forecasters of the day appear to have made no attempt to utilise the Ben Nevis data when framing their forecasts, or their forecasting rules. In fact, the offer of regular telegrams from the summit was not taken up—on the grounds of cost—although Ben Nevis readings were published daily in the principal Scottish newspapers and telegram observations were sent to the German Meteorological Office.

It is a great pity that the summit observations were not received more enthusiastically in London, because before wireless telegraphy there were no immediate observations from ships at sea. A systematic comparison between Fort William and the summit might have yielded clues to the three-dimensional structure of warm and cold fronts. It fell to the Norwegian meteorologists during the First World War to put forward the model of frontal depressions—those features that so dominate our British weather and which should be familiar to anyone who watches the TV weather man and his maps.



Ben Nevis observatory in winter (top) and the Heriot-Watt's automatic station, Cairn Gorm

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up to 141 mph) with an air temperature of -6°C.

The Royal Society of Edinburgh published the Ben Nevis observations and they provide a valuable and detailed record of mountain weather in the west of Scotland. The observatory staff, Alexander Buchan, the distinguished Secretary of the Scottish Meteorological Society, and others analysed the data in an attempt to determine weather patterns. However, the Meteorological Office forecasters of the day appear to have made no attempt to utilise the Ben Nevis data when framing their forecasts, or their forecasting rules. In fact, the offer of regular telegrams from the summit was not taken up—on the grounds of cost—although Ben Nevis readings were published daily in the principal Scottish newspapers and telegram observations were sent to the German Meteorological Office.

It is a great pity that the summit observations were not received more enthusiastically in London, because before wireless telegraphy there were no immediate observations from ships at sea. A systematic comparison between Fort William and the summit might have yielded clues to the three-dimensional structure of warm and cold fronts. It fell to the Norwegian meteorologists during the First World War to put forward the model of frontal depressions—those features that so dominate our British weather and which should be familiar to anyone who watches the TV weather man and his maps.

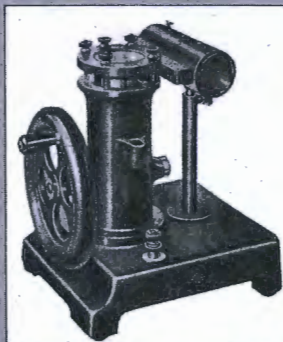
Was it of any use?

"WE HAD to face so often and in such various ways, the question 'Is it any use?'" claimed the director of the Meteorological Office, Sir Napier Shaw, when writing about the Ben Nevis observatory at the beginning of the century. "The real question," Sir Napier went on to add, was "Does the work stimulate that devotion to the extension of knowledge and the widening of our horizons, which are always the characteristics of scientific work? If it does, utility will manifest itself in more ways than one."

Charles Thomson Rees Wilson spent a fortnight on Ben Nevis in the autumn of 1894 working at the meteorological observatory, many years later he recalled (*Weather*, 1954, vol 9, p 309) the influence that the visit had on his work. When he stood at the edge of the great corrie he was excited to observe his shadow cast on wisps of cloud below him. And surrounding his shadow were brilliant coloured rings of light, or "glories". Wilson resolved to study the effect.

To imitate the "glories" in the laboratory, Wilson produced a cloud by suddenly expanding, and so cooling, moist air in a vessel. He noticed that the clouds formed at points and not everywhere at once. Sir J. J. Thomson suggested that the points might be electrons. Wilson was able to show that electrons and charged particles created wispy tracks of condensed water in his apparatus.

From these experiments emerged the famous Wilson cloud chamber. Lord Rutherford and Wilson soon found that they could infer much about the nature of the particles from the tracks produced in the cloud chamber. Their research set many other physicists exploring a host of atomic particles. Equally important though was Wilson's own work on condensation and especially his monumental contributions to the subjects of atmospheric electricity and the mechanism of thunderstorms. All said, the work more than confirms the use of the Ben Nevis Observatory. □



Tracks become visible in the glass chamber when this early machine is cranked

MEANINGLESS (ENIGMAS was 2079364, which is one of the interesting class of "curtailable" squares).

If the Ben Nevis data (containing more than two million values of the different weather elements) can be put on computer file, more ambitious analyses would become feasible. Potentially there is much useful information to be deduced from the old observations plus the recent Cairn Gorm data by using modern meteorological modelling techniques. Observations from Cairn Gorm are now being sent in real time by way of a microcomputer at Heriot-Watt to the Glasgow Weather Centre for evaluation of the use of such observations in mountain area forecasting. With the recent opening of the Meteorological Office's manned station in Aviemore, there again exists an opportunity to record the often dramatic contrast between summit and valley weather in the small but rugged mountains of Scotland. □

Dr Jim Barton is a member of the Department of Physics, Heriot-Watt University and Marjory Roy is superintendent of the Edinburgh Meteorological Office.

Naval intelligence

SUB-LIEUTENANT Ian Watson, by landing his Harrier on a Spanish freighter, may have set a trend that the Royal Navy will regret. We hear a scurrilous rumour that the British Polaris missile than ran amok while being tested at Cape Canaveral last week has a highly secret "intelligent" guidance system, that attempts to recreate the decision making ability of the human brain—artificial intelligence in the jargon. The rumour is that the missile's brain decided it was not going to be outdone by Sub Lt Watson and tried to land the missile on a Russian trawler that happened to be nearby. □

ENIGMA

No 216

Point to point
By Susan Denham

AS a challenging geometry puzzle, I asked my son to mark a prescribed number of points on a piece of paper, no three of them being in a straight line, and then to join each of the points to each of the others by straight lines. I knew by my choice of the number of points that he would not be able to do this without at least two of these lines crossing.

But I asked him to do it with some of his lines drawn in red and the rest drawn in blue, and in such a way that it would be impossible to find a red triangle or a blue triangle in the whole configuration. This he managed.

How many points had I asked him to draw?

A £5 book token will be awarded to the sender of the first correct solution opened on Thursday, 30 June. Please send entries to Enigma No 216, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 213, Enigma square was S. S. Marway of London

Answer to Enigma 213

Enigma's square

MEANINGLESS (ENIGMAS was 2079364, which is one of the interesting class of "curtailable" squares).

Rampant scientist

Milton Love believes that a little creative reconstruction could go a long way in science

HE CAME into my office and said, "I see you are writing for *New Scientist*."

Visibly preening, I agreed I had written a couple of pieces for the magazine.

"When are you going to write for a big, important number?"

Feathers drooping noticeably, I said, "What do you mean?"

He brought out one of those thick, glossy publications which litter the newsstands. "How are you going to achieve the international recognition you deserve by writing for the Attic of Journalism? You should be submitting items to *Cosmopolitan Playboy-hustler*."

Pointing to the titles of the articles on the cover he said, "Now here's what sells magazines."

I read the first title—"The Brooklyn proctologist's weight-off diet."

"No, no, below that."

"Creative divorce through yoga?"

"Not that one."

"Making friends through intimidation?"

"The last one on the left."

"What to tell your dog about sex."

"That's it! Sex! That's what sells magazines."

"Gee, the truth is I have never owned a dog and, well, I'm not sure I would know what to tell a dog about sex. Don't they just sort of . . . pick it up on their own?"

He sighed. "I am suggesting that, if you insist on writing for that rag, you can at least try to raise its circulation."

Sadly, there is truth in his words. Science is not sexy.

This is not to say that scientists have not studied sex in all its myriad incarnations. Indeed, few are the reproductive organs not measured, minced, manipulated or attached to all manner of recondite electrical instrumentation. Then, too, there are the uncounted researchers busily filming the sexual displays of the grouse, documenting the mating call of the timber wolf and recording the assorted moans, gasps and wheezes of the rather Bohemian couple next door.

Nor is it fair to imply that scientists have not practiced what they have preached. There are numerous, well-documented studies indicating that a significant percentage of scientists have engaged in sexual activity of one sort or another, at one



time or another, with one species or another.

Thus, science and scientists do not lack for substance—we fairly reek of it. Rather, our image is depauperate, not conjuring up the slightest degree of concupiscence—a sorry state indeed, when even advertisements for housing insulation are suggestive enough to drive one to a cold shower. Fortunately, there are a number of ways we might bump and grind our way into the sensual 1980s.

There are any number of physical improvements guaranteed to lend certain sexual allure to even the most retrogressive researcher. For example, codpieces could quickly become the essential accoutrement of every lab coat. Cool, padded and protruding, these would give an enhanced portrait of vigor and prowess, immediately changing the public's perceptions. Indeed, by using real cods, the misgivings of even the most conservative researchers will be assuaged. If it works for the Rolling Stones, it will work for Linus Pauling.

The virtually mythic Edward Teller has reached public stardom entirely on the basis of his eyebrows. Black and robust, reaching virtually unimpeded from ear to ear, they fairly scream of the testosterone coursing rampant through his veins. Teller's are sufficiently bushy and convoluted to have entrapped a majority of Napoleon's forces at Austerlitz.

Reflections on the present day

THE DAILY MIRROR proudly launched its "Day 1 of a vital series: Waste of a nation" on 1 June. The eye-catching display on the famous page 3 depicted an anywhere picture of Britain tumbling down before us. And the Iron Lady herself could only look on with a tinge of shame. But there, in the background, was a way ahead, and one that didn't resort to U-turn. A dose of tonic prized for its energy-giving values was well placed to hint at recovery. But recovery from what? Hitherto we believed that there was no known cure for the gay Western epidemic. □

Fortunately, while it is true that codpieces are most applicable to male scientists (though this should not preclude females from giving them a try), nearly everyone has eyebrows. The judicious use of hair transplants from more hirsute regions will allow all to approximate the lush growth of our premier sex symbol.

The press is our conduit to the laity and science has been notoriously lax in manipulating this most plastic of industries. For instance, scientific journals might change format to one more interesting and stimulating to the general public. *Nature* or *Science* might emulate the fabulously successful tabloids, luring to its pages thousands of sensation-seeking readers. By artfully changing a paper's title (and including numerous photographs of scantily-clad lab technicians), journals would gain a certain cachet missing today. For instance, "Autoradiographic evidence for a calcitonin receptor on testicular Leydig cells" (*Science*, vol 216, p 735) is much more spicy as: "Women! Here's that 'certain something' men want and need!" Or "Female moorhens compete for small fat males" (*Science*, vol 220, p 413) takes on a new aura as "Fatties do it more!"

Even more important than the title is the form in which the information is disseminated. As an example, here is an excerpt from "Bovine and mouse hybridomas that secrete bovine immunoglobulin G₁" (*Science*, vol 220, p 522). "We report here the interspecific fusion of a mouse hybridoma with normal bovine spleen cells, resulting in stable hybrid cell lines that secrete monoclonal bovine Ig molecules. Interspecific hybridomas were produced because HAT (hypoxanthine, aminopterin, thymidine)-sensitive bovine myeloma cell lines are not available."

Let us see what a bit of creative reconstruction might create:

"She disrobed slowly, draping her lab coat artlessly across the centrifuge. Her perfect, pink bee-stung tongue formed little O's around her lips. 'We've done it, you know,' she whispered. 'We've produced an interspecific fusion of normal bovine cells with a mouse hybridoma.'

"He glanced up from the bed, his eyes smouldering beneath sex-drugged lids. Sipping his Manzanillo Ten-Star Tequila he grunted, 'That cell line is a stable hybrid. They're secreting monoclonal bovine Ig molecules.'

"Maddened by desire, she ran her fingers through the thick black mat of hair on his chest 'Why?', she pleaded, 'Why produce an interspecific hybridoma?'

"He laughed savagely as he pulled her toward him. 'Because HAT (hypoxanthine, aminopterin, thymidine)-sensitive bovine myeloma cell lines are not available.'

"I am," she murmured.

Note the subtle difference in tone between the two papers.

I can but hope that this message will be an inspiration for my associates. I trust that the day is near when Francis Crick, having declaimed at length, will be pursued out of the lecture hall by hundreds of groupies, artlessly ripping at his clothing and making lewd, though admittedly fascinating, proposals. □

Milton Love writes from the Department of Biology, Occidental College, Los Angeles, California.

LETTERS

Literate engineers

I see it all, the boredom of the general election has got through to Bernard Dixon (Forum, 26 May, p 572) so he feels obliged to go and kick a few engineers.

In many engineering disciplines the technology changes so fast that specialised books are often out of date before they are published. So in these instances the answer for the information seeker is the journal, but even here the number of journals is so large that an information officer is required to sort out the chaff from the corn. Hence the journals do not have to waste time reviewing books and the engineer does not have to clutter up his office with same. The main victims of this situation of course are the truly marginally literate who use bookshelf capacity as a means of assessing intelligence.

With the vampire UGC cutting and sucking the "old blood" from the technological universities in favour of "new blood" from the old school tie, it is a wonder that we produce graduate engineers who can solder two pieces of wire together let alone use joined-up writing. It is the aim of the engineer to produce script which is unambiguous and not like Bernard's article with its "who can produce decent English" and "rather conclusively".

Engineers appreciate the type of script that one often sees from journalists and therefore I suggest that the advert about which Bernard writes was aimed at journalists who have not read the excellent editorial in the same issue of *New Scientist*.

However, I am glad to see that "The inevitable process of decay through which all empires pass when the fire and rhythm of speech is neglected for grammar and spelling" is not supported by the *New Scientist*. (There is an advertisement for the University of Sheffield in the same edition!)

Lorraine Tynons
Biggin Hill
Kent TN16 3HG



Dirty play

Roy Fuller fails to do justice to the vast range of health hazards surrounding the cricketer (Letters, 2 June, p 649).

He makes no mention of the unmentionable—cow pats on the village outfield, dog excreta on the public park outfield, swan, seagull and ducks (no pun intended) droppings on the riverside outfield.

I shudder to contemplate the consequences of this correspondence being read by the Health and Safety Executive. Will that august body lay down rules for the professional cricketer involving the necessity for pre-match inspections of the ground (don't forget the need for extensive chemical analysis for traces of 2,4,5-T, paraquat etc etc).

They might even insist that after every delivery the ball should be carefully sealed in a plastic bag and removed for decontamination or even incineration!

This, however, seems like a lot of balls.
Vincent A. Kelly
Caversham, Reading

Freedom to talk

Quite honestly, I do not see why Jeremy Cherfas makes of much fuss about one lecture of Fred Hoyle (Forum, 19 May, p 486).

OK, Fred Hoyle got his facts wrong. But, first, Darwin's *Origin* should not be taken as Holy Script, especially in the light of Francis

Hitching's recently published book *The Neck of the Gaffe—Where Darwin Went Wrong*.

Secondly, other scientific celebrations were known to err—even in their own field! For example, Jacques Monod's description of evolution in his book *Chance and Necessity* follows obsolete ideas of mutationism. And Abdus Salam put forward his theory of left-right symmetry violation connected with massless particles, although Rudolph Peierls said he did not believe that left-right symmetry could be violated in weak nuclear forces at all. Even Wolfgang Pauli told Salam to think of "something better".

If the mentioned people found it difficult to believe something in their own field, why could not Fred Hoyle, an astrophysicist, have similar difficulties in the field he is not quite at home with? Why does he have to be put on the pillory because he admits his beliefs publicly?

What I see as far more important is the freedom—everybody is entitled to one's belief or disbelief, whether one has been knighted or not, or became FRS. And everybody should be free to talk what one believes and not be stoned or burned at the stake for it!

Igor Fodor
West Germany

Etna eruption

Debra MacKenzie suggested that the attempt to divert a lava flow on Mount Etna might have been jeopardised by the fact that I and my colleagues had to return from Actua, owing to lack of funds, before the eruption finished, and that our continued collection of data about the flow was important to the diversion attempt (This Week, 12 May, p 359). This was not the case.

The diversion technique used by Italian scientists and engineers has been discussed among volcanologists for many decades and diversion attempts using similar principles were used in

Hawaii during the 1935 and 1942 eruptions. Our work on Etna, funded by the Royal Society and the Natural Environment Research Council (NERC), was to make a particular set of observations on lava rheology and flow field development. Although of relevance to developing new ideas for protecting property from flows, the success or failure of the present diversion attempt did not depend on our observations.

We are grateful to the officers of the Royal Society and the NERC for their help and prompt action in making available the funds requested thus allowing us to complete our work successfully.
J. E. Guest
Department of Physics & Astronomy
University College
London WC1E 6BT

Hybrid joke

The genie is now out of the retort, it would seem. Far from being mere foolish figments of your April imagination (Monitor, 31 March, p 888), Messrs William Wimpey and Barry MacDonald are very much alive and now giving interviews to journalists from the Brazilian news magazine *Veja* (27 April, p 84), about their exciting new beef-tomato hybrids. At least one Brazilian biologist is impressed that the German biologists have "altered the course of natural law". The joke is now on whom?

Joao Ferraz
Stephen de Looze
Freiburg i. Br.
West Germany

Pressure-tube reactors

Roger Milne and Fred Pearce in their article "Why Britain said no CANDU" (This Week, 2 June, p 614), do not seem to realise that, using ordinary water both as the coolant and, separately, as the moderator, a nuclear reactor of the pressure-tube type will work perfectly well, though it would probably be necessary to use

GRIMBLETON DOWN



Bill Tidy

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enriched fuel. If, however, suitable adjustments were made to the size of the "pile" enrichment of the fuel might not be necessary.

Such a pressure-tube reactor (PTR) would not require the use of expensive heavy water so that Britain's inability readily to supply this would not matter. Using existing technology, a PTR would be easier to construct and probably cheaper than a pressurised-water reactor (PWR). It would be safer and what is most important the public could have confidence in its safety in view of the Canadian experience with the similar CANDU. After all the former chief scientific adviser to the government has fairly recently written that the methods of testing the safety of the PWR pressure vessel need to be improved by a factor of 10 before its safety reaches an acceptable level. Should the containment of a PTR suffer damage, it can be repaired more easily than that of a PWR.

Furthermore, what is a considerable advantage, a PTR can be refuelled without being shut down which a PWR cannot be. No doubt British Aerospace would welcome another order for the necessary machinery which would be the same as supplied for the original CANDU. Now is the time for investigating the advantage of a pressure-tube reactor using ordinary water both as coolant and, separately as moderator.
*H. O. Worgor
 Ewell, Epsom, Surrey*

Molecular drive

My attention has been drawn belatedly to J. Grehan's comments (Letters, vol 97, p 678) on Gail Vines's article on "Molecular drive: a third force in evolution" (vol 96, p 664).

Grehan mistakenly equates molecular drive with another concept called orthogenesis. There are no biological similarities between the two concepts. Their only common ground is in the use of the word "internal".

Orthogenesis refers to internal laws of growth which are based on the supposedly limiting set of interactions between components of cells and tissues during development. Molecular drive refers to internal processes of turnover (gene conversion, unequal exchange, transposition) in multigene and non-genic families of DNA that are able to influence the spread of mutations.

If any such changes in the genetic composition of multigene families were to affect the particular proteins involved with cellular interactions and thus to affect the laws of growth, then there is conceivably an indirect connection between the two phenomena. However, natural selection acting on phenotypic variation due to single-copy genes could also provide this link.

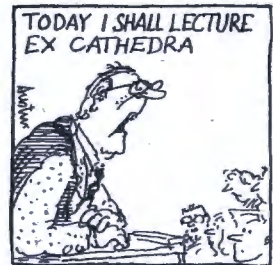
The detailed molecular background against which I use the word internal, and to which Vines correctly refers, is in the original article (*Nature*, vol 299, p 111).

*G. A. Dover
 Department of Genetics
 University of Cambridge*

Extra dimension

Paul Davies's review of John Polkinghorne's excellent book *The Way the World Is* (2 June, p 638) is remarkable not so much because of what it tells us of the book, but rather because of what it tells us about Paul Davies.

As a priest in the Church of England who is also engaged in research in theoretical astrophysics, I sometimes have to deal with the so called "fundamentalists" and their half-baked prejudices which pass as the "pseudo-science" of "creationism". The problem is one of having to argue with somebody who has replaced thought with a misplaced conviction or prejudice. Now it appears the same method of argument appears in the esteemed pages of *New Scientist!*



For example the success of the big bang theory and other advances of recent physics do not challenge many of the assumptions of Christian doctrine. Indeed the big bang theory itself is normally attributed to Abbe Lemaitre, a Roman Catholic priest, whose theory was officially endorsed, I think unwisely, by the Vatican! At times it seems almost unseemly that the scientific picture of a Universe evolving out of a fearsome explosion of nuclear particles and energy to form an ordered universe of galaxy, star, planet and complex living organisms should mirror so clearly the Biblical creation of an ordered process from chaos to man in a poem written millennia ago! The Bible of course adds the extra dimension by saying, "God did it", but that is "faith" not "sight".

Davies began by saying, "The continuing clash in perspective between science and religion... it seems to me that that clash exists nowhere except in his own mind, but then I suppose I am prejudiced."

*The Revd Garth Barber
 City of London Polytechnic*

The Severn Bridge

The caption to the illustration to your note (2 June, p 612) on the Severn Bridge asks the question "Is it safe?". The answer is a categorical "Yes"—so is the Wye Bridge.

Your reporter could not possibly discern from the report, because it did not explain the point, that Flint & Neill assessed the Severn Bridge, and the Wye Bridge, using a notional loading 2½ times that used to design the bridge, nor was there any indication of how this

notional load relates to the actual load on the bridge.

The main span of the Severn Bridge was designed for a distributed load of 2200 tons; the notional load is 5500 tons; and the load on the span for 98 per cent of the time, while traffic is moving freely, is about 300 tons. Only if there is a hold-up so that the whole span gets jam-packed, can the load approach 2000 tons. Therefore the design load was and is adequate. To get 5500 tons would require 130 fully-loaded 38-ton trucks on the span at one time, leaving no room for any cars. Such a load is possible, but commonsense says it is very unlikely and, with a modicum of good management, aided by vehicle counters and traffic lights, such a condition can be avoided at little cost and with little disruption to the traffic.

Similar comments apply to the Wye Bridge. Yet it is suggested that upwards of £28 million should be spent on modifying the bridges to enable them to carry freak loads solely composed of juggernauts packed nose-to-tail.

For a long time the Severn Bridge has been the subject of grossly exaggerated and emotive comments about fatigue and corrosion. Certainly neither are on a scale that warrants the lane closures and load limitations that have been imposed; both are within the range of regular maintenance.

Bluntly, acceptance of the report's proposals, with the ensuing severe disruption of traffic required to implement them, would involve a reprehensible waste of taxpayer's money and impose unnecessary restrictions on those using the crossing.

*David Fisher
 Freeman Fox & Partners
 London SW1*

Reincarnation?

If the chances of anyone being John Eccles are 10^{10,000} against, ("The trouble with thinking backwards", by Ralph Estling, 2 June p 619), then presumably all we need to do is count the number of living creatures on this Earth, from fungal spores to primates, and if there are more than 10^{10,000} of them, then the chances are, one will be John Eccles. Of course, if there are twice that many, then two will be John Eccles.

Historically, every time the number of creatures who ever lived reaches a multiple of 10^{10,000}, we should expect history to produce a John Eccles.

Is this mathematical proof of reincarnation?
*Sophie Griller
 London*

Wrong name

The chairman of Scientist Against Nuclear Arms is Michael Pentz, and not Michael Perutz, as we incorrectly stated in *New Scientist*, 2 June, p 612.

We welcome short communications. We reserve the right to edit the longer ones. Write to: Letters to the Editor, *New Scientist*, Commonwealth House, 1-19 New Oxford St, London WC1A 1NG.

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 Celltech Limited, 244-250 Bath Road, Slough, Berkshire SL1 4DY.

CELLTECH

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Recently awarded contracts have created a need for immediate expansion of on-site facilities and the design team. Some senior appointments have been filled from within, but there are still opportunities for Engineering Managers and Group Leaders to head up additional teams now being formed.

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levels there are several vacancies in each of the above work areas.

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(All posts are open to both male and female applicants).

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Qualifications _____

Area of interest (please tick)

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Communications Systems Radar/Signal Processing

Antenna Design Electronic Circuits (VHF/UHF)

Structures: Mechanical Thermal Dynamics

Ref BL 73.

Marconi
Space & Defence Systems



MEDICAL RESEARCH COUNCIL

National Institute for Medical Research

Division of Molecular Pharmacology
POST-DOCTORAL
BIOCHEMIST/
BIOPHYSICIST

Applications are invited from post-doctoral biochemists or biophysicists with an interest in protein structure and protein-ligand interactions for a post in the Division of Molecular Pharmacology for three years to work, in the first instance, on the binding of antifolate drugs to dihydrofolate reductase.

The project involves studies of the drug-enzyme interaction in atomic detail, with the ultimate aim of the rational design of new drugs. The principle techniques employed are NMR spectroscopy and computer graphics, and experience in the biological applications of either of these would be highly desirable. Excellent facilities are available for this work, including 500 MHz and multinuclear 200 MHz NMR spectrometers and a PDP 11-based colour graphics system.

Salary according to age and experience will be in the range £7655-£9370 plus £1158 London allowance.

Further information can be obtained from Dr J. Feeney or Dr G. C. K. Roberts (01-859 3666).

Applications, together with curriculum vitae, research experience and the names of two professional referees, should be sent to the Director, National Institute for Medical Research, The Ridgeway, Mill Hill NW7 1AA before 23 July, 1983, quoting ref: MP/4.

The Queen's University of Belfast

RESEARCH ON NUTRIENTS
IN SHELF SEAS

Marine Biology Station

A graduate research assistant supported by the NERC and the University is required for work investigating the distribution and dynamics of nutrients in the north-west Scottish shelf region. The post is tenable for three years and an ability to work at sea will be necessary. The research assistant may register for a PhD degree.

Salary range: £5560-£6375 per annum (under review).

Further particulars may be obtained from Dr G. Swidge, Queen's University of Belfast, Marine Biology Station, Portaferry, Co Down BT22 1FF, Northern Ireland.

Applications including a curriculum vitae and the names and addresses of two referees should be sent to the Personnel Officer, The Queen's University of Belfast, Belfast BT7 1NN, Northern Ireland. Closing date: 8 July, 1983. (Please quote Ref. 83/NS.)

PROGRAMMER

Applications are invited for the post of Programmer grade 1B. The computing unit is well equipped with DEC PDP-11 equipment and a variety of micro-computers. One of the PDP-11s is used as a remote job entry terminal to the University of London network (Ahmdahl V8) and to a commercial bureau database. The work is very varied and the appointed person will work mainly in FORTRAN, BASIC and assembler in a small unit providing medical statistics and scientific support services.

The salary (under review) is in the range of £5550-£8085 plus London Weighting Allowance, according to age and experience. Applications please by letter with curriculum vitae to Dr G. S. King, Institute of Obstetrics and Gynaecology, Queen Charlotte's Maternity Hospital, Goldhawk Road, London W6 6XG.

THE NATIONAL HOSPITALS FOR NERVOUS DISEASES

Queen Square, London WC1N 3BG

BASIC GRADE MEDICAL LABORATORY SCIENTIFIC OFFICER

A temporary Basic Grade MLSO is required to undertake duties in the Department of routine Chemical Pathology, to cover maternity leave until the end of March 1984. A Junior 'B' MLSO with experience may be considered.

For further details and an application form please contact the Personnel Department at the above address. Tel 01-837 3611 Ext 65.

Closing date for the return of completed applications is 30 June, 1983.

AIRCRAFT RESEARCH ASSOCIATION LTD VACANCIES FOR MATHEMATICIANS TO WORK ON

COMPUTATIONAL FLUID MECHANICS

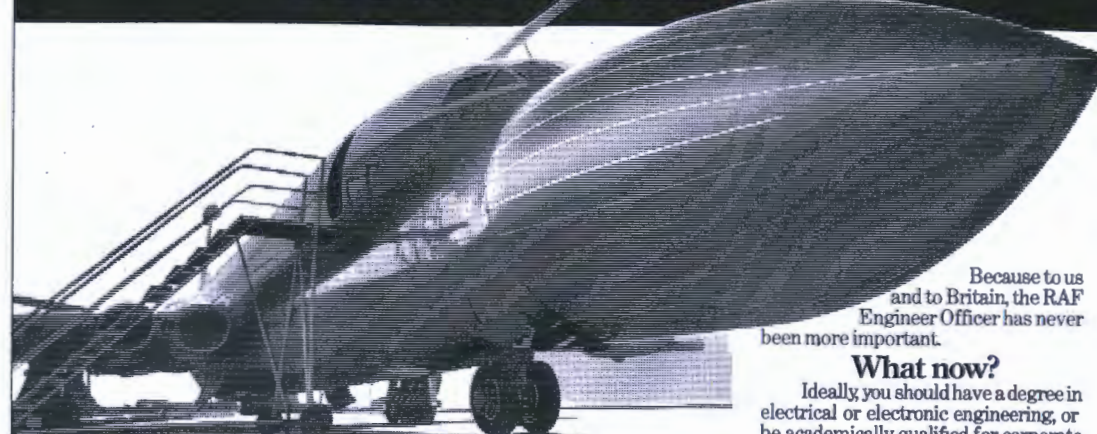
Our Computational Fluid Mechanics Section is engaged in the development of theoretical methods which are used in advanced aerodynamic design throughout the British aircraft industry. We are looking for persons with appropriate experience and interest to join this team which has a reputation for high quality work. The major methods currently being developed are related to transonic flow field calculations.

Applicants should possess a post-graduate degree in mathematics preferably with post-graduate experience in some branch of applied mathematics together with an ability to use computers effectively. Of prime importance is the ability to produce innovative ideas and develop individual projects.

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For more information call in at any RAF Careers Information Office or write to Group Captain J. F. Boon, FBIM, RAF, at RAF Officer Careers (609/EP4), London Road, Stanmore, Middlesex HA7 4PZ. Please include your date of birth and your present and/or intended qualifications.

Formal application must be made in the UK.

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RAF Officer

are far ranging. There are jobs that will stretch your creative potential to its limit, others that will give you new insights into rapidly evolving technologies.

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Like its sub-hunting sister, the new Mark 3 Nimrod AEW will be jam-packed with electronic wizardry. For any electronics engineer it'll be an Aladdin's cave, filled with some of the most ingenious radar, advanced computer hardware and software you could hope to work with. Yet that's exactly what you could be doing after a 12-month, fully paid, post-graduate Aerosystems course, following your officer training. And the training you'll receive could count towards your Chartered Engineering status.

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Our work covers every facet of integrated communication systems, but you will be particularly involved in the following areas:

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- * Microprocessor applications
- * Software development tools (MASCOT/ADA)

A relevant degree will need to be supported by at least 5 years' experience which should cover systems design in a defence environment, real time microprocessor based applications and CORAL or a similar high-level language. A knowledge of MASCOT would be a distinct advantage.

This is a senior engineering appointment, and we are looking for someone with the potential to move towards a technical management role.

An excellent initial salary will reflect both your experience and the importance of the work you'll be doing, and will be supported by a full range of benefits including generous relocation assistance, where appropriate, to this delightfully unspoilt area of Essex.

Please phone Harlow 29531 Ext. 2371 for an application form, or write with full c.v. to: Maureen Brook, Standard Telecommunication Laboratories Limited, London Road, Harlow, Essex. CM17 9NA.

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UNIVERSITY OF SWAZILAND

Applications are invited from suitable qualified candidates for the post of

LECTURER/SENIOR LECTURER in SOIL SCIENCE

in the Crop Production Department. The successful candidate will have a Master's degree in Soil Science. Preference will be given to candidates who hold Ph.D degrees and have had teaching experience in the subject at University level.

The successful candidate will be expected to teach interalia the following courses to undergraduate students:

1. Soil Genesis
2. Classification and Survey
3. Soil Fertility
4. Crop nutrition and Fertilizer use
5. Management of Tropical and Sub-Tropical soils.

He/She will also be expected to participate in the development of the Department.

Salary Scale: Lecturer: E2460-E12000 Senior Lecturer: E12060-E13620 (£1 Sterling = E1.72425). Entry point on both scales based on qualifications and experience.

Local candidates: Permanent and pensionable terms of service after successful completion of two years on probation. Expatriate candidates: Short term contracts of two years; 25% gratuity for the first two years and 37% in the second two years; 10% inducement allowance; education allowance; accommodation at reasonable rental; travelling expenses for appointee and dependent children not over the age of 19 on appointment and normal termination; biennial leave.

Detailed applications (3 copies) including a curriculum vitae, copies of academic certificates, the names and addresses of three referees and details of present salary should be forwarded not later than June 30 1983 to the Registrar University of Swaziland, P/Bag Kwaluseni, Swaziland. Applications resident in the UK should also send 1 copy to the Overseas Educational Appointments Department, The British Council, 90/91 Tottenham Court Road, London W1P 0DT quoting reference U85/83. Further details available from either address.



DEPARTMENT OF BIOLOGY

Applications are invited for the post of Lecturer in the Department of Biology. Candidates should be entomologists with postdoctoral experience and research interests in biochemistry, behaviour, physiology or ecology and preferably with an interest in chemistry. The person appointed will be responsible for the organisation of an existing MSc course in Insect Control and would be expected to make a substantial contribution to the teaching of the course as well as maintaining an active research programme.

Salary scale: £7190 x £450 (15)-£14 125 per annum.

The initial salary will depend on qualifications and experience. Further particulars may be obtained from D. A. S. Copland, Staffing Department, The University, Southampton SO9 6NH, to whom applications (7 copies from UK applicants) should be sent not later than 30 June, quoting reference No. 188/A/NS.

Re-Advertisement

ROYAL HOLLOWAY COLLEGE (UNIVERSITY OF LONDON)

Biochemistry Department

LECTURER IN PLANT MOLECULAR BIOLOGY/ BIOCHEMISTRY

Lectureship in Plant Molecular Biology/Biochemistry is available following the award of additional UGC funds in support of plant biotechnology. Candidates should have an active research interest in molecular aspects of plant systems with potential industrial applications and will complement an expanding College based group in Molecular Plant Sciences. Salary scale £8376-£15 311 including London allowance.

Candidates who have applied before may be reconsidered if they so wish. Please send self-addressed envelope for further details to Mrs D. J. Odds, Personnel Officer, Royal Holloway College, Egham Hill, Egham, Surrey TW20 0EX.

ROYAL MARSDEN HOSPITAL Fulham Road, London SW3 M1SG-DEPARTMENT OF SURGICAL PATHOLOGY

Salary £6488-£28744 pa according to experience.

Applications are invited from suitably qualified Medical Laboratory Scientific Officers for this post in a busy, modern routine Histology Department, with special interests in Immunocytochemistry and plastic section work.

Whitley Council terms and conditions of service apply.

For an application form and job description please contact the Personnel Department, Tel 01-352 8171 ext 446/447.

Closing date: 30 June 1983.

Medical Statistician

International Clinical Research to c.£15,000

Our client is the UK Research Centre of a well known international pharmaceutical company at the forefront of innovative research. It is located in a pleasant, semi-rural area of the Home Counties.

We seek an experienced Medical Statistician to head-up a new, specialised Statistical Unit within the 20-strong Clinical Research Department, which handles clinical trials in the UK and continental Europe from human pharmacology right through to post-marketing clinical assessments.

Key aspects of the job involve:

- Taking over responsibility for existing statistical work within the department, and establishing a high-calibre internal statistical service for the planning, design and interpretation of clinical trials.
- Provision of a consultancy service to investigators, which will probably involve short monthly European trips.

● Liaison with company EDP departments, which will require an initial and subsequent yearly visits to the USA.

The Clinical Research Department has on-line access to the company's IBM 38/34, 3031 and 3033 computers, and uses the SAS package as well as Statpak and Minitab on Tymshare.

For this pivotal appointment we seek a statistician qualified to at least degree level, who should have already gained experience applying statistical procedures to clinical trial data and who has a good appreciation of computing and programming. The successful candidate will have the style to be accepted at the highest levels inside and outside the company.

In addition to a highly attractive salary other benefits will include free life assurance, a non-contributory pension scheme and assistance with relocation expenses.

Please write in confidence for an application form, or phone if you would like to discuss the appointment further before applying:

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Toxicologists

Huntingdon Research Centre PLC is a contract research organisation working on the safety evaluation of pharmaceuticals, agricultural and general industrial chemicals.

We are seeking both experienced Toxicologists and recent graduates who wish to enter this important field. You will join highly professional teams engaged in general toxicological research and should ideally be First Class honours graduates in Biology, Zoology, Physiology or Biochemistry.

Our work is sponsored by companies from many parts of the world and as well as the interest of working with a wide variety of test substances there is the added interest of meeting and communicating with people from other countries.

We offer an attractive salary and excellent benefits with relocation assistance, if required. The Centre is located in pleasant countryside with excellent road and rail links to Cambridge, London and the Midlands.

Closing date for applications is 7th July 1983. Please apply in writing, with a full c.v. to Nancy McCree, Personnel Officer, Division of Toxicology,

Huntingdon Research Centre,
Huntingdon PE18 6ES
telephone 0480 890431,
extension 3251.

HRC
Huntingdon Research Centre

THE UNIVERSITY OF MANCHESTER

Department of Computer Science
RESEARCH ASSISTANT

Applications are invited for the above SERC-funded post to work on a project studying methods of representing knowledge so that it can be transferred from one Intelligent Knowledge Based System to another. The work will involve constructing an integrated information system containing information retrieval, word processing, graphics and other functions.

Applicants should have a good honours degree in Computer Science or equivalent qualification, experience of UNIX and PASCAL, and knowledge of IKBS techniques would be an advantage. Post tenable for three years from July 1 or as soon as possible thereafter. Salary range pa: £6375-£7225 (under review) (Superannuation). Further details and application forms returnable as soon as possible, are available from Dr F. N. Teskey, Department of Computer Science, The University, Manchester M13 9PL.

A vacancy has arisen for the post of HEAD OF REGISTRATION

Applicants should have a degree in biological science and several year's experience interpreting the worldwide regulatory requirements covering pharmaceuticals, agrochemicals and industrial chemicals. This experience should include a practical knowledge of preparation of product licence applications (human and veterinary), clinical trial requests, pesticide clearance submissions and notifications for new chemical substances.

For an application form please write to Box No D736.

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£10 000-£18 000+benefits

Our Client is a very successful Systems House, with a first class track record in Defence Systems. They require a number of additional people to fill their expanding project teams in the following areas:

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★ A Senior Consultant with experience in operational and systems studies in the Naval area.

★ A Consultant with more general experience in Defence Studies, Simulation or O.R.

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★ A senior appointment for candidates with Applied Mathematics background and experience of advanced filtering and tracking applications.

Simulators

★ Senior Consultant with experience of Test Rig or Training Simulators.

Real Time Software Design

★ Junior Team Leaders. Excellent opportunity to combine technical skills with responsibility for small teams and client liaison. Proven capability of Real Time Software Design on military projects is essential. CORAL/VAX is preferable.

Hardware Engineers

★ Microprocessor Engineers with experience of building Micro Systems.

★ Signal Processing Analyst with two/three years experience.

★ Electronic Engineers with exposure to software.

Successful candidates will enjoy a very professional environment where individual effort and contribution is rewarded by a progressive career development scheme.

Please telephone 01-399 9183 for further details, or write enclosing your CV.

APRIL Advertising

5 Brighton Road, Surbiton Surrey KT6 5LX. Telephone 01-399 9183

FIELD STUDIES COUNCIL

TEACHING POSTS

Tutors in ECOLOGY required summer 1983 at Dale Fort and Slopston Ley Field Centres. Single, good degree, educational qualification desirable. Research opportunities. Salary: £4200 x 177 x 177 - £4554 plus free board and lodging. Closing date for applications Thursday 30 June 1983. Further details and application forms from The Director, Field Studies Council, Preston Montford, Montford Bridge, Shrewsbury SY4 1HW.

Dale Fort Field Centre, Haverfordwest, Dyfed: special interest in MARINE BIOLOGY. Preference for candidate holding BSAC II class diving qualification (or equivalent).

Slopston Ley Field Centre, Kingsbridge, Devon: preference given to those with ZOOLOGICAL experience, though all will be considered.

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For further details and an application form please contact John Spencer at the address below or send a detailed CV. Full confidentiality assured.



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Specialist recruitment for Aerospace, Defence & Communications Industries (24 hours)

UNIVERSITY OF THE WEST INDIES—TRINIDAD

Applications are invited from suitably qualified candidates for the post of

PROFESSOR OF AGRICULTURAL ECONOMICS

in the Department of Agricultural Economics and Farm Management. Applicants should have interests in Quantitative Analysis and/or Agricultural Development. Interest in other areas of Agricultural Economics will be an advantage.

Duties will involve some coursework teaching and participation in the research programme personally (possibly with the help of research assistants) and through supervising students, and to provide leadership in the discipline of Agricultural Economics. Salary Scale TT\$91 788-TT\$111 372 (£1sterling=TT\$3.8472).

FSSU unfurnished accommodation is available at 10% or furnished accommodation at 12% or housing allowance of 20% of pensionable salary. Up to five (5) full economy passages on appointment and on normal termination. Study and Travel Grant. Detailed application giving qualifications and experience and naming three (3) referees to Secretary, U.W.I., St. Augustine, Trinidad, W.I. Applicants resident in the UK should also send one (1) copy to the Overseas Educational Appointments Department, The British Council, 90/91 Tottenham Court Road, London W1P 0DT quoting reference U92/83. Further details obtainable from either source.

Field Officer

The Gloucestershire Trust for Nature Conservation has a vacancy for a Field Officer to assist the Conservation Officer with the practical management of the Trust's fifty Nature Reserves and in the provision of advice to private landowners. The post will be on a three year contract, grant aided by the Nature Conservancy Council. The salary will be £4500 pa.

Candidates should have a good honours degree in Biology, Geography or a related subject. The successful candidate is likely to have obtained additional practical experience in field survey and conservation work. A full driving licence is essential.

Applications must be made on the form which is available on receipt of a SAE from the Gloucestershire Trust for Nature Conservation, Church House, Standish, Stonehouse, Gloucestershire GL10 3EL. The closing date for entries is Friday, 8 July, 1983.

UNIVERSITY OF WARWICK

Electron Transport Theory in Structures with Variable Dimensionality

An SERC supported three year post for a theoretical physicist is available in the Department of Physics from 1 October, 1983. The salary is in the range £7630-£10 710 pa.

The successful applicant will work with Professor P. N. Butcher, Department of Physics, to develop the theory of electron transport for semiconductor structures in which the effective dimensionality of the electron gas can be changed from three to two and from two to one. He will also participate in other activities of the Theoretical Physics Group.

Enquiries should be addressed to Professor P. N. Butcher, Department of Physics, University of Warwick, Coventry, CV4 7AL, UK.

MEDICAL RESEARCH

Editorial ability and knowledge of drugs (particularly CV's) are main requirements for interesting job. Tel 01-387 3408.

An Investigatory and Advisory Role in Pharmacy

£12 505-£14 830

This post within the Scientific and Technical Branch of Supply Division offers the opportunity to join a professional, London-based team providing advice, information and consultancy services to pharmaceutical and related departments in hospitals, to the pharmaceutical and medical supplies industries, and to government organisations (both at home and abroad). This involves the assessment and approval of sterile medical and surgical products used in the NHS including the inspection of manufacturing facilities and quality control procedures.

The successful candidate will be particularly concerned with pharmaceutical supplies and providing advice within DHSS and to other government departments. This will involve liaison with and visits to the pharmaceutical and allied industries and contact at senior level; representation on committees and working parties; liaison with the Medicines Licencing Authority and the Medicines Inspectorate; preparation and monitoring of applications and licences held by DHSS.

For more information about the work tel: Miss M. N. Duncan on 01-636 6811 ext 3104.

Candidates must have a degree (or equivalent qualification) in Pharmacy and at least five years' experience in a relative field of work.

Starting salary (including £1250 Inner London Weighting) between £12 505-£14 830 depending on qualification and experience. Promotion prospects.

For further details and an application form (to be returned by 8 July, 1983) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551. (Answering service operates outside office hours.) Please quote ref: T/6005. Department of Health and Social Security.

CENTRAL PUBLIC HEALTH LABORATORY COLINDALE

SENIOR MEDICAL LABORATORY SCIENTIFIC OFFICER (MICROBIOLOGY/IMMUNOLOGY)

Required to assist the Director CPHL in a research project concerned with resistance to bacteriological infections. Some experience of cell or cellular immunology techniques would be an advantage.

Further information can be obtained from Professor A. A. Glynn, Director, Central Public Health Laboratory, 175 Colindale Avenue, London NW9 5HT. Tel: 01-205 7041.

National Health Service terms and conditions of service will apply.

Salary scale £7197-£9507 plus £596 London Weighting.

Application forms are available from the Personnel Officer, Central Public Health Laboratory, and should be returned to her by 30 June.

THE CITY UNIVERSITY Department of Chemistry

Research Assistantships High Energy Density Batteries

Applications are invited for the following research assistantships

- Optimisation of bifunctional air electrodes
- Mechanism of anodic dissolution of lightweight alloys

The salary is within the range £7496 to £8376 pa inclusive of London Allowance. Candidates should have a good honours degree in Chemistry, Chemical Engineering or Materials Science. The above posts are for one year in the first instance with the possibility of an extension up to a maximum of three years.

Applications, together with the names of two referees, should be sent to Professor A. C. C. Tseung, Department of Chemistry, The City University, Northampton Square, London EC1V 0HB.

Biologist for Scientific Administration Swindon

A Biologist is required to join the Marine Life Sciences Section at the Headquarters Science Division of the Natural Environment Research Council, Swindon, Wilts. The Section provides specialist administrative support to Council, its senior officers, and its committees responsible for the formulation and implementation of policy for the marine life sciences. The duties are wide ranging and involve the planning and organisation of meetings, liaison with NERC Institutes, universities and other organisations undertaking marine research, and the provision of scientific information and advice within Headquarters. It is likely that the operation of Council's procedures for support of university research and training in the aquatic life sciences area will be a particular responsibility of the person appointed.

An interest in scientific administration and ability to communicate in writing are essential.

Qualifications: A first or upper second class honours degree in a biological science or a related subject. At least two years relevant post graduate experience, ideally in aquatic sciences, is required for appointment at Higher Scientific Officer (HSO) and at least four years for appointment at Senior Scientific Officer (SSO).

Salary: HSO £7,149-£9,561; SSO £8,970-£11,476. Starting salary will depend on age, qualifications and experience.

The Staff of NERC are not civil servants, but their pay and conditions of service are similar to those of the Civil Service. Staff are members of the NERC Superannuation Scheme.

Further information about the post (and application form) is available from: Mrs P. Childs on Swindon (0793) 40101 Ext 323. Completed forms should be returned to Mrs Childs at the Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wilts SN2 1EU, by 14 July 1983.

Natural Environment Research Council

Huddersfield Polytechnic

Department of Life Sciences

Re-Advertisement

PRINCIPAL LECTURER (Ref ACA/467B)

Salary £12 519 - 13 938 (bar) £15 744

Applications are invited for the permanent post of Principal Lecturer in Human Ecology. The successful candidate is likely to possess or demonstrate the following:-

- wide experience of, and involvement in, human environmental issues
- substantial and currently active research interests in Human Ecology
- ability and preparedness to make an important academic and administrative contribution to the BSc (HONS) Human Ecology degree, and to take a leading role in its future development

Further details and application forms are available from the Personnel Office, The Polytechnic, Queensgate, Huddersfield HD1 3DH. Tel: (0484) 22280, Ext 2224 and should be returned by 30 June, 1983.

INTERNATIONAL DRUG DEVELOPMENT

Warner Lambert is a major international pharmaceutical group at the forefront of research and development. From its South Hampshire base, the International Biometrics Unit administers and analyses clinical research programmes throughout the world. This team is still expanding and has now created the following four positions:

Two Clinical Data Managers/Monitors

C.D.M.s are responsible for handling the data coming from phase III clinical studies conducted worldwide. They monitor, code and enter data on to the computer and work closely with Statisticians and Medical Writers in the preparation of final study reports. The minimum educational requirement for these positions is Science 'A' levels, but a biological science degree is preferable. Previous experience within the industry, in clinical trials, regulatory affairs or medical representation is desirable for these vacancies. Appointments will be made at the Clinical Data Monitor or Manager level depending on experience and education.

Statistician

The Statistician will be part of a small team analysing the clinical data prepared by the C.D.M.s. He or she will make extensive use of the Hewlett Packard 3000 computer and any application programs as back

B.M.D.P., which may be acquired or developed within the unit. A degree in Statistics, or membership of the Institute of Statisticians is essential and preference would be given to applicants able to offer relevant experience within the industry.

Medical Writer

The Medical Writer will be one of a team of three Writers responsible for writing the final study reports of the clinical trials, using data supplied by the C.D.M.s and the Statisticians. They should possess a biological science degree and be able to offer experience in technical writing, ideally as a Medical Writer, Drug Information or Registrations Assistant within the pharmaceutical industry.

Salary for all these positions will be in the range £8,000 to £10,000 depending on education and experience. The Company will pay generous relocation expenses where appropriate. Other benefits include bonus, contributory pension scheme and flexible working hours. Please ring or write for an application form to Mrs. C. M. Cook, Senior Personnel Officer, Warner Lambert (U.K.) Limited, Mitchell House, Southampton Road, Eastleigh, Hants. Tel: Eastleigh (0703) 619791.

Closing date for applications will be Friday, 8th July, 1983.

WARNER LAMBERT

BEXLEY HEALTH AUTHORITY QUEEN MARY'S HOSPITAL SIDCUP, KENT. CHEMICAL PATHOLOGY Medical Laboratory Scientific Officer

qualified in Clinical Chemistry required in the Chemical Pathology Department of this new District General Hospital of 600 beds.

This is a busy department with good opportunities for further study.

A Junior studying for Higher TEC, or a graduate with an appropriate science degree would be considered for this post.

An On-Call system is in operation.

Whitley Council conditions of service plus London Weighting allowance.

Application with names of two referees to Mr J. Newton, Senior Chief M.S.O from whom further information may be obtained. 01-302 2678 ext 4098.

UNIVERSITY COLLEGE LONDON Department of Phonetics & Linguistics

RESEARCH ASSISTANT— HEARING RESEARCH

Physicist required to work in the field of electrocochlear stimulation in the totally deaf. A new five year MRC-funded post (starting July 1983) in an established multi-disciplinary group with collaborating members in London (University College London and Guy's Hospital) and Cambridge (Laboratory of Experimental Psychology). The successful applicant will be based in London. Work involves speech signal processing, biocompatible materials, practical prosthesis design and work with individual patients. Preparation for a higher degree is possible. Salary £7190 +£1186 London Allowance. Applications (no form) should be sent to Professor A. J. Fourcin, Department of Phonetics & Linguistics, University College London, Wolfson House, 4 Stephenson Way, London NW1 2HE.

UNIVERSITY OF WARWICK RESEARCH TECHNICIAN

The Department of Biological Sciences has a vacancy for a technician in the Development Biology Research Group. The work involves nucleic acid biochemistry and gene cloning techniques. Applications are invited from graduates and others with appropriate qualifications and experience in biochemistry and/or microbiology. The post is for a contract period extending to September 1984. Salary on the Technician Grade 2 scale: £5151-£6035 pa. Application should be made by letter giving full details of age, qualifications and experience, quoting Ref No: 45/T/83/F to the Personnel Office, University of Warwick, Coventry CV4 7AL by 23rd June 1983.

AUDIO-VISUAL TECHNICIAN

(Grade 4) required for main Teaching and Conference building. Experience in the operation repair and maintenance of audio visual equipment. Some electronic knowledge desirable. Some paid work available out of normal hours. Salary in scale £5826-£6702 pa. Application forms are available from Personnel Office, University of Reading, Whiteknights, Reading RG6 2AH. Telephone (0734) 875123 ext 448. Please quote Ref T08A.

TELECOMMUNICATIONS MANAGER

Leading position for an exceptional graduate who has an in depth understanding of communication technology. Experience will have been gained of PABX, modems, packet switching, local area networks and the development of micro processor based systems. **HERKES**

IMAGE PROCESSING ENGINEER

Hardware and Software for Robotic vision and Optical Character Recognition. Experience should have been gained in the fields of sensors and optics, electronics and a/v. **HERKES**

MATHEMATICIANS—R/W ENGINEERS

Providing advanced computer and microprocessor systems for commercial and defence industries. Areas of involvement cover acoustic telemetry and control, oceanographic sensors and position fixing. **HERKES**

VOICE RECOGNITION ENGINEER

Involved in the developing area of design and implementation of systems using voice and input/output. Ideally an engineering background with knowledge of COAL and Assembly level programming. **HERKES**

For more details contact Stephen Holt, 2, Elm Court, Elm, Tot Winder (07535) 5426.

PROJECT ENGINEERING/MGT—£16 000

To lead teams involved in multi-disciplined high technology projects, areas of knowledge should include microwave radar, EMC, nuclear environment, reliability, mechanisms, timers etc. **SURRY/8 COAST.**

ENERGY CONSERVATION/MGT—Eng.

Consultants to evaluate energy systems with clients including economic and technical studies, energy demand forecasting, audits, chemical, mechanical or thermodynamic background desirable. 6 OF LONDON.

SOFTWARE—£2000-£12 000—

Competent software people needed throughout the south with scientific/engineering background for projects including distributed data acquisition, simulation, underwater systems etc. PLM, Perran, Pasaal, DEC, IBM etc. useful.

ACOUSTIC/VEHICLE/DYNAMICS SPECIALISTS—£2000-£12 000—

We have limited openings for specialists in the above fields who are seeking advancement or diversification with well established or expanding companies. **SURRY/8 COAST.**

For more details contact Keith Harty, Shaw House, Tunstade, Guildford (GU5) 6266 or after hours (0425) 719929.

1. PROJECT MANAGER—£12 000+Car-

Small software consultancy requires engineer to control a development team from concept stages through to commissioning. 290 based systems, projects are mainly business orientated. N LONDON.

2. TELECOMMUNICATIONS DESIGN ENGINEER—£12 000—

Analogue / digital / microprocessor based systems. Original design team from customer specifications, control projects through to commissioning. Products range from photo-telemetry equipment to medium speed data equipment. N LONDON.

3. SENIOR MICROWAVE ENGINEER—£11 600+Review—

Radars/sonar projects within new research lab. Control small teams involved in a wide variety of projects. Openings available for Junior staff. **HERTS.**

4. RESEARCH ENGINEER—£10 000—

Mathematical modelling techniques for use in avionics field. The applications being in systems design, computer programming and general engineering projects. The work will involve computer programme development. **HERKES**

For more details contact Alan Gell, Equitable House, Ridgeway Road, St Albans (0753) 50116, or after hours (0753) 50222.

Food Chemists/ Microbiologists Ware, Herts

Our new laboratory facility in Ware is one year old and we are looking for additional staff to complement the existing team. We require Senior Food Chemists and Microbiologists educated to HNC/Degree level in Chemistry or Microbiology, preferably with supervisory experience.

The laboratory monitors the quality of our 'own label' products particularly dry groceries, wines and spirits, health and beauty aids, paper goods and fresh foods, providing a technical service and product development work.

The FOOD CHEMISTS must have experience in either food or household products, together with a knowledge of food analysis and instrumental techniques such as G.L.C. and A.A.

The MICROBIOLOGIST must have experience in food microbiology in order to carry out our stringent quality control checks on all fresh food products.

Tesco benefits include negotiable salaries, a sophisticated working environment, staff discount scheme (effective after 12 months service) and a contributory pension scheme.

To provide yourself with a good career and pleasant working conditions, please apply for an application form to Mrs L. Lee, Personnel Department, Tesco Stores Ltd., Tesco House, Delamare Road, Chesbunt, Herts EN8 9SL. Tel: Waltham Cross 32222, ext 3154.



THE UNIVERSITY COLLEGE OF WALES ABERYSTWYTH POST-DOCTORAL RESEARCH ASSISTANT

Department of Agriculture

Applications are invited for an agronomist to work in collaboration with plant physiologists on the changes in plant growth substances in potatoes in relation to physiological ageing and the effects of such changes on subsequent field performance. The project is supported by an ARC grant and is tenable for three years.

Candidates should possess a good Honours degree in Agriculture or a relevant Agricultural or Biological Science together with appropriate postgraduate experience. Salary on the IA Range for Research and Analogous Staff £7190 to £11 615 per annum.

Application forms and further particulars can be obtained from the Registrar (Staffing Office), The University College of Wales, Old College, King Street, Aberystwyth SY23 2AX (Tel 0970 3177, Ext 207). Closing date for applications: Friday, 1 July 1983.

UNIVERSITY OF ABERDEEN

Department of Bio-Medical Physics and Bio-Engineering RESEARCH ASSISTANT

Applications are invited from Physicists for the above Cancer Research Funded post to work on ultrasound hyperthermia of tissues. Experience with μ -computers would be particularly helpful. Appointment tenable until October 1984 in the first instance. Further details from Dr D. J. Watmough. Tel (0224) 681818 ext 3207.

Salary up to £9875 pa on the IA Scale for Research and Analogous Staff.

Application forms from The Secretary, The University, Aberdeen, with whom applications (2 copies) should be lodged by 15 July, 1983.

NATURE CONSERVANCY COUNCIL RESEARCH ON SEABIRDS AT SEA

The seabirds at sea research programme is designed to investigate specific aspects of the behaviour and distribution of seabirds off-shore. Observations will be concentrated in the oil production and exploration areas around Britain's coasts. The results will support responses to offshore pollution contingency planning.

Applications are invited from ornithologists/marine biologists/oceanographers for two contract posts extending for three years. Preference will be given to candidates with special interests in seabird ecology and fisheries biology. Experience in data handling is essential for at least one of the posts. One post will be designated team leader and graded HSO/SSO (Post 1); the other post will be graded SO/HSO (Post 2).

The posts are based in Aberdeen. Candidates will be required to work offshore from boats or oil exploitation structures and carry out surveys from light aircraft. The posts will entail a lot of travel and time away from Aberdeen. A current driving licence is essential.

Candidates for appointment as a Scientific Officer should have an honours degree or equivalent in a relevant scientific subject. For Higher Scientific Officer, a minimum of two year's relevant post-graduate experience is additionally required and for Senior Scientific Officer, a minimum of four years relevant post-graduate experience is needed.

Salary scales: SO: £5682-£7765
HSO: £7149-£9561
SSO: £8970-£11 476

Salary is dependent on age and qualifications.

Leave allowance: SO: 4 weeks and 2 days
HSO: 4 weeks and 2 days
SSO: 5 weeks.

Application forms and further details for POST 1 are available from Mr L. K. Keely and for POST 2 from Miss J. A. Condie, Personnel 1, Nature Conservancy Council, Godwin House, George Street, Huntingdon, Cambs PE18 6BU. (Telephone 0480 58191).

Closing date for receipt of completed application forms is 6 July, 1983.

UNIVERSITY OF EDINBURGH

Department of Physics

RESEARCH ASSOCIATE IN X-RAY DIFFRACTION

Applications are invited for the post of research associate to take part in a programme of X-ray diffraction experiments associated with the study of structural phase transitions. This project will include the development of high-pressure crystallography, some work on incommensurate crystal structures, and involvement in some parallel neutron-diffraction experiments.

The appointment, for one year in the first instance, commences October 1983 at a salary according to age and experience, on scale 1A. Superannuation under USS. Applicants should have, or be about to obtain, a PhD.

Applications with the names of two referees and a statement of applicant's interests and career to date to Dr R. J. Nelmes, Department of Physics, University of Edinburgh, Mayfield Road, Edinburgh EH9 3JZ, to arrive as soon as possible. Further details on request. Please quote Reference No. 5095.

ROYAL FREE HOSPITAL SCHOOL OF MEDICINE (University of London)

Department of Haematology

RESEARCH TECHNICIAN

Biochemistry graduate required immediately for three years to join a small group of cellular biologists to work on a Wellcome Trust funded project studying biochemical aspects of haemopoietic progenitor cell differentiation. Experience in nucleic acid enzymology would be an advantage.

Salary on Whitley Council Scale.

Further details and application forms are available from the School Office R. F. H. S. M., Rowland Hill Street, London NW9 2PF or telephone 01-794-0500 X 4262. Closing date 1 July 1983. Please quote reference H/T.

Management Personnel
Recruitment Selection & Search
WINDSOR GUILDFORD ST ALBANS

Research in Domestic and Commercial gas utilisation

Watson House Research Station—London SW1
Group Leader

[Combustion Related Studies] up to £16,433

To be responsible for planning and directing the work of a multi-disciplinary team of scientists and engineers working on combustion related studies — applied studies of flueing, for example, the environmental aspect of combustion and gas interchangeability.

Duties require a proven record in R&D Management, together with specialised knowledge of one or more of the team's activities and the communications ability to promote the work within the gas industry and among manufacturers.

Applicants should have at least a good honours degree in a relevant discipline, and will preferably be of Chartered Engineer status. Ref. WH/323/NS.

Engineers

[Gas utilisation in new houses] up to £12,739

Two vacancies in multi-disciplinary team working on novel gas appliances for providing a heating and hot water service to new highly-insulated housing, and on novel methods of supplying gas to, and venting products from, such houses.

The work on appliance design involves studies of heat transfer, control systems and combustion performance and valve engineering, whilst that on installation/flueing involves the development of radical alternatives to existing types of meter installation, gas pipework, appliance connection and flueing systems.

Applicants for either of these posts should combine creative ability, a practical outlook, and will have an honours degree in mechanical engineering or a related subject. Salary will be between £7,084—£12,779 [including Inner London Weighting]. Ref. WH/319/NS.

Please write with career details and quoting appropriate reference number, to Personnel Officer [Fulham], British Gas, Watson House, Peterborough Road, London SW6 3HN or phone Mrs White on 01-736 1212 Ext. 3358.

All positions are open to both men and women and benefits are those normally associated with a large progressive organisation.

BRITISH GAS

QBC INDUSTRIAL RESEARCH LIMITED
(QUEEN MARY COLLEGE)

Applications are invited for the post of—

FIRE RESEARCH SCIENTIST

To join a group of scientists studying smoke and toxic gas suppression of burning polymers and the fire behaviour of furniture and furnishings, electric cables, building materials and industrial components. Experience of polymer science, organic chemistry, thermal degradation of polymers, combustion chemistry, instrumentation or fire safety would be an advantage. Starting salary will be negotiable according to age, qualifications and experience, in the range of £7000-£11 000 pa 20 days vacation (plus extended public holidays) and friendly working atmosphere.

Letters of application (with cv) should be sent to: Steve Grayson, QBC Industrial Research Ltd, 229 Mile End Road, London E1 4AA.

Graduated in Life Sciences in June 1983?

Talk to the professionals about a career as a Medical Representative

If you want a career in industry, and have thought of becoming a Medical Representative it will pay you to obtain effective career advice from the professionals. We have contacts with all the leading Pharmaceutical Companies, and vacancies throughout the U.K.

For a local interview (no fee payable) and the possibility of a career position ring: 0256 55955 (out of hours answering service) Sutcliffe Selection, 46/48 Essex Road, Basingstoke, RG21 1TB.

Sutcliffe Selection

UNIVERSITY OF THE WEST INDIES—TRINIDAD
Applications are invited from suitably qualified candidates for the following posts in the Department of Mathematics, UWI, St Augustine, Trinidad, WI.

1. PROFESSOR OF STATISTICS
The appointee will be required to teach at undergraduate and post-graduate levels to students in the Faculties of Natural Sciences and Arts & General Studies. He/she will also be expected to teach at the undergraduate level in the Faculty of Engineering, and to contribute to the development of Statistics in the Department. A candidate with a feeling for Applied Statistics would be an asset to the Department.

2. PROFESSOR OF COMPUTER SCIENCE
The appointee would be, in addition to the teaching and research commitments of the post, be expected to contribute to the development of a Department of Computer Science. Salary Scale TT\$91 788-TT\$111 372 (£1 sterling=TT\$3.8472).

FESU unfurnished accommodation if available at 10% or furnished accommodation at 12% or housing allowance at 20% of pensionable salary. Up to five (5) full economy passages on appointment and on normal termination. Study and Travel Grant. Detailed applications giving qualifications and experience and naming three (3) referees to the Secretary, UWI, St Augustine, Trinidad, WI. Applicants resident in the UK should also send one copy to the Overseas Educational Appointments Department, The British Council, 90/91 Tottenham Court Road, London W1P 0DT quoting reference U101/83. Further details obtainable from either source.

UNIVERSITY OF BRISTOL

Department of Aeronautical Engineering

RESEARCH ASSISTANT—HIGH LIFT AERODYNAMICS

The Department wishes to recruit a suitably qualified graduate to undertake research into the aerodynamics of wings with slotted flaps. The work, which is part of a national programme of high lift wing research, will be funded by the SERC with additional funding and participation by the Royal Aircraft Establishment. The approach will be largely experimental, aimed primarily at acquiring a detailed understanding of the flow in the region of the outboard end of the flap. The main tests will be conducted in the large British Aerospace wind tunnel at Bristol, using an existing major RAE high lift research model. These tests will be augmented by work in the University's own wind tunnels.

Applicants should have a good honours degree in Aeronautical Engineering or the equivalent, preferably combined with relevant industrial experience. The appointment will be of three years' duration; the starting salary will depend on age, qualifications and experience with a minimum of £8310 per annum.

The successful candidate would be expected to register for a higher degree. Applications, giving the names of two referees, should be sent to Professor L. F. Crabtree, Queen's Building, University Walk, Bristol BS8 1TR.

MEDICAL RESEARCH COUNCIL
MAMMALIAN DEVELOPMENT UNIT

RESEARCH TECHNICIAN

required for project involving microinjection of DNA into mouse eggs and teratocarcinoma cells. Previous work experience embryo culture, cell culture, recombinant DNA technology or micro-manipulation would be advantageous.

Salary according to age and experience.

Applications, including CV and names and addresses of two referees, should be sent to the Secretary, MRC Mammalian Development Unit, Wolfson House, 4 Stephenson Way, London NW1 2HE, to arrive not later than 30 June, 1983.

UNIVERSITY OF LONDON
INSTITUTE OF OBSTETRICS & GYNAECOLOGY
SCIENTIST

required, initially for two years, to join the in vitro fertilisation team at Hammersmith Hospital. A background in embryology, serology or biochemistry with some experience in cell culture techniques will be essential; training in handling of human gametes will be available. Preference will be given to a person in their late twenties, who is enthusiastic and able to interact well with colleagues. The successful candidate who will be given some independent activity, will work under the direction of Dr S. G. Hillier who leads the scientific team. The work is arduous but exciting and there will be possibilities of original research. Salary will be negotiable at around £10 000 pa and overtime payments may be available in view of work during unsocial hours. A candidate of suitable background will be given academic status. Apply immediately, with curriculum vitae and names of two referees, to Dr R. M. L. Winston, Hammersmith Hospital, London W12 0HS.

REGISTRATION MANAGER

— ethical pharmaceuticals £12,000 + car

Napp Laboratories is one of the UK's fastest growing pharmaceutical companies and has an international reputation based both on technological innovation and sales and marketing expertise. Now with the continuing development of new products in worldwide markets and the promotion of the present holder of this position to an international role, we wish to appoint a Registration Manager at our new, purpose built, architecturally advanced headquarters at Cambridge.

This important appointment carries responsibility for the preparation and maintenance of Product Licence and Clinical Trial Approvals for the UK and Eire; the preparation of export registration data packages and the maintenance of registrations in export territories. The job holder will be assisted by the Registration Officer and have the support of a Technical Services Pharmacist.

The position calls for a man or woman, aged under 35, with a degree in a biological or life science (or pharmacy) coupled with at least two years' experience of the UK, Irish and export registration of human pharmaceutical products and preferably a minimum of five years in the pharmaceutical industry.

Particularly important are a confident, outgoing personality, well developed communication skills and an ability to maintain standards under pressure. Membership of the BIRA would be desirable including successful completion of the Association's introductory course on UK and Irish Registration. Experience of direct communication with the DHSS and NDAB would be desirable, as would a knowledge of the UK Review of Medicines Programme.

This appointment offers a unique opportunity for a young Registration professional to gain valuable experience and assume

greater responsibility in this vital function.

Salary will be c.£12,000 per annum plus an attractive range of benefits including contributory pension, free life assurance, BUPA, PHI, a choice of quality car and 20 days' holiday. Future career prospects within this fast growing company are excellent.

Write or telephone for an application form to Michael Healey, Personnel Manager, Napp Laboratories Limited, Cambridge Science Park, Milton Road, Cambridge CB4 4BH. Telephone: Cambridge 314876.



NAPP LABORATORIES

The Science Park, Cambridge CB4 4BH.

NAPP Member of Napp Pharmaceutical Group

Creative Micro-Programmer—Medical Advertising

Major international medical communications and advertising agency requires highly competent basic programmer with a flair for screen and graphic design. Ability to work in a team environment is essential.

Lavey/Wolff/Swift is the leading medical agency in Europe in the use of micro-computer and video disc applications in medical communication and promotion, and the position is a major career opportunity.

Salary will be competitive. Applications are invited from programmers with appropriate experience including recent graduates with appropriate project experience.

Write in first instance to
J R Fullarton BSc Ph D

Lavey/Wolff/Swift

31 St Petersburg Place London W2 4LA

UNIVERSITY OF ST ANDREWS
Department of Psychology

A TECHNICAL ASSISTANT

is required to work for 12 months on an MRC research project on perception in man and monkey. Duties will include animal training and neurophysiological recording. Applicants should have a minimum of three years experience and ONC/City and Guilds or equivalent qualification. Experience in electronics would be an advantage. Salary within range £5151 to £5297 per annum (Technician Grade 3) according to experience.

Further details are available from Dr D. I. Perrett, Department of Psychology, University of St Andrews.

Applications, with full curriculum vitae and the names of two referees, should be sent to the Establishments Officer, The University, College Gate, St Andrews, Fife KY16 9AJ by 27 June, 1983.

EAST MALLING RESEARCH STATION

HEAD OF PLANT PHYSIOLOGY DEPARTMENT

£15 605 to £19 317

A Plant Physiologist/Biochemist, with extensive experience of the practice and management of relevant research is required to lead research on the physiology of fruit and related crops. A strong background in plant biochemistry or biochemical physiology would be an advantage.

Appointment in Senior Principal Scientific Officer scale from £15 605 to £19 317. Non-contributory superannuation.

Further particulars and application form from the Deputy Secretary, East Malling Research Station, East Malling, Maidstone, Kent ME19 6BJ by 30 June, 1983.

Senior Toxicologist

In the competitive field of ethical pharmaceuticals, the name Smith Kline & French is synonymous with intensive research and development. Our Toxicology and Pathology department plays an important part in each drug development programme, testing potential compounds to determine their safety and preparing high quality reports for submission to the appropriate regulatory authorities.

Due to internal development, we now have a vacancy for a Senior Toxicologist to act as study director for toxicology studies. As well as his/her own studies the appointed person will supervise graduate study supervisors running their own studies.

The right man or woman will be qualified in Veterinary Medicine or be a PhD Physiologist or Pharmacologist. A Dip Tox or MRC Path in Toxicology will be an advantage.

Experience as a study director designing, running and reporting toxicology studies to standards required by Regulatory Authorities is desirable but not essential. You will need experience in organising and motivating scientific personnel. You should also be able to provide expertise in at least one key area of toxicology and have a proven record of contribution to the science of toxicology.

You can expect an attractive salary and full range of generous benefits including free BUPA, bonus plan, contributory pension scheme, free life assurance and flexible working arrangements.

Please write for an application form or send a detailed c.v. outlining qualifications and experience to the Personnel Officer, quoting reference number 933/B.

SK&F

SMITH KLINE & FRENCH RESEARCH LIMITED
The Frythe, Welwyn, Herts AL6 9AR.

Assistant Librarian

Redland Technology Limited is the Central Research and Development Division of Redland PLC, a multi-national Group, manufacturing building and construction materials in over 30 countries throughout the world, with a long record of technical innovation.

A vacancy exists for a qualified Assistant Librarian to work in the Company's small Library and Information Section. Duties will include the usual library routines such as journal circulation, loans, filing and photocopying, together with an opportunity to develop information skills such as abstracting from both commercial and technical journals and dealing with enquiries. A technical background in materials science, chemistry or physics and/or experience in the construction industry would be an advantage.

Salary subject to age and qualifications, will be within £5,000-£6,350 range, relocation expenses are negotiable.

This post carries the benefits you would expect to be found in a major industrial group, including 25 days annual holiday, contributory pension scheme, generous sick pay scheme, and good prospects for promotion both within the company and the group. Redland Technology is situated in the country on the outskirts of Horsham. There is company transport to and from Horsham town.

Please telephone for an application form and further details of this vacancy, or write to Mr R.A.G. Poulton, Personnel Manager, quoting vacancy Ref. 14/83 at Redland Technology Limited, Graylands, Horsham, Sussex. (Horsham 50222).

Redland

TECHNOLOGY

UNIVERSITY OF ST ANDREWS Department of Anatomy & Experimental Pathology POSTDOCTORAL RESEARCH ASSISTANT

Applications are invited for the position of postdoctoral Research Assistant to carry out work on the development of haemopoietic tissues and the interdependence of bone and bone marrow. Applicants should have expertise in tissue culture techniques and experience of histological methods and electron microscopy would be advantageous. The appointment is funded by the Wellcome Trust for three years. Starting salary £7190 per annum plus US5.

Informal enquiries can be made to Dr E. G. Wright, in the Department of Anatomy and Experimental Pathology (St Andrews 76161 Ext 7110).

Applications (2 copies, preferably in typescript) with curriculum vitae and names and addresses of 2 referees should be sent to the Establishment Officer, The University, College Gate, St Andrews, Fife by 30 June 1983.

UNIVERSITY OF WARWICK Compton Scattering Studies of Electron Density in Metals and Alloys

POSTDOCTORAL RESEARCH ASSISTANTSHIP

AN SERC-supported three year post for an experimental physicist is available in the Department of Physics, commencing 1 October, 1983, at an initial salary £7630 pa on the Research Range IA scale.

The successful applicant, working under the direction of Dr M. J. Cooper, will be principally involved in Compton scattering studies of transition metals and alloys carried out on the 198Au Compton spectrometer installed at the Rutherford Appleton Laboratory. He may also participate in other studies with the Compton spectrometers in the Department.

Enquiries should be addressed to Dr M. J. Cooper, Department of Physics, University of Warwick, Coventry CV4 7AL, UK.

UWIST

University of Wales

PHARMACY RESEARCH ASSOCIATE

within the area of novel wound management products.

Salary: within Range 1A Research and Analytical Staff
£7190-£8976 per annum.

Requests (quoting Ref. A.45) for details and application form to Staffing Office, UWIST, PO Box 68, Cardiff CF1 3XA.
Closing date: 15 July, 1983.

UNIVERSITY COLLEGE LONDON Department of Chemistry POSTDOCTORAL POSITION IN ORGANOMETALLIC CHEMISTRY

Applications are invited for an SERC postdoctoral assistantship to study the chemistry of simple organo-organic ligands in dinuclear and trinuclear transition metal compounds. The appointment will be from 1 October, 1983 for one year with possible renewal for a second with initial salary in the range £6375-£7225 plus £1158 London Allowance (FDRA IA pts 1-3).

Applications with cv and names of two referees should be sent to Dr A. J. Deeming, Dept of Chemistry, University College London, 20 Gordon Street, WC1H 0AJ

POLYMER RESEARCH Rubber in Engineering

A vacancy exists for an ENGINEER/PHYSICIST to work on the properties of rubber related to engineering applications. A good Honours degree is essential with a PhD or equivalent research experience. Some experience in the rubber industry may be an advantage.

Topics currently under investigation include:

- finite element analysis
- fatigue and fracture mechanics of rubber
- general engineering design with rubber
- durability

The successful candidate would be expected to work in one of the above or a related field, and also to contribute to an advisory service for industry.

The position is at senior scientist/higher scientist level. Salary scales are based on those of the Scientific Civil Service.

Applications with cv and naming two referees should be addressed to: The Director (ref AS), The Malaysian Rubber Producers' Research Association, Brickendonbury, Hertford SG13 8NL.

THE UNIVERSITY OF SHEFFIELD LECTURESHIP IN THE DEPARTMENT OF OBSTETRICS AND GYNAECOLOGY (Non-Clinical)

Applications are invited from men and women for the above post tenable from a date to be arranged. Applicants should have experience in reproductive endocrinology with special experience in the human and previous clinical involvement would be an advantage. Initial salary in the range £5275-£11105 a year, rising to £13505 a year (under review). Expected age of candidates up to about 35 years but older candidates not precluded. Particulars from the Registrar and Secretary (Staffing), the University, Sheffield S10 2TN to whom applications (5 copies), including the names and addresses of three referees, should be sent by 4 July, 1983. Quote Ref. R854/H.

LUDWIG INSTITUTE FOR CANCER RESEARCH (LONDON BRANCH)

Hadow Laboratories, Clifton Avenue, Sutton, Surrey SM2 5PX.
ANIMAL TECHNICIAN
required to work in the Animal Unit. Applicants should possess the A1AT or equivalent qualification. The successful candidate will be required to assist with the general running of the Unit and also to work in conjunction with the Clinical Research Group currently

aiming to improve treatment of hormone sensitive human breast cancer using a rat model developed at this Institute. A current Home Office Licence is essential and a pharmacological background an advantage.

Salary on MRC Technician Scale £5491-£7747 pa + £596 pa LW according to age and experience. Applications with details of career and two referees should be sent to the Administrator at the above address. Closing date for applications 8 July, 1983.

MRC Radiobiology Unit

MRC RADIOBIOLOGY UNIT

TECHNICIAN/JUNIOR TECHNICIAN

The Medical Research Council Radiobiology Unit at Harwell requires a Junior Technician or Technician for work in Cytogenetics, studying the effects of radiations and chemicals on cells and chromosomes.

Duties will involve the establishment and maintenance of a variety of cells in culture and the application of modern cytological techniques for routine screening and for experiments.

Minimum qualifications for a Junior Technician are 4 'O' levels which should include maths and at least one science subject. For a Technician, the qualifications required are HNC or a degree in biological sciences or genetics. Some practical experience in cytology would be an advantage.

Salary according to age and experience on the scale £3019-£4818 for a Junior Technician and £5491-£7747 for a Technician. Ref J1K5/CF.

RESEARCH OFFICER

We will shortly have a vacancy for a Research Officer in a group investigating the genetic effects of radiation and other agents in *rat*, for a graduate or HNC holder in Biology, Genetics, Zoology or Physiology. The post will be temporary, initially for 6 months only, to cover a period of maternity leave, although there is the possibility that it may become permanent later. The work is varied and includes animal genetics, cytogenetics, tissue culture etc. Unless the successful candidate has at least two years appropriate laboratory experience, they will be appointed initially as a Technician, with consideration later for re-grading.

Salary according to age and experience on the scale £5304-£8126 for a Research Officer and £5491-£7747 for a Technician. Ref MFL/YG.

The Unit is situated in pleasant rural surroundings on the edge of the Berkshire Downs and yet is convenient for Didcot and Oxford. Assisted home-to-work transport is available to most local areas. There are restaurant and recreational facilities on site and hostel accommodation is available for single people.

Please send application for both positions (quoting the relevant reference), together with curriculum vitae and names of two referees, to the Personnel Officer, Medical Research Council Radiobiology Unit, Harwell, Didcot, Oxon OX11 0RD. Closing date 4 July, 1983.

WESTMINSTER SCHOOL

HEAD OF COMPUTING/ELECTRONICS

Applications are invited for a new post of "Head of Computer Studies and Electronics" which is to be established in January 1984.

The successful applicant would be responsible for developing existing facilities and arrangements into a single new Department.

A new computer laboratory and electronics laboratory will be ready for use by the autumn.

Applications together with the names of two referees to: The Head Master, Westminster School, 17 Dean's Yard, London SW1, from whom further details may be obtained.

UNIVERSITY OF CAMBRIDGE Department of Physics RESEARCH ASSISTANT

A Post Doctoral Research Assistant is sought by the Theory of Condensed Matter group at the Cavendish Laboratory. The post is funded by SERC for a theoretical physicist with experience in the modern mathematical developments in random mapping theory as applied to problems such as aggregation and polymer theory. Salary in the range £6375 to £8940. Applications to The Secretary, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE by 30 June, 1983.

HARROW SCHOOL, MIDDLESEX RESIDENT COMPUTER PROGRAMMER

A one or two research chair is available for a specialist to carry out his own research into educational programming. Access will be available to a variety of microcomputers available. In return for full board and lodging and a basic stipend the researcher would be expected to guide some of the project work carried out by senior pupils and to teach others on a limited scale. Applicants should write to the Head Master with curriculum vitae and references.

UNIVERSITY OF SOUTHAMPTON BIOCHEMICAL AND INSTRUMENTATION TECHNICIAN

Applications are invited for an appointment in the Physiology/Pharmacology Group of the School of Biochemical and Physiological Sciences. The successful applicant will have experience and knowledge of basic biochemical instrumentation, including spectrometers, centrifuges, recording equipment etc, and will be responsible for providing specialist biochemical support for research and post-graduate training programmes.

The appointment will be made on salary scale grade 4 £5826-£6702 or grade 5 £6278-£7332 per annum with initial salary depending upon qualifications and experience. Minimum qualifications ONC/TEC or equivalent with several years experience but graduates with research experience in Biochemistry, or other relevant experience, are encouraged to apply.

Applications (two copies) giving date of birth, details of qualifications and experience together with the names and addresses of two referees, should be sent to Mr C. N. Saul, The University, Southampton SO9 5NH quoting reference 511/T.

UNIVERSITY OF BRISTOL Department of Zoology ARC RESEARCH GROUP ON PHOTOPERIODISM AND REPRODUCTION

Applications are invited before 8 July, 1983 for the post of graduate research assistant in the above Group. The work involves a study of the neural and endocrine changes that occur during seasonal reproduction in birds. A range of techniques are employed but an important one is hormone radioimmunoassay and experience in this area would be advantageous though not essential.

Applicants should have, or expect to obtain this year, a degree in Zoology, Physiology or a related discipline. Salary will be within the University Scale 1B (£5550-£8085). The terms of the appointment exclude the person reading for the degree of PhD. A curriculum vitae together with the names of two referees should be sent to Professor B. K. Follett, Department of Zoology, The University, Bristol BS8 1UG, from whom further information is also available. The post is available immediately and is supported until September, 1984 in the first instance.

UNIVERSITY COLLEGE LONDON Department of Phonetics & Linguistics RESEARCH ASSISTANT— HEARING RESEARCH

Work on speech perception and production with profoundly deaf patients in the development and application of new electrical and acoustic methods of testing and rehabilitation. A new five year MRC-funded post (starting July 1983) exists in an established multi-disciplinary group with collaborating members in London (University College London and Guy's Hospital). Applicants should have a first degree in Speech Science or related area. Opportunity also exists for work on other types of communication dis-order; preparation for a higher degree is possible. Salary £6310 + £1186 London Allowance. Applications (no form) should be sent to Professor A. J. Fourcin, Department of Phonetics & Linguistics, University College, London, Wolfson House, 4 Stephenson Way, London NW1 2HE.

CULTURE IMPROVEMENT SECTION HEAD -

INTERNATIONAL PROCESS DEVELOPMENT GROUP

Pfizer, one of the world's leading pharmaceutical companies, is a multi-national organisation with world wide manufacturing facilities producing an extensive range of science based products, many of which are produced by fermentation.

The International Process Development Group based at Sandwich in Kent is responsible for the development of novel approaches to the fermentation and recovery processes used in International Production.

Currently, we are seeking to appoint a Section Head for the Culture Improvement Laboratory. In this position you will lead a small highly skilled team engaged in the use of modern techniques, including recombinant DNA technology, to improve the performance of organisms which are of importance to the fermentation and recovery plants within Pfizer International.

We are looking for a self-motivated person who can work independently to produce novel approaches to strain improvement. Candidates should have a good first degree and a PhD in microbiology/microbial biochemistry with experience in microbial physiology and an interest in genetics. Post doctoral experience in the application of the above fields to streptomycetes would be ideal, although application from new PhDs or those with experience of other species will be considered.

This challenging appointment offers a highly competitive basic salary plus a bonus related to personal performance. We also offer generous help with relocation.

We employ some 1400 people, of whom over 250 are graduates, on our Sandwich site which is in pleasant rural surroundings, close to coastal resorts, championship golf courses, the Continent and good sailing waters. We have a thriving Sports and Social Club with first class amenities.

If you are interested in the appointment please send your curriculum vitae, in confidence, to Dr M. C. Hall, Senior Personnel Officer, Pfizer Limited, Sandwich, Kent.



AGRICULTURAL
RESEARCH COUNCIL
FOOD RESEARCH
INSTITUTE
PROCESS PHYSICS
DIVISION

Principal Scientist

A scientist is required to lead a team studying the physical and structural properties of food materials during processing. The initial aim will be to establish the basis of physical behaviour during extrusion processes and to establish a team which will extend the same interest to the efficiency and control of other processes.

Qualifications: First or upper second class Honours degree and PhD in Physics, Physical Chemistry, Chemical Engineering or a related discipline with postdoctoral experience in structure and mechanical properties of complex materials.

Salary: Principal Scientific Officer scale £11 343-£14 931, or Senior Scientific Officer scale £9 970-£11 478. Non-contributory superannuation scheme.

Further details and application forms from the Secretary, Food Research Institute, Colney Lane, Norwich NR4 7UA quoting reference 82/B. Closing date: 30 June 1983.

Applications are invited for a

CHIEF PHYSIOLOGICAL MEASUREMENT TECHNICIAN

To be responsible for the Cardiac Department of North Tees General Hospital. The Hospital of 1,000 beds is recently built and provides all the medical services for the North Tees District on one site.

The Cardiac Department is well equipped for non-invasive cardiac investigation, including real-time echocardiography, treadmill exercise testing, Holter monitoring and tape analysis. It would be an advantage if applicants have experience of these techniques, permanent pacemaker testing and simple respiratory tests.

As well as the Chief Technician, the department has two Physiological Measurement Technicians and a Cardiographer.

Salary: £7386 - £9,212 p.a. for a 37 hour week.

Application form and further details quoting ref. P12/59 can be obtained from the Personnel Manager, North Tees General Hospital, Hardwick, Stockton on Tees, Cleveland. Tel: Stockton 62122 extension 816. Closing date: 30th June, 1983.



NORTH TEES HEALTH AUTHORITY

The Hatfield Polytechnic School of Natural Sciences POST-DOCTORAL RESEARCH ASSISTANTSHIP

Applications are invited for an SERC supported Post-Doctoral Research Assistantship to study nickel containing enzymes using EXAFS and related techniques. A knowledge of EXAFS is not a prerequisite. The Assistantship is tenable for three years from 1 July, 1983 or an agreed later date. Initial salary £7101 per annum.

Applicants should send cv and names of two referees to The Staffing Office, The Hatfield Polytechnic, PO Box 109, College Lane, Hatfield, Herts. Further details may be obtained from Dr B. Piggott, Division of Chemistry, School of Natural Sciences, The Hatfield Polytechnic (Tel Hatfield 68100 ext 3229).

Please quote reference: 633. Closing date: 24 June, 1983.

UNIVERSITY OF LEICESTER The Leicester Biocentre

Applicants are invited, from suitably-qualified candidates, for two technical staff positions in the newly-established Leicester Biocentre.

POST 1 Reference GFC/1 is for a Grade 3 Technician to work on a three-year project studying the genetic control of protein secretion in yeast.

POST 2 Reference LBOP/T5 is for a Grade 3 or Grade 5 Technician (dependent upon qualifications and experience) to work on a project involving the use of tissue culture techniques to study the introduction and expression of foreign genes in plant cells. This appointment will, in the first instance, run until 30 September, 1987.

Salary scales: Grade 3—£5151-£6035; Grade 5—£6279-£7332.

Applications, in writing, including a detailed Curriculum Vitae and naming two referees, should be sent to: Ms S. N. Dilks, Technical Manager, The Leicester Biocentre, Medical Sciences Building, University of Leicester, Leicester LE1 7RH. The closing date for applications is 24 June, 1983.

MEDICAL REP JOB CENTRE

Use over 33 years experience of the pharmaceutical industry to help you break into medical selling! We are renowned for our career counselling, our confidentiality, and our personal attention.

Vacancies exist throughout the UK with major companies. For early interview...

ROY EYRES
01-549 6633

Plant Pathologist

Use your scientific expertise in a Marketing role.

The Plant Protection Division of ICI is an international reputation and is a leading company in the development and manufacture of crop protection products.

We have an excellent opening for a Plant Pathologist to be responsible for planning, implementing and controlling all aspects of the technical work necessary to launch new proprietary plant fungicides throughout the North and South American markets. It's a role which will provide an interesting and attractive opportunity for an ambitious, commercially-orientated man or woman to develop a career in product management/marketing.

We're looking for someone, aged 26-34, with either a good first degree in Plant Pathology supported by some specialist experience, or preferably a PhD. Some post-graduate work experience is essential, including a knowledge of field trials management and, ideally, some involvement in international or commercial operations.

The position demands self-motivation and an ability to work with the minimum of supervision. Also important is a well developed business sense and a capacity to apply original and creative thought to identifying and developing potential market opportunities. A knowledge of Spanish/Portuguese is desirable—a willingness to learn is essential.

An attractive salary will be offered plus profit sharing scheme and assistance with relocation, where appropriate, to this pleasant location.

Write with brief personal and career details to Mrs S. A. Crouch, Personnel Officer, Plant Protection Division, Imperial Chemical Industries PLC, Fernhurst, Haslemere, Surrey GU27 3JE.



Plant Protection
Division

UNIVERSITY OF
NEWCASTLE UPON TYNE
Within Research Group for
High-Strength Materials
Crystallography Laboratory
Department of Metallurgy and
Engineering Materials

Post-doctoral Research Associateships

Three Research Associateships are available for work on:

- (1) Applications of transmission electron microscopy in materials science, concerned particularly with steels and related engineering ceramics, with new hard-metal materials, and with metal strengthening by the formation of mixed solute-atom clusters.
- (2) The production and characterisation of new hard metals for cutting and non-cutting applications in which tungsten carbide and cobalt are replaced by other interstitial alloys and matrix materials.
- (3) The development of corrosion-resistant, high-strength steel wire for use in marine environments.

Appointments (1) and (2) are for three years and appointment (3) for two years, all starting as soon as possible, but not later than October 1983.

Starting salary will be up to £2800 pa on the Range 1A scale (£7190-£11 615) according to age, qualifications and experience. Applications, with full curriculum vitae and the names and addresses of three referees, should be sent to Professor K. H. Jack, Crystallography Laboratory, The University, Newcastle upon Tyne NE1 7RU (telephone 0632-328311 ext 3201) as soon as possible, from whom further particulars can be obtained. Please quote reference NS.



QUALITY CONTROL- SECTION MANAGER

The major international brewing group, Guinness Overseas Limited has interests spanning three continents: Africa, The Americas and The Far East.

We have a vacancy for a Quality Manager (Overseas) to run the section within the laboratory of the Park Royal company which provides essential quality control support for these operations.

Reporting to the Quality Control Manager, but also working in close liaison with the technical department of the overseas company, you will be responsible for ensuring that your section gives a fully effective service.

Technical, managerial and training skills will be involved. Your own practical work will be of an advanced nature including trouble shooting and analytical development work. Some overseas travel on quality control and training projects will be required from time to time.

Applicants must possess a degree in chemistry or other appropriate discipline and have had four to five years in quality control preferably including some supervisory experience. Previous work experience in brewing would be an advantage.

In addition to an attractive starting salary we provide a comprehensive benefits package including profit share and non-contributory pension.

Please write with full career details to:
Mr D. J. Emptage, Assistant Staff Manager.

GUINNESS

Arthur Guinness Son & Co. (Park Royal) Limited,
Park Royal Brewery, London NW10 7RR.

THE UNIVERSITY OF LANCASTER

DEPARTMENT OF
ENVIRONMENTAL SCIENCES

Research Assistant

Applications are invited for the post of postgraduate research assistant to work with Professor Peter Young of the Department of Environmental Sciences, and Dr Keith Bevan of the Institute of Hydrology, on a NERC sponsored, three-year study of the 'Aggregated Dead Zone' model for transportation and dispersion in river systems. The study will involve extensive field work and supporting theoretical studies using micro and main-frame computers.

Applicants should possess a good honours degree or its equivalent in an appropriate subject, and preference will be given to applicants with previous experience in field work and computer usage. Salary on the Research 18 Range, (£6310-£8530).

Further particulars may be obtained (quoting reference L280/B) from the Establishment Office, University House, Bailrigg, Lancaster LA1 4YW. (Tel 0624 85291 Ext 4213), where applications (five copies) naming three referees, should be sent NOT LATER THAN 8 JULY, 1983.

The European Molecular Biology Laboratory, a research institute situated in Heidelberg, West Germany, invites applicants for the following vacancy at the Laboratory's Outstation at the Deutsches Elektronensynchrotron (DESY) site in Hamburg.

BIOPHYSICIST/PHYSICAL BIOCHEMIST

to interact collaboratively with visiting groups using time resolved X-ray diffraction and scattering methods for the study of poorly ordered systems (fibres, solutions, gels). There will also be an opportunity to carry out a limited in-house research project. Applicants must have a PhD and experience in particular with X-ray structural methods. Experience in biochemistry will be an asset.

An above-average salary will be offered to the successful candidate. Certain allowances are payable in addition, depending on personal circumstances. An initial contract of 3 years' duration which can be renewed, will be offered.

Please write briefly for an application form quoting ref. 83/21 to:
EMBL, Personnel Section, Postfach 10.2209
D 6900 HEIDELBERG.

Research Engineers- Computerised Vision Systems

STL at Harlow, the Research Centre of Standard Telephones and Cables plc, is engaged on a programme of research into computerised vision and tactile sensing and related techniques.

We are looking for decisive, forward-looking men and women to provide the innovative flair and initiative to develop this new technology whilst maintaining a practical and positive attitude to the development of working systems.

Graduate Electronics Engineers or Applied Physicists, you should be able to bring us some sound industrial experience in programming and dedicated microprocessor projects.

There are excellent opportunities for career advancement as well as involvement in an exciting new field.

Competitive initial salaries will reflect both your own achievements and the complexity of the challenge you'll be accepting. A full range of benefits includes relocation assistance, where appropriate, to this essentially rural area just 25 miles from London.

Please phone Harlow 29531 Ext. 2371 for an application form, or write with full c.v. to: Maureen Brook, Standard Telecommunication Laboratories Limited, London Road, Harlow, Essex. CM17 9NA.

The Research Centre of **STC**

STL

BARR & STROUD, BORN, BASED AND GROWING FAST IN SCOTLAND
NEED

PHYSICISTS/APPLIED PHYSICISTS (two posts)

The persons we are looking for will be capable of accepting project responsibility and be prepared to engage actively in the practical aspects of the work. The positions are in our General Physics Department, in a group, in which vacuum deposited optical thin film development and investigation of laser damage in materials and coatings, form the main thrust of the activities. The successful candidates will have a good degree in Physics or closely related discipline but just as importantly, they will

be practical people with some work experience in areas relevant to the above.
AT BARR AND STROUD
: Research into new technologies is encouraged (our expanding business depends on it).
: Salaries are paid to individuals for responsibility, experience and merit. (Not to groups on rigid scales.)

INTERESTED?

Send full career details to
Donna Green,
Personnel Officer,
BARR AND STROUD LIMITED,
Caxton Street,
Annisland,
GLASGOW G13 1HZ.

Barr & Stroud
Technologists of Excellence

UNIVERSITY OF THE WEST INDIES—TRINIDAD

Applications are invited from suitably qualified candidates for the post of

PROFESSOR OF AGRICULTURAL ENGINEERING

In the Faculty of Engineering, UWI St. Augustine, Trinidad, W.I. The successful applicant will be required to give strong leadership in this teaching programme and will also be expected to initiate research programmes relevant to the needs of the Caribbean region. Preference will be given to those applicants with knowledge and experience of Agricultural Engineering in the Caribbean Region. Salary Scale TT\$91 788 to TT\$111 372 (£1 sterling=TT\$3.8472).

FESU unfurnished accommodation is available at 10% or furnished accommodation at 12% or housing allowance of 20% of pensionable salary. Up to five (5) full economy passages on appointment and on normal termination. Study and Travel Grant. Detailed applications giving qualifications and experience and naming three (3) referees to the Secretary, UWI, St. Augustine, Trinidad, W.I. Applicants resident in the UK should also send one (1) copy to the Overseas Educational Appointments Department, The British Council, 80/91 Tottenham Court Road, London W1P 0DT quoting reference U98/83. Further details are available from either source.

BIRKBECK COLLEGE (University of London)

HEAD TECHNICIAN— DEPARTMENT OF ZOOLOGY

Applications invited from suitably qualified candidates, with practical experience in zoological techniques and day to day running of technical support services for teaching and research activities. Duties to include organisation and supervision of the work of a technical staff of eight, and of the teaching and research laboratory services, in-service training of technicians as required and maintenance of records and accounts. Also, dependant on experience and expertise of appointee, provision of technical service in support of teaching and research as appropriate to department needs. Appointment according to experience and qualifications in Grade 6/7 in salary range £9500-£10 600 p.a. (including London Weighting, under review). Permanent superannuated post, 31 days leave, annual season ticket loan scheme. Apply with full c.v. and names of two referees to Assistant Secretary (Personnel) (NS) Birkbeck College, Malet Street, London WC1E 7HX or Telephone 01-580 6622, ext 529 for further details and application form.

CHELSEA COLLEGE

University of London
A POSTDOCTORAL RESEARCH ASSISTANT

is required to join a research group investigating the structure and function of model and biological membranes. Particular experience in biophysical methods would be an advantage but is not essential. The post is supported by the SERC for one year and the salary will be within the range £7190-£8080 p.a. plus £1186 London Allowance.

Applicants are requested to send a curriculum vitae and the names of two referees to Dr P. J. Quinn, Department of Biochemistry, Chelsea College, Manresa Road, London SW3 6LX, from whom further particulars may be obtained.

POLY.LINA LTD

IMPROVED METHODS FOR THE PRODUCTION OF POLYETHYLENE FILM

Applications are invited for two posts on a development programme at Poly-Lina in collaboration with the Department of Non-Metallic Materials, Brunel University. The first post will involve the production of polyethylene film using existing and new techniques, and candidates for this post would, typically, be graduates in one of the following subjects: Mechanical Engineering; Materials Science; Chemical Engineering or Polymer Technology. The second post involves the structural characterisation of films and the development of on-line film characterisation methods. Candidates for this post should be Physics graduates with an aptitude for the development of instrumentation for quality control.

Candidates should be able, self-motivated persons, capable of working on a development programme with an industrial firm which is a leader in the field of consumer packaging products. Poly-Lina has exhibited growth rates in excess of 20% per annum for the last three years and now has a turnover of £12m of which about 20% is exported.

The posts are for a fixed duration of two years, but offer excellent career opportunities for those interested on the polymer field.

Applicants should be under 30 years of age. The salary will be in the range £7496-£8816. In addition, the successful applicant will benefit from Poly-Lina's profit sharing scheme. Application forms and further particulars may be obtained from the Personnel Manager, Poly-Lina, Millmarsh Lane, Brimsdown, Middlesex EN3 7PU.

ROYAL MILITARY COLLEGE OF SCIENCE

Shrivenham, Swindon

Department of Mechanical Engineering

HIGHER RESEARCH SCIENTIST ENGINE TRANSMISSIONS

Applications are invited for the post of Higher Research Scientist to investigate fast, shockless gearchanges by automatic, microprocessor, control of engine and gearbox.

The applicant should hold a good honours degree in Mechanical Engineering, have a sound understanding of the principles of reciprocating engines and transmission systems and should be prepared to undertake work of both a practical and theoretical nature. It may be possible for a suitable candidate to register for a higher degree.

The appointment will be for a period of two years initially, in the grade of Higher Research Scientist, on a salary scale of £7 149 to £9561 (entry point depending on qualifications and experience).

Application forms and further information may be obtained from the Civilian Admin Office, Royal Military College of Science, Shrivenham, Swindon, Wilts SN6 6LA. Tel: (0793) 782551, ext 421. please quote reference HQ 120/1/134.

Closing date for applications 13 July, 1983.

UNIVERSITY OF BATH School of Engineering RESEARCH IN MANUFACTURING

We are seeking a number of good honours graduates, or those expecting to graduate, in engineering and applied science to join our research team. The work in the application of computers in manufacture will lead to higher degrees, and enhanced career prospects. Projects include: Advanced Process Planning, Industrial Robotics, Machine Vision, Solid Modelling, Flexibility in Batch Production, Knowledge Based Systems in Manufacture. Some of these involving industrial collaboration will be based at leading firms in Southern England. Studentships and research officer posts are available. For further details write or phone Prof J. Black, Head, School of Engineering, University of Bath, Bath BA2 7AY. Tel 0225 61244.

MRC CLINICAL RESEARCH CENTRE (NORTHWICK PARK HOSPITAL) WATFORD ROAD HARROW MIDDLESEX HA1 3UJ

Technician

A vacancy exists in the division of comparative medicine of this large Biochemical Research Institute for a person with a degree or equivalent qualifications in an appropriate Biological subject to assist in the care and management of laboratory animals. The successful candidate will initially be required to undertake laboratory work as part of the division research programme.

A knowledge of biochemical techniques would be an advantage.

Specialised training in animal husbandry will be given if necessary.

Salary will be within the range of £6084-£8304 depending on age and previous experience. For an application form and job description write to Miss B. Shaw quoting reference 102/2/3875. Closing date for application 30 June, 1983.

COUNTRYSIDE COMMISSION FOR SCOTLAND

Applications are invited for the post of

PROJECT OFFICER

for a project aimed to develop experience in the management of upland footpaths. Applicants should possess qualifications in a field such as Civil Engineering, Soil Science, Geology, Ecology or have experience in recreation or land management.

This is initially a two year contract post and the salary scale is £7178-9681 with placing according to experience.

Further particulars and application forms may be obtained from the Assistant Secretary,

**Countryside Commission for Scotland
Battleby, Redgorton, Perth PH1 3EW
Telephone (0738) 27921**

MANAGING DIRECTOR biotechnology

BIOSCOT LIMITED has been set up jointly by Edinburgh and Heriot-Watt Universities to undertake collaborative projects in BIOTECHNOLOGY on a contract research basis for external clients, and on its own behalf.

Some of this research may lead to the setting up of downstream companies, to produce and market Biotechnology products, in which BIOSCOT would participate.

The Managing Director will be responsible for:

- Managing the Company within sound commercial guidelines including the international marketing of BIOSCOT's services to industry and government agencies.
- Directing the activities of scientists and support staff responsible for research across a wide range of biotechnological applications.
- The person we seek will have:
 - a track record in senior management within the Health Care, Agribusiness, Food Processing, Brewing and Distilling or related industries
 - a scientific background.

The challenge of establishing a new business venture in biotechnology, based in Edinburgh, an attractive remuneration package, plus working in a stimulating commercial and scientific environment make this a unique opportunity.

Please apply with full career details to:

Duncan I. Cameron, Chairman,
BIOSCOT Limited,
Heriot-Watt University,
Chambers Street,
Edinburgh EH1 1HX

A Bigger Career Choice in Medical Sales

If you have a scientific or paramedical background and want to succeed in a commercial environment leading to a managerial role, then phone Andrew Osborne or Alistair Ross now on 01-222 1547.

**Ross Warren
Recruitment**

Pharmacological Research-HNC

Smith Kline and French Research is one of the world's leading pharmaceutical companies. We now need a Pharmacologist to participate in the biological investigation of potential new cardiovascular drugs.

The position will suit someone with HNC, or an equivalent qualification in Applied Biology, who has an interest in pharmacological techniques. The ideal candidate should have gained several years relevant technical experience within a similar environment, and be able to carry out the work involved with the minimum of supervision. Possession of a Home Office Licence is desirable.

The rewards are as attractive as our environment. We offer a competitive salary and a range of company benefits including free BUPA, bonus plan, free life assurance and flexible working hours.

Please write for an application form, or forward a detailed c.v. outlining qualifications and experience quoting reference number NS/930/S to the Personnel Officer.

SK&F

SMITH KLINE & FRENCH RESEARCH LIMITED
The Frythe, Welwyn, Herts AL6 9AR.

Principal

The Institute is seeking a Principal to take up appointment by the Autumn of 1984.

The Principal is the Institute's chief academic and administrative officer, and leads in the formulation of academic and other policies for the future development of the Institute. The Institute is independently incorporated by Royal Charter and receives its grant directly from the University Grants Committee. It is also the Faculty of Technology in the University of Manchester.

Currently it has, in 21 departments, approximately 4,500



UMIST

The University of Manchester Institute of Science and Technology

full-time students, 420 members of the academic staff, including 47 Professors, and 1,400 members of the non-teaching staff.

The Chairman of the Council, F. A. Russell, JP, MBA, invites interested persons, who believe they could offer appropriate qualifications and experience, to communicate with him under private cover, when further particulars of the appointment will be supplied. Correspondence should be addressed to him, c/o The Registrar, UMIST, PO Box 88, Manchester M60 1QD.

The Institute reserves the right to invite candidates for the Principalship.

Editor

for a successful publisher active at an advanced level in the physical sciences and technology. The person appointed will be responsible for expansion of existing publishing programme.

The prospects for the successful candidate (age: 33-43) are excellent. Although the Editorial Offices of Applied Science Publishers Ltd (a Company within Elsevier Science Publishers) are in Almarle Street, London, candidates should send a CV, passport photograph and details of salary expected to:

Managing Director,
Applied Science Publishers Ltd,
22 Ripplside Commercial Estate,
Barking, Essex.

TOPEXPRESS LIMITED RESEARCH SCIENTIST

A highly-successful scientific consultancy seeks bright and enterprising people to work in the areas of Vibration, Acoustics and Control. Research experience in these fields would be a decided advantage.

Applications with Curriculum Vitae and names of two referees to Dr C. F. Rose, Topexpress Limited, 13/14 Round Church Street, Cambridge CB2 8AD.

ABSTRACTORS
wanted, part-time, for acoustics and rare-earth topics, Central London. Brentwood (0277) 224632.

ANIMAL DISEASES RESEARCH ASSOCIATION

Moreudun Research Institute
SENIOR SCIENTIFIC OFFICER/
PRINCIPAL SCIENTIFIC
OFFICER

A vacancy is presently available in the above grade for a member of staff to lead an Immunology Group being formed at Moreudun Institute to study immunology of diseases of ruminants. Applicants must have substantial experience in immunology. Knowledge and expertise of monoclonal antibody techniques and of cellular immune mechanisms would be important.

Applicants should have a first or upper second class honours degree in an appropriate subject with at least 4 years relevant post-qualifying experience for Senior Scientific Officer and additional relevant experience for Principal Scientific Officer. Preference will be given to applicants possessing a PhD qualification. Salary scale Senior Scientific Officer £8970-£11 476 pa, Principal Scientific Officer £11 343-£14 831 pa. Non-contributory superannuation scheme. Applications giving the names and addresses of 2 referees should be forwarded to the Secretary, Animal Diseases Research Association, Moreudun Institute, 408 Gilmerton Road, Edinburgh, EH17 7JH from whom further particulars may be obtained. Applications close 8 July, 1983.

YORKSHIRE REGIONAL HEALTH AUTHORITY

Regional Medical Physics Service
Department of Medical Physics,
Grimsby

SENIOR PHYSICIST
Salary £9010 rising to £11 649 pa.

Required to join the small but active department in Grimsby and to be associated with the Medical Physics Service for the whole of Humberside through which scientific and technical support is provided.

This post is primarily associated with the Nuclear Medicine Services (Imaging and RIA) and the work will be based at the newly opened District General Hospital later in 1983. The successful candidate will be expected to co-operate in similar work in other regional centres.

Candidates should hold a good honours degree in physics and must have had not less than four years experience in medical physics or related work including a substantial period specialising in clinical radioisotope work.

Application form and job description available from the Regional Personnel Officer, Yorkshire Regional Health Authority, Park Parade, Harrogate HG1 5AH. Tel (0423) 65061 ext 108/109. Please quote ref no FT34. Closing date 1 July, 1983.

BEATSON INSTITUTE FOR CANCER RESEARCH SCIENTIST

There is a vacancy for a post-doctoral scientist with training in molecular biology to join a team involved in a long-term study of gene expression and its control during the differentiation and maturation of human myeloid cells. Some background in cell biology will be an advantage. MRC conditions of service apply; appointment will be to University Research Staff Range IA or II (salary from £6375 to £13 505) depending on age and experience. Applications to Dr G. D. Birnie, Beatson Institute for Cancer Research, Gartcube Estate, Switchback Road, Bearsden, Glasgow G61 1BD should include cv and names of three referees.

SEVERN TRENT WATER AUTHORITY TAME DIVISION

SCIENTIFIC OFFICER

£9999-£11 184 pa (from 1 July, 1983)

The division is seeking a graduate chemical or electrical engineer, or scientist with a strong engineering background; to lead a group involved with instrumental water quality monitoring.

The duties will cover all aspects of instrumental water quality monitoring from site evaluation through design and implementation to the maintenance of equipment. There will be ample opportunity for practical involvement.

Preference will be given to applicants with at least three years relevant experience with continuous on-line measuring systems. Possession of a clean current driving licence is essential. The post is based at the divisional laboratories at Tame House in central Birmingham.

Applications forms by telephone request are available from the Personnel Office, Tame Division, Severn Trent Water Authority on 021 233 1616 Ext 2190. Please quote Ref IA 945. Closing date for the return of completed application forms: 30 June, 1983. This post is open to both men and women.



SEVERN TRENT WATER

UNIVERSITY OF ABERDEEN Department of Pharmacology POSTDOCTORAL RESEARCH ASSISTANT

Required for an investigation of the morphological and electrophysiological characteristics of peptide-containing neurones of guinea-pig intestine. Post supported by MRC project grant to Dr G. M. Lees for three years. Candidates should have experience with electrophysiological techniques, particularly intracellular recording; previous experience in the field of gastro-intestinal physiology is not required.

Commencing salary up to £7190 pa on the range IA scale for Research and Analogous staff.

Further particulars and application forms from the Secretary, The University, Aberdeen, with whom applications (two copies) should be lodged by 25 July, 1983.

Mrs Maureen Shaw, Personnel Officer, University of Aberdeen, General Administration, University Office, Regent Walk, Aberdeen AB9 1FX Scotland.

DURHAM UNIVERSITY

Department of Physics
Applications are invited for a

TEMPORARY LECTURESHIP IN ASTRONOMY

tenable for three years from 1 October, 1983. Teaching duties include lecturing on topics in Astronomy and Physics at both undergraduate and postgraduate level and laboratory demonstrations. The research work to be carried out will include the development of novel instrumentation for large optical telescopes.

Initial salary in the range £6375-£7225 (under review) on the Lecturers' scale plus USS benefits. Applications (3 copies) naming three referees should be sent by 15 July, 1983 to the Registrar, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

HOME COUNTIES AND WEST COUNTRY

£9000-£17 000 + Relocation

Our client, one of UK's leading Information Systems Houses offer attractive career openings in the fields of Signal Processing, Underwater Tech, Marine Navigation, Automotive Engineering, Communications and Electronics in London, Home Counties and the West Country.

In particular, they now seek

ELECTRONICS ENGINEERS, SYSTEMS ENGINEERS, SCIENTIFIC PROGRAMMERS, MATHEMATICIANS, OPERATION RESEARCH & SOFTWARE MODELLERS, MICROPROCESSOR DESIGN ENGINEERS

Applicants must have a Degree (Maths, Physics, Electrical, Computer Science) plus a minimum of two years relevant experience. For more information contact

CBS APPOINTMENTS

1 Wootton Gardens, Bournemouth

0202-292155. Evenings 825408 (Agy.)

UNIVERSITY OF ST ANDREWS

Department of Anatomy & Experimental Pathology

LECTURER

Applications are invited from graduates in the biological sciences or from medical graduates for a Lectureship in the Department of Anatomy and Experimental Pathology.

The successful applicant will be expected to contribute to the courses provided for preclinical students and for science students. Current research interests include cell biology, functional neuroanatomy, haematology, radiobiology and tumour biology. Excellent facilities are available for research and postgraduate teaching.

Salary at appropriate point on scale £7190 to £14 125 pa, starting salary probably not above £8425 pa plus USS. Applications (two copies preferably in typescript) with the names of three referees should be sent by 8 July, 1983 to the Establishments Officer, The University, College Gate, St Andrews, Fife KY16 9AJ, from whom further particulars are available.

Publications Officer

The National Radiological Protection Board is seeking a Publications Officer, to undertake the following duties at its headquarters at Chilton in Oxfordshire.

Editing technical reports and other publications, including competing and standardising references, checking units, organising production of illustrations, proof reading and liaising with printers and designers.

Assisting with other information work, such as the preparation of entries in directories, editing or drafting exhibition scripts and writing the text of information sheets; assisting other staff in providing information to the media on all aspects of the Board's work.

The successful candidate will probably be a young graduate with some experience in technical editing or work on scientific journals, or both.

The appointment will be in the grade of Assistant Information Officer, with a salary range of £4865 at age 18 rising to £8195 at age 20, to a maximum of £8645. Other benefits include a good pension scheme, generous annual and sick leave allowances and flexible working hours.

For an application form, please contact Mrs V. J. Gibson, (Ref: PER A/182), Establishments and Personnel Branch, National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ, or telephone Abingdon (0235) 831600 Ext 553/548. Closing date for applications: 1 July, 1983.

National Radiological
Protection Board

UNIVERSITY OF MANCHESTER

Department of Botany
PATTERN FORMATION IN THE
DEVELOPING MUSHROOM
FRUITBODY OF COPRINUS

RESEARCH ASSISTANT

Applications invited for a Research Assistantship funded by SERC to determine the exact relationship between cells in the fruit-body gill tissues of the basidiomycete fungus *Coprinus cinereus*, as part of a study of enzyme control during morphogenesis. Initial salary range £6310-£7190 pa (Superannuation). The project is suitable for registration for a higher degree. Applicants should have, or expect to obtain, at least a 2(i) Honours Degree in an appropriate subject. The post is tenable from July 1st or as soon as possible thereafter. Applications, including a curriculum vitae and names and telephone numbers of two referees, should be sent to Dr David Moore, Department of Botany, The University, Manchester M13 9PL, to reach him by June 30th.

ROYAL POSTGRADUATE MEDICAL SCHOOL (University of London)

Chemical Pathology
ANALYTICAL CHEMIST
(Scientific Officer/Technician) required in the Peptide Research Laboratory.

Qualifications: HNC or degree in chemistry, preferably with experience in peptide chromatography (especially HPLC) and amino acid analysis. Appointment for eighteen months in the first instance, with a possibility of extension.

Salary up to £7500 pa, depending on qualifications and experience. Application forms and further particulars can be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Ducane Road, London W12 0BB quoting reference number 4/MS/RS. Closing date: 7 July 1983.

Applicants should have a PhD in Mathematics or Theoretical Physics, preferably with interests in modern methods of differential geometry and octonions. The successful applicant will work with Dr R. W. Tucker on problems related to unification schemes involving gravitation.

Further particulars may be obtained (quoting reference L282/B), from the Establishment Office, University House, Bailrigg, Lancaster, LA1 4YW, (Tel 0524 66201 Ext 4213), where applications (five copies), naming three referees, should be sent, Not Later Than 1 July, 1983.

Medicinal Chemist Pharmaceutical Research

As part of our commitment to the discovery, and development of prescription medicines, we need a post-doctoral medicinal chemist to play an important role in a research group involved in the design and synthesis of novel compounds exerting a specific action at pharmacological receptors.

We need a Chemist with post-doctoral experience in either industry or academia. Proven ability in devising and carrying out organic synthesis is essential. Experience in medicinal chemistry, or relevant biologically orientated research, and in using physical organic principles and techniques, would be distinctly advantageous.

We pay an attractive salary and full range of benefits including free BUPA, bonus plan, contributory pension scheme, free life assurance and flexible working arrangements.

Please write for an application form or send a detailed c.v. outlining qualifications and experience to the Personnel Officer, quoting reference number 935/S.

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SMITH KLINE & FRENCH RESEARCH LIMITED
The Frythe, Welwyn, Herts AL6 9AR.

OXFORD POLYTECHNIC RESEARCH ASSISTANT

IN
PHYSICAL SCIENCES
Selective Optical Materials for
Energy Efficiency

The Department of Geology and Physical Sciences is seeking to appoint a Research Assistant to work for three years on the preparation and characterisation of optically selective materials used to improve the thermal efficiency of solar energy converters. Particular emphasis is placed on the study of transparent heat insulating coatings on polymeric substrates and the potential of electrochromic materials for use in innovative converter designs. Surfaces will be prepared using chemical and vacuum evaporation techniques and analysed using reflectance and transmittance spectroscopy and electron microscopy. Durability aspects of the materials will also be studied.

Candidates for the post should possess a good honours degree, preferably in chemistry or materials science. The successful applicant will be permitted to register for the degree of MPhil/PhD with the CNA and will be required to undertake some teaching at undergraduate level. Starting salary is in the range £4847-£5649 p.a. The post is available from 1 September, 1983.

Applications which should include a curriculum vitae and the names and addresses of two referees should be sent to Mrs Judy Blakey, Administration, Oxford Polytechnic, Headington, Oxford OX3 0BP, from whom further particulars of the post may also be obtained. Closing date: 30 June, 1983.

UNIVERSITY OF MANCHESTER

Department of Chemistry/
Daresbury Laboratory
POST DOCTORAL RESEARCH
ASSOCIATE IN EXPERIMENTAL
X-RAY SPECTROSCOPY

Applications invited for the above post, funded by SERC, tenable from October 1st, 1983, or as soon as possible thereafter, for an initial period of two years. The successful candidate will be expected to pursue research at the Synchrotron Radiation Source at Daresbury and will be responsible for implementing and commissioning of a fluorescence detection facility on the newly commissioned X-ray Spectroscopy Station on the Wiggler beam line. Applicants are expected to hold a Ph.D. in experimental science; experience with X-ray detectors, general instrumentation, and computing would be advantageous. Salary range £7190-£7630 p.a. (Superannuation). Applications together with a full curriculum vitae and the names and addresses of two referees, to either Dr C. D. Garner, Department of Chemistry, The University, Manchester M13 9PL or Dr S. S. Hasnain, The Daresbury Laboratory, Warrington WA4 4AD by July 31st 1983.

UNITED MEDICAL SCHOOLS OF
GUYS AND ST THOMAS'S
HOSPITALS
QUALIFIED LABORATORY
SCIENTIFIC OFFICER

required for two years in the Renal Laboratory, Department of Medicine, at Guy's to work on a project studying immunological and non-immunological mechanisms of endothelial cell injury. Experience in cell culture techniques would be an advantage. Initial salary for qualified Laboratory Scientific Officer in range £5491-£6851 plus 2997 London Weighting.

Apply in writing, stating age and giving details of qualifications and experience, to the Deputy Secretary, United Medical Schools, Guy's Hospital Medical School, London Bridge SE1 9RT, quoting Ref RM1.

UNIVERSITY OF CAMBRIDGE Department of Pathology Clinical Microbiology and Public Health Laboratory

R6 TECHNICIAN
required in the Clinical Microbiology and Public Health Laboratory at New Addenbrooke's Hospital, Hills Road, Cambridge, to assist in a two year Microbiology Research Project supported by funds from the MRC. The aim of the project is to develop a typing scheme for clinical isolates of *Clostridium difficile*. The successful applicant will be required to carry out the necessary experimental work under supervision. Other duties will include care of apparatus preparation of reagents and special media and maintenance of adequate stocks to meet the requirements of the project. There may be opportunity to work for a higher educational qualification.

Qualifications—HNC or equivalent. Salary range £5830-£6011 p.a. Applications from new graduates welcome at a salary of £4521 p.a.

Applications in writing to The Superintendent, Department of Pathology, Tennis Court Road, Cambridge CB2 1QP giving names and addresses of two referees and quoting PF 114.



HYDRAULIC ENGINEERING: RESEARCH FELLOW

The Department of Civil Engineering is seeking a good honours graduate, with appropriate research experience, to undertake and co-ordinate research experience into Low-Cost Hydraulics Structures Using Rock Protected Earth Slopes. This is a 3-year SERC contract with UK consultant involvement. Postgraduate research students will also participate in this programme. Starting salary £6745 p.a.

Written applications, including the names of two referees, should reach Dr E. V. H. Smith, Department of Civil Engineering, not later than 30 June 1983. Please quote Ref: NS.

THE OPEN UNIVERSITY Faculty of Science

TEMPORARY COURSE
CO-ORDINATOR IN PHYSICS

Applications are invited for a temporary post as a Course Co-ordinator in the Physics Discipline. The main duties of the post are to provide a range of academic, administrative and editorial services to course teams producing multi-media undergraduate courses in Physics. Applicants should have a first degree in Physics or a relevant subject and an interest in academic administration.

The appointment is for three years and the salary will be within the Course Co-ordinator 1B salary scale of £6310-£9675 p.a.

Application forms and further particulars are available from the Assistant Secretary Science (4600/2), The Open University, Walton Hall, Milton Keynes MK7 6AA (postcards only please) or telephone Milton Keynes (0908) 653481 or 653993; there is a 24 hour answering service on 653868.

Closing date for applications: 4 July.

CSIRO Research Scientist/ Senior Research Scientist

\$A23 340-\$A34 330
Division of Building Research
Highett, Vic, Australia

CSIRO conducts scientific and technological research in laboratories located throughout Australia and employs about 7500 staff, of whom some 2900 are professional scientists. The Organisation's research activities are grouped into five Institutes: Animal and Food Sciences, Biological Resources, Energy and Earth Resources, Industrial Technology and Physical Sciences. The CSIRO Division of Building Research is a member of the Institute of Industrial Technology.

FIELD: Building Operations and Economics.

GENERAL: The Division is located in Melbourne and has a staff of 225, including 36 research scientists. Research at the Division covers a wide range of topics aimed at increasing efficiency and effectiveness in the building and construction sector of the economy and all the industries and disciplines in this sector; enhancing the potential standard of accommodation for all Australians at work, at play, and at home; and minimising any adverse impacts of the construction sector on the environment. One of the four major research programmes deals with Life Cycle Performance.

DUTIES: The appointee will undertake research into systems, operations, and economics at the building or industry level, particularly the cost-effectiveness of components and systems over their whole life cycles with particular concern for the evaluation of building quality.

QUALIFICATIONS: Applicants should have a PhD, or equivalent, in a field related to science, mathematics, operations research, engineering, building or economics together with relevant research experience. Familiarity with life cycle costing and computer simulation would be an advantage.

TENURE: A term of three years with Australian government superannuation benefits available.

APPLICATIONS: Stating full personal and professional details, the names of at least two referees and quoting reference No A1358 should be directed to:

The Chief, CSIRO Division of Building Research, PO Box 56, Highett, Vic 3190, Australia. By 15 July, 1983.

TECHNICIAN GRADE 3
required to assist with the organisation and maintenance of Biophysical, Physical and Radio Chemistry laboratories. Duties will include the preparation of reagents and instruments. Opportunities will be given to participate in more advanced work. Minimum qualifications—HNC or two A levels of equivalent qualification. Minimum experience—three years. Possible day release. Five weeks annual holiday. Salary £5151-6035 p.a. plus L.W. £1220 p.a. Letter of application to Personnel Officer, The School of Pharmacy, 29/39 Brunswick Square, London WC1N 1AX.

UNIVERSITY OF LONDON INSTITUTE OF OBSTETRICS & GYNAECOLOGY

Experienced
Radioimmunoassay Technician

required immediately to work in the In Vitro Fertilisation programme at Hammersmith Hospital. Salary according to age and experience and because the work involves assays during unobtainable hours suitable overtime payments will be made. Apply with curriculum vitae and two referees to Dr R. M. L. Winston, Hammersmith Hospital, London W12 0BS.

Closing date for applications: 4 July.

OXFORD POLYTECHNIC LECTURER II/ SENIOR LECTURER IN PHYSICAL SCIENCES

(Inorganic/Organic/Organometallic Chemistry)

Applications are invited for the post of Lecturer II/Senior Lecturer in Physical Sciences (Inorganic/Organic/Organometallic Chemistry) tenable in the Department of Geology and Physical Sciences from 1 September, 1983. The successful applicant will contribute to the teaching in inorganic and organic chemistry within the Department's undergraduate and TEC courses in Physical Sciences and Chemistry.

The person appointed will be expected to undertake and develop research extending the existing activity with the Department.

Salary according to qualifications and experience, currently in the following ranges:

Lecturer II £7215-£11 568

Senior Lecturer £10 683-£13 443

An application form and further details of the post and the Department may be obtained from Mrs Judy Blakey, Administration, Oxford Polytechnic, Headington, Oxford OX3 0BP.

Closing date: 30 June, 1983.

INNER LONDON EDUCATION AUTHORITY London College of Furniture 41-71 Commercial Road, E1 1LA RESEARCH ASSISTANT

required in the design and application of non-metallic conventional or novel materials in furniture and related products, such as musical instruments and equipment for disabled people.

The assistant will be expected to undertake a specific research programme and participate in the ongoing research and development programme of the college. A teaching commitment of up to six hours per week will be expected.

Applicants must have a degree or acceptable equivalent in an appropriate field of material technology. Salary scales in accordance with the Burman (FE) Report: £4680-£5355 (plus £939 Inner London Allowance). Starting point depending on qualifications, training and experience. Application forms and further details are obtainable from the Senior Administrative Officer at the College.

ILEA is an equal opportunity employer.

THE ROYAL VETERINARY COLLEGE University of London Division of Parasitological Studies Department of Microbiology and Parasitology

TECHNICIAN GRADE 3—
BACTERIOLOGY

Duties include the collection, maintenance and preparation of material for practical classes for veterinary undergraduates and assistance with the research programmes in the Section.

Applicants should hold an intermediate qualification at least and have some relevant experience; a degree in microbiology will be an advantage.

Salary scale: £6371 to £7255 p.a. (inclusive of London Allowance).

Application form obtainable from Personnel Department, The Royal Veterinary College, Royal College Street, London NW1 0TU. (Tel 01-387 2898 ext 264).

UNIVERSITY OF CAMBRIDGE

Department of Chemical
Engineering

A POSTDOCTORAL RESEARCH
ASSISTANT

funded by the British Technology Group for a period of up to three years is required to work in the area of high performance polymer tape production. The work will be concerned with developing and optimising an existing experimental facility for the manufacture of high strength polymeric tapes which would subsequently be tested as composites. Desirable applicants should have experience in either Chemical Engineering, Material Science, Polymer Technology or Physics. Age related Salary in the range £6800-£8085. Applicants should include the names or two referees and be sent to Dr M. R. Mackley, Department of Chemical Engineering, Pembroke Street, Cambridge.

UNIVERSITY OF OXFORD

Department of Experimental
Psychology

POSTDOCTORAL RESEARCH
WORKER—GRADE 1A

Applications are invited for a post-doctoral research post concerned with the application of voltammetric methods to the recording of brain activity in behaving animals. The appointment is supported by the MRC and would be for two years, starting as soon as possible. Experience with electrophysiological, electrochemical, behavioural and especially computing techniques would be an advantage.

Applications in writing with curriculum vitae and the names and addresses of two referees should be sent to Dr J. A. Gray, Department of Experimental Psychology, University of Oxford, South Parks Road, Oxford OX1 3D.

CLINICAL RESEARCH GROUP OF THE MAX-PLANCK-GESELLSCHAFT AT THE UNIVERSITY OF GÖTTINGEN, FRG.

A post-doctoral position is available immediately for a young scientist with experience in radioimmunoassay and peptide purification. The work of the Research Group involves the isolation and characterisation of biologically active peptides in the gastrointestinal tract.

The appointment will be either at the BAT IIA or BAT IB level (salary 45 000-55 000 p.a. according to experience) and is for up to five years.

Please send applications with curriculum vitae, names of three referees and recent reprints to:

Dr J. M. Conlon
Klinische Arbeitsgruppe
für Gastrointestinale Endokrinologie
der Max-Planck-Gesellschaft
an der Medizinischen Klinik
der Universität Göttingen
Humboldtallee 1
D-3400 GÖTTINGEN

MOUNT VERNON HOSPITAL

Marie Curie Research Wing
Regional Radiotherapy Centre
Northwood, Middlesex HA6 2RN
ASSISTANT RESEARCH
OFFICER
(0277-77471+LWE596)

Applications are invited for the position of Assistant Research Officer. The successful applicant will join a Clinical Research Group currently funded until September 1986 by a Medical Research Council Programme Grant and concerned with the sensitisation of hypoxic tumour cells to improve the radiotherapy of malignant disease.

The current research interests of the group include the introduction of new chemical hypoxic cell sensitizers into the clinic and the development of radio-frequency capacitance techniques for heat therapy. Candidates are expected to have a good honours degree in physics, biology, electronics/bioengineering, computer science or related discipline. An interest and/or experience in statistics and computer techniques would be an advantage.

Those interested in the post may obtain application/job description forms from the Senior Research Officer, Mr Peter Anderson. Suitable candidates will be invited to visit the unit, by prior arrangement, before the formal interview. Tel Northwood 26111 ext 533/4.

MAKE USE OF YOUR SCIENCE

Your science degree, laboratory background, or 'A' levels could help you become a medical/scientific representative. Many vacancies for trainees exist throughout the UK with excellent salaries + car + benefits. Phone or write (no stamp needed), for your copy of our information leaflet to Colin Mackinnon.

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LECTURES, MEETINGS AND COURSES

Sports and Science?

Are you keen on sport, yet interested in Biology as well?

If you have 2 'A' levels, one of them in a science subject, Nonington College in Kent has got the perfect degree course to offer you.

B.A. (Hons) Movement Studies with Biology

Combine Sports and Science by studying for an Honours Degree that combines Movement Studies with Biology. Human Biology, Animal Physiology, Ecology and Animal Movement are included in biological studies.

For an early interview ring Nonington College on 0304 840671.

Nonington College
KENT COUNTY COUNCIL
EDUCATION COMMITTEE

UNIVERSITY OF DUNDEE

Ninewells Hospital and Medical School

MSc IN ANALYTICAL BIOCHEMISTRY

This full-time 12 month Course, based in the Department of Biochemical Medicine at Ninewells Hospital, consists of lectures, practicals and project work covering such analytical techniques as chromatography (GLC, TLC, HPLC), mass spectrometry (GC-MS, LC-MS), radioisotope techniques and immunology, centrifugal fast analysers, automated analysis, photometric and electrochemical methods, all of which are relevant to the routine and research aspects of the biomedical sciences.

The course will be of value to graduates considering careers involving the identification and analysis of drugs, Clinical Chemistry, Environmental Analysis or related disciplines.

Applicants should normally possess an Honours Degree in a Scientific discipline. Suitably qualified applicants are eligible for support under the Manpower Services Commission TOPS awards scheme.

For further details contact either Dr J. D. Baly or Dr T. S. Isles, Department of Biochemical Medicine, Ninewells Hospital and Medical School, Dundee DD1 9SY (0382 60111, ext 2563, 2601).

UMIST

INFORMATION TECHNOLOGY

MSc COURSE IN

Integrated Circuit System Design

One year full-time MSc Course in the Design and Fabrication of Microelectronic Components, Services, Systems and CAD Tools. Student-designed circuits will be manufactured by in-house and SERC facilities.

Applications invited from Honours Graduates in Electronic Engineering, Computer Science and Physics, or from holders of equivalent professional qualifications. This Course forms part of the SERC's Information Technology Initiative and is recognised by them for Advanced course studentships. The course is also recognised by the ETB for industrial grants.

Details and application forms from: Dr A. P. Ambler, Department of Electrical Engineering Electronics, UMIST, PO Box Manchester M60 1QD, or telephone 081-236-3311 ext 2035 as soon as possible. Please quote reference EEE/C7/AJ.

FLUID ENGINEERING

Cranfield

MSc in DESIGN OF FLOW SYSTEMS

This one-year course is run by the Fluid Engineering Unit and covers design aspects of

- fluid mechanics and flow instrumentation
- open channel hydraulics
- pipe and duct systems
- seals and pumps
- high pressure hydraulics
- solids handling

The course commences in October and is suitable for graduate engineers who work, or intend to work, in areas such as the process industries, where flow systems are important. Project work will be carried out in the extensive laboratories used by BHRA for industrial research. Studentships are available for suitable applicants.

Please send further details of the MSc in Design of Flow Systems, together with an application form

Name.....
Address.....
Tel.....

Complete the details and return to:

Dr Vivien Morris, (Ref 830)
Fluid Engineering Unit, Cranfield Institute of Technology,
Cranfield, Bedford MK43 0AL
Tel. Bedford (0234) 750111 Ext. 3422

THE OPEN UNIVERSITY

MSc in Mathematics

by part-time external study

Applications are invited for a part-time MSc programme in Mathematics starting in January, 1984. A range of courses is offered in the broad area of pure and applied mathematics, the first two of which, available in 1984, are *Nonlinear Ordinary Differential Equations* and *Applied Functional Analysis*. A further three courses will be added in 1985: *Analytic Number Theory*, *Matrix Groups* and *Theoretical Mechanics*, to be followed by *Functional Analysis* in 1986. Six courses must be taken to gain the degree.

The programme is open to applicants in any part of the United Kingdom. Study is home-based; there is no requirement to attend lectures or tutorials. Teaching is by correspondence texts and set books, with continuous assessment and end-of-year written examinations. There is flexibility for students to choose the period of time over which the degree is completed. The average length of study will be three to four years but there is provision for students to take the degree over a shorter or longer period.

Applicants should normally have at least a second class honours degree in Mathematics or a degree with a high mathematical content, for further particulars and application forms please send a Postcard to the Higher Degrees Office, The Open University, PO Box 49, Milton Keynes MK7 6AD or telephone Milton Keynes (0908) 653806. Please quote reference (MT/3). The closing date for receipt of applications is 30 July, 1983.

FLUID ENGINEERING

Cranfield

MSc/PhD BY RESEARCH

The Fluid Engineering Unit offers a range of projects suitable for higher degrees in the following areas;

- Advanced flowmeter design
- Two phase flow instrumentation
- Flow around pump impellers, compressors and fans
- Jet cleaning of oil rigs
- Free surface flows at hydraulic intakes
- Numerical methods in fluid mechanics
- Water turbine design using computational and experimental techniques
- Analysis of pressure surges in flexible tubes
- Hydraulic and pneumatic transport of solids
- Optical transducers for process industry applications.

Candidates should have first or upper second class honours degrees in relevant subjects. Studentships are available for suitable applicants.

For further details please contact Professor R. C. Baker, (Ref 832)
Fluid Engineering Unit,
Cranfield Institute of Technology,
Cranfield, Bedford MK43 0AL
Tel. Bedford (0234) 752739

North East London Polytechnic Division of Applied Physics and Charing Cross Hospital Department of Medical Physics MSc Medical Radiation Physics

This is a part-time, two year course on Tuesday afternoons and evenings at the Polytechnic and Hospital sites. It leads to the MSc award of the CNA. Applicants should have an Honours degree in Physics or in some subject with a major Physics content. The syllabus covers computing, radiation physics, radiation detection, radiation safety, radiography, computed tomography, radiotherapy, radionuclide imaging and the use of non-ionising radiation.

Details and application forms may be obtained from:

The Science Faculty Registrar, North East London Polytechnic, Romford Road E15 4LZ. Tel 01-590 7722 Ext 4014.

NELP North East London Polytechnic

UNIVERSITY OF BIRMINGHAM

Department of Physics

M.Sc. COURSE IN THE PHYSICS AND TECHNOLOGY OF NUCLEAR REACTORS

Applications are invited from candidates having, or expecting, an upper second or first class degree in physics, mathematics, metallurgy or engineering. A limited number of SERC studentships are available. For further details and application forms apply to: Dr Derek Baynon, Department of Physics, University of Birmingham, PO Box 363, Birmingham B15 2TT. Tel 021-472 1301. Ext 2078 quoting NS.

STUDENTSIPS

UNIVERSITY OF MANCHESTER Department of Chemistry RESEARCH STUDENTSHIP IN PICOSECOND LASER SPECTROSCOPY

A CASE research studentship is available commencing October 1983 for research into the application of picosecond lasers to ultrafast photophysical and photochemical processes in molecules. Applications to Dr G. S. Beedard, Department of Chemistry, The University, Manchester M13 9PL, stating qualifications and names and addresses of two academic referees.



AMERSHAM INTERNATIONAL THE UNIVERSITY, SOUTHAMPTON SERC CASE STUDENTSHIP IN CHEMISTRY

Applications are invited for a SERC CASE Studentship for three years leading to the degree of PhD. The project will involve the synthesis of bifunctional chelates for the binding of radioactive metal ions to carrier proteins and the assessment of the labelled carriers as diagnostic aids in nuclear medicine. Further details may be obtained from Dr P. Wyeth, Department of Chemistry, The University, Southampton SO9 5NH.

UNIVERSITY OF ABERDEEN

Department of Natural Philosophy RESEARCH STUDENTSHIP

Applications are invited for an SERC Research Studentship in Information Technology, tenable for three years from October 1983 and leading to a PhD degree, to investigate acoustics and data analysis for surface texture evaluation using high resolution ultrasonic probes.

Applicants should have or expect to obtain a first or good second class Honours degree in Physics or Electrical Engineering. Further information and application forms can be obtained from Dr M. A. Player, Department of Natural Philosophy, Aberdeen University, Aberdeen AB9 2UE. Tel: 0224 40241.

UNIVERSITY OF LONDON INSTITUTE OF ONSTURBES & GYNAECOLOGY

Experienced Radioimmunoassay Technician

required immediately to work in the *In Vitro* Fertilisation programme at Hammermith Hospital. Salary according to age and experience and because the work involves assays during unobtainable hours suitable overtime payments will be made. Apply with curriculum vitae and two referees to Dr R. M. L. Winston, Hammermith Hospital, London W12 0HS.

BIRKBECK COLLEGE

(University of London)

RESEARCH STUDENTSHIPS IN CHEMISTRY

Applications are invited for several postgraduate studentships (funded by SERC and other sources) for courses leading to the degree of Ph.D. The research areas available include spectroscopy, medicinal chemistry, solar energy conversion, photochemistry and synthetic inorganic chemistry.

Applications, with a curriculum vitae and the names of two referees, should be sent to Professor C. D. Flint, Birkbeck College, Malet Street, London WC1E 7HX as soon as possible.

UNIVERSITY OF BATH SCHOOL OF BIOLOGICAL SCIENCES SERC/CASE RESEARCH STUDENTSHIP

This studentship is funded in collaboration with Beecham Pharmaceuticals and is supervised by Dr G. D. Holman. The project will investigate toxin induced necrosis in isolated enterocytes and the mechanism of action of antineoplastic drugs. Application forms should be obtained from Dr G. D. Holman, Biochemistry Department, University of Bath, Claverton Down, Bath.

KING'S COLLEGE HOSPITAL MEDICAL SCHOOL

(University of London)
Department of Anaesthesia
Applications are invited for a POST-GRADUATE RESEARCH STUDENTSHIP

Leading to a PhD, available from 1 October, 1983.

The research project will be in the area of transduction mechanisms in arterial chemoreceptors, and will involve a range of electrophysiological techniques.

The successful applicant will have access to facilities both in the Physiology Department at King's College, London, and in the Anaesthetics Department at King's College Hospital.

Candidates should have First Class Honours or a good 2nd class degree in physiology or related subjects.

Applications, including CV and the names of two referees to Dr J. C. Ponte, Dept of Anaesthetics, King's College Hospital Medical School, Denmark Hill, London SE5 8RX, from whom further details can be obtained.

WYE COLLEGE

(University of London)

RESEARCH STUDENTSHIP

Applications are invited for a Research Studentship commencing in October 1983, leading to the degree of MPhil or PhD. The project is concerned with the concept of lethal synthesis as applied to herbicides and plant growth regulators, their activity and metabolism.

The successful candidate is likely to hold a First or Upper Second Class Honours degree (or equivalent) in Chemistry, have considerable experience inorganic synthesis, and an interest in applying his/her chemical expertise to biological systems.

Applications with details of career and names of two referees, should be sent to Dr N. G. Clark, Wye College, Wye, Ashford, Kent TN25 5AH.

UNIVERSITY OF ABERDEEN

Institute of Environmental and Offshore Medicine

POSTGRADUATE STUDENTSHIP

Applications are invited from suitably qualified graduates in physiology, biochemistry or a related subject, for a postgraduate studentship within the Institute. The topic of research will be the effects of variations in substrate availability on the metabolic response to exercise. Both human and animal models will be employed.

The studentship is available at normal Research Council rates, from 1 October, 1983. Applications, including CV and the names of two referees, should reach Mrs M. Shaw, Personnel Officer, University Office, Regent Walk, Aberdeen AB9 1FX by 7 July, 1983.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

RESEARCH STUDENTSHIPS IN PHYSICS AND CHEMISTRY

Research Studentships (SERC funded and others) are available for work leading to the PhD degree in a range of topics. Applications from those who hold or expect to obtain first or upper second class honours degrees in these or related fields should be made to the Head of School of Physical and Molecular Sciences, University College of North Wales, Bangor, Gwynedd LL57 2UW (Tel 0248 351151, ext 223) not later than 20 July, 1983.

PLYMOUTH POLYTECHNIC

NERC (CASE) RESEARCH STUDENTSHIP

Research into chemical processes during estuarine mixing.

A research student is required to join a collaborative investigation of chemical processes in estuaries. The work involves a study of the chemical kinetics of solution-particle interactions in estuarine media. The laboratory studies will be complemented by extensive fieldwork in the Tamar Estuary using facilities at the collaborating Institute.

Applicants should hold or expect to obtain a good Honours degree in Chemistry or an equivalent qualification. The project is for three years and the student will be expected to register for a higher degree.

Application forms, to be returned by 30 June 1983 can be obtained with further particulars from Dr Millward, Department of Marine Science, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA.

UNIVERSITY OF HULL

Physics Department

CASE AND IT* STUDENTSHIPS

Two studentships are available in a research group involved in optically detected magnetic resonance studies in semiconductors important for devices. The work involves low temperature microwave and luminescence spectroscopy in a group which takes an active part in international collaborative research programmes. The CASE award is with Dr M. S. Skolnikoff at RSRE, Malvern and involves the characterisation of defects in bulk III-V semiconductors. The IT* studentship involves the characterisation of spin effects in semiconductor heterostructures.

Please send applications with the names of two referees to Dr B. C. Caversall, Department of Physics, The University of Hull, Hull HU6 7RX, from whom further information can be obtained.

* Information Technology.

UNIVERSITY OF EDINBURGH

STUDENTSHIP IN ENVIRONMENTAL PHYSICS

Applications are invited for a NERC studentship leading to the degree of PhD for research on the CO₂ exchanges between vegetation and the atmosphere in steady conditions. This is a CASE award with Dr M. Unsworth of the NERC Institute of Terrestrial Ecology. The project will extend existing work with sonic anemometers on the eddy transfer of heat from crops. The student will develop instrumentation for measuring rapid fluctuations of CO₂ concentration and will interface this to existing electronics to calculate the correlations between meteorometer and gas analyser signals. The method will be tested against gradient methods over moorland.

A good Honours Degree in Physics or Engineering with interests in Biology—or the converse—is essential.

Enquiries to Professor P. G. Jarvis, Dept of Forestry & Natural Resources, King's Buildings, Mayfield Road, Edinburgh EH9 3JU.

UNIVERSITY OF NOTTINGHAM

Departments of Health Care of the Elderly and Physiology and Pharmacology

Exercise Physiology/Epidemiology POSTDOCTORAL FELLOWSHIPS AND POSTGRADUATE STUDENTSHIPS

Professors Tom Arie and P. H. Fentem are seeking to make four appointments to a small team which will undertake research into the patterns of physical and psychological capacities in the elderly and their maintenance. There are two fellowships which are suitable for candidates with a higher degree and two post-graduate studentships for candidates with a good first degree.

The grant is for 5 years. The initial appointment will be for two years: renewal is subject to an annual review. The salary scale for the fellowships will be on the scale for non-clinical lecturers, and the studentships will be awarded according to the terms and conditions offered by the Research Councils.

Applicants should submit their curriculum vitae and the names of two referees to: Professor P. H. Fentem, Department of Physiology and Pharmacology, Medical School, Queen's Medical Centre, Nottingham NG7 2UH by 30 June, 1983.

THE UNIVERSITY OF SHEFFIELD

Department of Medical Physics and Clinical Engineering

TWO STUDENTSHIPS

Applications are invited from graduates with first or second class (Division 1) honours degrees in Physical Sciences for SERC and NERC studentships to work on the following topics:

1. Automatic analysis of auditory evoked electrical potentials to assess hearing in children.
2. Analytical and experimental studies of the mechanical behaviour of soft biological tissue.

Further details from Professor M. M. Black, Department of Medical Physics and Clinical Engineering, Royal Hallamshire Hospital, Glossop Road, Sheffield S10 2JF. (Telephone 0742-26484, ext 2712). Quote ref RB50/H.

UNIVERSITY OF LIVERPOOL

Departments of Zoology and Botany, and BIOC Ltd, Prescott, Merseyside.

TRACE METALS IN ECOSYSTEMS SERC CASE STUDENTSHIP

Applications are invited from graduates or those who hope to graduate this year with a First or Upper Second Class Honours degree in an appropriate subject. The project involves the study of mechanisms of heavy metal tolerance in invertebrates and small mammals in stressed environments using electron microscopy, X-ray microanalysis and other modern analytical techniques. The successful candidate will be expected to register for a PhD and will be jointly supervised by Dr D. J. Thompson (Zoology), Dr M. S. Johnson (Botany) and Dr H. Holden (BIOC).

Requests for further details or applications, consisting of a curriculum vitae and the names of two referees, should be received as soon as possible by The Registrar, The University, PO Box 147, Liverpool L69 3BX. Quote Ref: RV/960.

THE SCHOOL OF PHARMACY

University of London

Toxicology Unit, Department of Pharmacology SERC (CASE) STUDENTSHIP

A three-year CASE studentship, funded by SERC is available for a good honours graduate (minimum upper second class) with a strong background in chemistry or biochemistry to work for a PhD degree, commencing 1 October, 1983.

The project will involve the study of *in vivo* cell biochemistry under the influence of model toxic compounds by high resolution ¹H and ¹³C nuclear magnetic resonance (nmr) spectroscopy. The metabolic fate of these compounds in hepatocytes will also be investigated both by nmr and conventional biochemical techniques in order to elucidate basic mechanisms of toxicity and carcinogenicity. Work will be carried out in collaboration with Dr C. R. Elcombe at the ICI Central Toxicology Laboratory, Alderley Park, Macclesfield, Cheshire.

Letters of application, including a curriculum vitae and the names of two referees, should be sent to: Dr J. K. Nicholson, Toxicology Unit, Department of Pharmacology, The School of Pharmacy, 20/38 Brunswick Square, London, WC1N 1AX. (Tel 01-837 7651 Ext 89). Closing date 1 July, 1983.

ROYAL FREE HOSPITAL SCHOOL OF MEDICINE (University of London)

Department of Biochemistry and Chemistry

SERC RESEARCH STUDENTSHIP

Applications are invited from graduates or students taking honours degrees this summer in Biochemistry or related subjects for a three year SERC research studentship. The successful candidate will register for a higher degree in the University of London. Applicants must have a good honours degree (at least grade II (i)).

The project concerns changes in cell surface properties in cell biology and pathology.

A curriculum vitae and the names of two academic referees should be sent to Dr D. Fisher, Department of Biochemistry and Chemistry, RFHSM, Rowland Hill Street, London NW3 2PF, as soon as possible.

Further details are available on request.

AGRICULTURAL RESEARCH COUNCIL

FOOD RESEARCH INSTITUTE

CASE Research Studentship

Applications are invited for CASE Research Studentships for work on the following project:

1. The Surface Rheology of Biopolymers (Ref: CASE 8) Academic Body—Imperial College, Department of Chemical Engineering and Chemical Technology.
2. Rheology of Food Systems (Ref: CASE 9) Academic Body—University of Cambridge, Cavendish Laboratory.

The awards are tenable for three years from October 1983 and will lead to the degree of PhD.

Application forms and further particulars from the Secretary, Food Research Institute, Colney Lane, Norwich NR4 7UA. Closing date: 30 June, 1983.

University college of Swansea

Research Studentships

The Science and Engineering Research Council is prepared this year to offer suitable candidates a limited number of research studentships tenable in the Department of Zoology at the University College of Swansea. Applications are sought in the following areas: electromagnetic stimulation of bone formation; gametogenesis and metamorphosis in Bryozoa; morphology and physiology of intertidal Colembola; and nervous co-ordination in colonial invertebrates.

The University College of Swansea also offers a studentship for a well qualified candidate with interest or experience in cellular or molecular biology. The project concerns culturing cells which secrete medically useful substances, with the aim of developing techniques for growing these cells on a large scale.

The value of the studentships will be in line with SERC rates.

Further particulars may be obtained from the Secretary, Department of Zoology, University College of Swansea, Singleton Park, Swansea SA2 8PP.

THE UNIVERSITY OF MANCHESTER

Department of Chemistry

SERC CASE RESEARCH STUDENTSHIP INTO 2D NMR OF OLIGOPEPTIDES

Applications invited for the above post. The Studentship will involve collaboration with ICI Ltd (Pharmaceuticals Division), to investigate the application of two-dimensional Fourier transform NMR spectroscopy to the study of peptide conformation. Applications, including a curriculum vitae and the names of two referees, should be sent as soon as possible to Dr G. A. Morris, Department of Chemistry, The University, Manchester M13 9PL.

Portsmouth Polytechnic

Department of Biological Sciences

Two SERC studentships, must have 2(i) or first class honours degree and may register for a higher degree.

Studentship I
Aspects of differentiation and transcription using the slime mould *Physarum polycephalum*. Biophysics Research Group.

Studentship II
The reproductive biology and distribution of the immigrant serpulid *Hydrotus exoniensis*. Okuda, Dr C. H. Thorpe.

An investigation into the distribution, growth and reproduction of local intertidal and subtidal calcareous crustaceans. Drs Y. M. Butler and W. F. Farnham. All at the Marine Laboratory, Hayling Island.

Please reply to the Administrative Assistant, Department of Biological Sciences, King Henry 1 Street, Portsmouth PO1 2DY (Tel 0795 527481, Ext 322) for further details and application forms.

UNIVERSITY OF BIRMINGHAM

Department of Physics

Applications are invited from candidates having or expecting a good upper second or first class degree in physics or mathematics for research studentships in

FUSION AND FISSION PHYSICS and related topics.
For more details and application forms please apply to: Dr Derek Brynnon, Department of Physics, University of Birmingham, PO Box 363, Birmingham B15 2TT. Tel 021 472 1301 Ext 2078 quoting NS.

DURHAM UNIVERSITY

Department of Anthropology

Applications are invited for a three-year RESEARCH STUDENTSHIP to work with Dr M. T. Smith on "Migration and Genetic Structure among North Yorkshire Coastal Populations". The successful applicant will have at least an upper second class degree with a specialism in biological anthropology, evolutionary biology, genetics or historical demography.

The project is designed to evaluate a linear stepping-stone model of migration by prediction of genetic structure from historical demographic data.

Further details are available from Dr M. T. Smith, Department of Anthropology, 43 Old Elvet, Durham DH1 3NH to whom applications should be sent as soon as possible.

UNIVERSITY OF LEICESTER

RESEARCH STUDENTSHIP

An award is available for a collaborative project between Dr R. O. Stephen (Department of Physiology), Dr C. D. Ockelford (Department of Anatomy) and an industrial sponsor.

Applicants should have, or expect to obtain, a good honours degree in Physics, Electronic Engineering or allied subjects. The project consists of the development of a stereoscopic microscope for use in detecting ocular disease in man and a stroboscopic microscope for measuring human sperm motility.

Applications with full curriculum vitae and the names of two referees should be sent to Dr R. O. Stephen, Department of Physiology, University of Leicester, from whom further details can be obtained.

UNIVERSITY OF YORK

Department of Biology

York YO1 5DD
A RESEARCH STUDENTSHIP is available for three years to work for a Higher Degree on Mechanisms of Immune Attack and Astrocyte Activation in Glial Cell Cultures in relation to Mechanisms of Demyelination in the Central Nervous System. The project is funded by the Multiple Sclerosis Society.

Applicants must have at least an upper second class degree in the Biological Sciences, some experience with immunology and/or tissue culture work would be helpful.

Further information can be obtained from Dr M. G. Rumsby at the above address to whom applications containing the names of at least two academic referees should be sent as soon as possible.

UNIVERSITY OF NOTTINGHAM

Department of Botany

SERC CASE STUDENTSHIP
Applications are invited from biological science graduates with a 1st or 2(i) degree for a SERC CASE studentship, in collaboration with Shell Research Ltd, for studies on somatic hybridisation by fusion of protoplasts from grain legumes. The studentship is tenable for three years from 1 October, 1983, and the successful candidate will be registered for the degree of PhD.

A letter of application, including a curriculum vitae and the names of two referees, should be sent to Professor E. C. Cocking and Dr M. R. Davey, Plant Genetic Manipulation Group, Department of Botany, University of Nottingham, NG7 2RD, by 30 June, 1983.

Institute of Oceanographic Sciences (Bidston)

NERC Research Studentship

Hydrodynamics of Liverpool Bay including the Mersey and Dee Estuaries

A renewal of interest in this topic has arisen with proposals for (a) tidal barriers, (b) study of heavy metals, (c) construction of sewage treatment works, (d) construction of coastal defences and (e) land reclamation. A study of basic scientific problems associated with the above will be carried out using two and three dimensional models operated on the CRAY computer.

The studentship is for three years beginning 1 October, 1983 and leading to a PhD Degree (University of Liverpool). Applicants should have (or expect to receive) a 1 or 2.1 honours degree in mathematics, numerical analysis, physics or engineering. Further information from Dr N. S. Heaps or Dr D. Prandle, Institute of Oceanographic Sciences, Bidston Observatory, Birkenhead, Merseyside L43 7RA (tel: 051-653 8633). Applications should include a curriculum vitae and names of two referees. Closing date 7 July, 1983.

NATURAL ENVIRONMENT RESEARCH COUNCIL

UMIST

Chemical Engineering Department

CASE AWARD

An SERC CASE award is available from October 1983 for a joint project with ICI Organics Division on the Precipitation of Sulphonic Acids. The study will involve work on the phase equilibrium, batch precipitation and phase characterisation of a number of sulphonic acids and some of the work will be carried out at ICI Huddersfield Works.

The position would be suitable for someone who has obtained, or will be awarded this summer, a first degree in chemical engineering or chemistry. Normal conditions for SERC Research Studentship apply. Requests for further information and application forms quoting reference CE/SS/A/J should be sent to Professor J. Garside, Department of Chemical Engineering, UMIST, P O Box 88, Manchester M60 1UD. Telephone 061-236 3311 ext 2106.

UNIVERSITY COLLEGE, CARDIFF

Identification of Minor Components

Oil Refinery Products

SERC CASE STUDENTSHIP

Applications are invited from chemistry graduates with a good Honours degree for a project involving extensive use of mass spectrometry and chromatography (gc and hplc), and some small scale synthetic work (in association with Esso Research, Mr S. F. Noel).

Applications with curriculum vitae and names of two referees should be sent as soon as possible to Dr D. E. Games, Department of Chemistry, University College, PO Box 78, Cardiff CF1 1XL.

SERC CASE AWARD
Research Studentship for three years leading to higher degree. Project "Mechanisms of activation of polymorphonuclear leucocytes". 2(i) Degree or above required. Usual SERC studentship conditions. Further details from and applications including CV and two referees, to Dr P. N. Platt, University Department of Rheumatology, Royal Victoria Infirmary, Newcastle upon Tyne.

UMIST

UNIVERSITY OF WALES

DEPARTMENT OF APPLIED BIOLOGY

RESEARCH STUDENTSHIP

Applications are invited for a Research Studentship (tenable for 3 years from 1 October 1983) to study population dynamics of young salmon under supervision of Prof. R. J. H. Beverton FRS and Dr R. Williams and in close collaboration with staff of the Welsh Water Authority. Student will be located at UMIST Field Centre, Newbridge-on-Wye, for field studies.

Applicants should hold a first or upper second class Honours degree and must be Home students for fee purposes. Basic stipend at Research Council rates. Maximum value of studentship is £4300, from which fees are deducted. Details and application forms are available from Prof. R. W. Edwards, Department of Applied Biology, UMIST, Cardiff, to whom completed forms must be returned by 30 June 1983.

UNIVERSITY OF NOTTINGHAM

Department of Botany

NATIONAL WESTMINSTER BANK RESEARCH FUND

Applications are invited for a POST-GRADUATE RESEARCH STUDENTSHIP.

supported by the National Westminster Bank Research Fund, to work for a higher degree on an ultrastructural and stereological analysis of plant protoplasts during isolation and fusion.

The value of the studentship will be equivalent to a SERC award and will run, in the first instance, from October 1983 for two years.

Applicants should have, or expect to have, a good Honours Degree in a biological science and should apply (curriculum vitae plus names and addresses of two referees) to Dr L. G. Briarty and Dr M. R. Davey, Botany Department, University of Nottingham, University Park, Nottingham NG7 2RD, by 30 June, 1983.

UNIVERSITY OF NOTTINGHAM

Department of Bio Chemistry

SERC CASE STUDENTSHIP
Applications are invited for a studentship expected to lead to a PhD degree for research on the control of cholesterol synthesis in lactation. The project will be in collaboration with the Hannah Research Institute, Ayr. Applicants will need a first or upper second class honours degree in Biochemistry or related subject.

Applications including curriculum vitae and names of two academic referees to Dr B. Middleton, Department of Biochemistry, Medical School, Queen's Medical Centre, Nottingham NG7 2UH.

UNIVERSITY OF ST ANDREWS

CASE RESEARCH STUDENTSHIPS IN PHYSICS

SERC studentships are available in ionized gas and semiconductor physics, tenable for three years from October 1983. Further details can be obtained from Professor R. A. Stradling, Department of Physics, University of St Andrews, North Haugh, St Andrews, Fife KY16 9SS.

FELLOWSHIPS, GRANTS & SCHOLARSHIPS

UNIVERSITY OF WARWICK

POSTDOCTORAL FELLOWSHIP-PHYSICS

To work in collaboration with professor P. W. McMillan in the Department of Physics. The appointment is for two years in the first instance with the possibility of an extension, and the research programme will be concerned with the development and investigation of hard ceramic type materials for specialised applications. The work will involve studies of nucleation and crystallisation of glasses and of composite materials using a range of sophisticated analytical techniques. Applicants should have a strong interest in the physics of materials and should possess or expect to have a Ph.D. in any area related to materials science or solid state physics. Salary on the Research Range 1A scale: £7180-£11 615 pa. Enquiries and applications to Professor P. W. McMillan, Department of Physics, University of Warwick, Coventry CV4 7AL. Closing date for receipt of applications 5th July 1983.

ROYAL FREE HOSPITAL SCHOOL OF MEDICINE (University of London)

Department of Biochemistry and Chemistry

JUNIOR RESEARCH FELLOWSHIP

Applications are invited from graduates or students obtaining a good honours degree this summer in Biochemistry or related subjects for a three year Junior Research Fellowship. The successful candidate will register for a higher degree in the University of London. The project concerns the biochemical and ultrastructural mechanisms of membrane fusion reactions in cells and organelles.

A curriculum vitae and the names of two academic referees should be sent to Professor J. A. Lucy, Department of Biochemistry and Chemistry, Royal Free Hospital School of Medicine, Rowland Hill Street, London NW3 2PF by 24 June, 1983. Further details are available on request.

Electronics Research Fellowships in Japan

PhD-level researchers for one year contracts with a world leader in high-tech R&D

In the competitive fields of audio-video, home and medical electronics, communications and systems/control technologies, energy, VLSI device simulation (CAD), Toshiba is up among the world leaders. A position that was primarily established - and now vigorously maintained - by a massive commitment to R&D both in terms of capital expenditure and manpower.

To promote even greater understanding between the UK and Japan through co-operation in high technology research activities, we have created the Toshiba Fellowship Programme, which is scheduled to begin in November.

Two fellowships are available each year of our superbly equipped facilities just outside Tokyo and successful candidates will be offered the opportunity to conduct, in conjunction with our own engineers, the basic research work associated mainly with the following areas:

VLSI Device Design Simulation (CAD) • Semiconductor Technology • Crystal Growth • Surface Physics • Opto-electronics • Electro-magnetic Waves

• Surface Acoustic Waves • Pattern Recognition. Ideally aged under 35, applicants must be of British nationality, and currently engaged as researchers in UK academic or government laboratories, having obtained a PhD or equivalent in an engineering or scientific field.

With a one-year contract (renewable up to a maximum of 12 months), Fellows will enjoy a pre-tax annual allowance of approximately £24,000, together with free air passages to and from Tokyo (including spouse and children), and a relocation allowance equal to about £540 on both arrival and departure.

Simultaneously, Fellows will be provided with ample opportunities to become acquainted with both Japanese industry and culture.

For an application form, please telephone 01-242 7295 or write to the Toshiba Fellowship Programme at Toshiba Corporation (London Office), Audrey House, Ely Place, London EC1N 6SN.

Closing date: Applications must be made before 11th July 1983.

TOSHIBA
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DEPARTMENT OF CHEMISTRY

Postdoctoral Research Fellowship
in
Synthetic Organic Chemistry

Research Fellowships are available for development of new synthetic methods and for target synthesis of natural products. Starting salary on the scale £3745-£7630 per annum according to age and experience, beginning 1 October, 1983, although earlier or later date could be arranged.

Applications with curriculum vitae and names of two referees should be sent as soon as possible to Professor R. C. Cookson, Department of Chemistry, The University, Southampton SO9 5NH. Please quote Ref: NS.

LUNDY FIELD SOCIETY
SMALL RESEARCH GRANTS
The Lundy Field Society is offering a few small grants, maximum of £500 each, for research into a wide range of aspects of the biology, geology, geography, archeology and history of the island of Lundy in the Bristol Channel. Particulars may be obtained from the Secretary, Mr P. B. F. Cole, 2 Beaufort Close, Reigate, Surrey RH2 9DC.

THE ANIMAL HEALTH TRUST Unit of Comparative Ophthalmology POST-DOCTORAL RESEARCH FELLOWSHIP

Applications are invited for the above post subject to continued funding by a major funding body to study the antigens of Moraxella bovis, the aetiological agent of infectious bovine keratoconjunctivitis. The purpose of this project will be to develop a serotyping scheme for this organism and to evaluate cell antigens for their association with pathogenicity and potential as components of a vaccine. Candidates must be familiar with general bacteriological techniques and have some experience in immunology and antigen analysis.

The post is tenable for three years and is on the salary range £6375 to £11105 according to age and experience.

Further information may be obtained by telephoning Dr P. J. Cox, Newmarket (0638) 750643. Applications and curriculum vitae should be sent to The Station Secretary, Small Animals Centre, AHT Lanwades Park, Kennett, Newmarket, Suffolk, from whom application forms may be obtained.

APPOINTMENTS

MSc PhD ANALYTICAL CHEMIST
Recently graduated with wide knowledge of non-isotopic immunoassay. Urgently seeks employment in Research and Development. Box No D735.

WANTED

PHYSICS GRADUATE
5 years experience in Health Physics /Radiation Protection and Personnel Dosimetry.
Will work in UK and Europe Box D734.

AWARDS

Natural Environment Research Council Estuarine Processes a NERC Special Topic Programme

The NERC has set aside a sum of money to promote new initiatives in research on estuarine processes. This money will be available for an initial period of three years and will be dispensed through the NERC Special Topic Award scheme. This scheme gives special emphasis to the promotion of a multi-disciplinary approach to research and development of collaborative programmes between research institutes and university/polytechnic groups.

Proposals from members of staff of UK universities and polytechnics for support under the Estuarine Processes Special Topic are now invited. Further details and application forms are available from:

Dr P. Williamson, NERC, Polaris House, North Star Avenue, Swindon, Wilts SN2 1EU.

Closing date for receipt of applications is 1 September.

NUFFIELD FOUNDATION

Awards to Newly Appointed Science Lecturers

The Trustees of the Nuffield Foundation are offering a limited number of awards of up to £4000 to newly appointed University and Polytechnic science lecturers. The object of the awards is to give assistance to such lecturers in the early stages of their independent research careers. Awards will be made competitively and preference will be given to lecturers wishing to explore novel and original lines of research that may not yet be at a stage suitable for Research Council support. The awards may not be used for salaries but otherwise may be used flexibly in the furtherance of the award holder's research programme.

Nature of Awards

The awards are for a sum of up to £4000 over two years. Apart from the condition that the awards may not be used for personal salaries or to employ assistants full time, the only other restriction is that they must be used exclusively to support the award holder's own research. They may be used, among other things, for small items of equipment, for consumables and for occasional research and technical assistance; they may also contribute towards travel and attendance at conferences. Applicants will be asked to provide an outline of how they will spend the award but may be allowed subsequently to change their plans, subject to approval from the Foundation.

After two years award holders will be asked to write a report on the use they have made of the award.

Eligibility

Applicants must be newly appointed to lectureships or equivalent posts in Science, Applied Science, Mathematics, Engineering or Medical departments. Candidates must apply within 12 months of taking up their posts and may apply between the time of being appointed and taking up the post.

How to apply

Applications must be on the appropriate form, which is available from the Foundation. Applicants will be asked to provide a full curriculum vitae and to describe their proposed programme of research for the next two to three years. They will be asked to provide a letter from the Head of Department, which must include a statement of the degree of departmental support being made available. Applicants will also be asked to provide the names of two scientists who know their scientific work and who will act as referees.

The first closing date for the scheme is 31 October, 1983. Thereafter, and until further notice, there will be two closing dates a year; 31 March and 31 October. Decisions will be made within two months of the closing dates. Awards are made formally to the University or Polytechnic and will be available as soon as the institution concerned has signified its acceptance of the award.

Application forms may be obtained from the Nuffield Foundation, Nuffield Lodge, Regent's Park, London NW1 4RS.

The scheme is only open to applicants from institutions within the United Kingdom.

UNIVERSITY OF BATH

School of Electrical Engineering

SERC (CASE) Award D5082

Applications are invited from suitably qualified graduates to undertake research work, in collaboration with ICL (Stevenage), into the Reciprocity of Propagation in Induction Loop Systems.

Applicants must have academic and residential qualifications suitable to SERC and an interest in radio transmission and computers would be an advantage. Periods of attachment at ICL will be required. The successful applicant will be expected eventually to submit a thesis on the work for a Higher degree.

Application forms and further information may be obtained by writing to Mr W. E. Whelan, School of Electrical Engineering, University of Bath, Claverton Down, Bath BA2 7AY.

IMPERIAL COLLEGE

(Department of Physics)

A CASE AWARD
is to be filled for a collaborative project involving the spectroscopy group (Physics Department, Imperial College) and the UKAEA Culham for Ultraviolet Spectroscopy of Tokamak Plasmas. The aim is to study highly stripped ion spectra and radiative loss mechanisms from fusion devices. Interested candidates should contact Dr J. P. Connerade, Blackett Laboratory, Imperial College, London SW7 2BZ by 9 July 1983.

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PERSONAL

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TENDERS

Opportunities in Radioactive Waste Management Quality Assurance Evaluation

The Department of the Environment is seeking tenders from organisations prepared to undertake general research in the field of radioactive waste treatment and the evaluation of treated or untreated radioactive wastes.

The organisation concerned will be required to handle packaged radioactive waste in containers up to 500 litres capacity, up to 200 GBq alpha activity and/or 20 TBq beta/gamma activity. Similar specific activity levels are likely to be involved in carrying out associated research projects.

In the first instance the contract is likely to be for three years with a possible extension to the development of a Quality Assurance Evaluation Laboratory.

Potential contractor's requiring further information or proposing to submit a tender should contact Dr M. W. Jones, Department of the Environment, Room A537, Romney House, 43 Marsham Street SW1P 3PY in the first instance by 24 June, 1983 for final submission of tenders by 27 July, 1983.

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ARIADNE

IN A supermarket on the outskirts of one of those new towns that effortlessly combine boring architecture with wind-blown squalor, I was appreciating once more the wonders of the scientific age. Every item bought by a customer was skidded across a transparent panel, whereupon, not only the price of it, but a description of the article was printed out on the bill, too, thus getting rid of the familiar kitchen puzzlement of what the 49 pence was for.

Afterwards, looking at the items, impressed, I bogged down in an ignorance just as familiar. The codes are printed, as everyone knows, in stripes of black and white on the wrappers. I have had several goes at deciphering what the code is. Try as I may, I cannot relate the width or number of stripes to the printed figures, even comparing what I think is the code for a figure to its second appearance in the stripes.

No doubt, it is all simplicity itself and I am seldom afraid to confess ignorance, a form of self-congratulation if ever there was one. So if anyone would care to explain it to me, gratitude will be his. □

THOSE with 40 dollars to spare and who already have a small computer and a total lack of imagination, coupled with an absence of culinary skill, should immediately charge out and shout for aid from Virtual Combinatics of Rockport, in the US. (I admit it would be a loud shout and a difficult one, but the principle is sound.)

With the money you can buy a program called Micro Cookbook and your problems of what to do with leftovers stored in the refrigerator are solved. Switch on the computer, put in the program, tell the electronic circuits what you have in the saucer-covered bowls and old bits of plastic wrap and all kinds of delicious dishes will be suggested. You can even enter your own recipes, if you have any, create your own cookbook and prepare a shopping list. All that is possible instead of looking in a book and using pencil and paper. Truly, the kitchen of the future holds out dazzling prospects for anyone who can't summon up enough intelligence to whip something up from leftovers but has enough to operate a computer.

All, however, may not be well. The program has been produced by someone who is not too handy with spelling. An American friend tells me that an owner of a Micro Cookbook asked it to recommend an Italian dish containing tomatoes. The versatile, amazing wizard in the kitchen replied, "There are no Italian dishes containing tomatoes." The program recognising only "tomatos". Mamma mia!

Also on sale is the computer age bar guide, named Micro Barmate. The news leaves me stirred and shaken. □



WHILE we are on the subject (what it will appear in due course, if I may so express myself), this magazine has received an interesting report from an Australian research institute, about pigeons, though it concerns American homing pigeons.

The current theory is that the homing capabilities of homing pigeons depend, at least in part, on a small speck of magnetite in the birds' brains. In a test of this theory, two groups of 20 pigeons, one a control group and the other the experimental, were taken 35 kilometres away from their roost to be released. The birds in the test group were first exposed, the report says, to temperatures greater than the curie temperature of magnetite, thus making the magnetite ineffective as a compass. Records were kept of the return rate of both groups.

All the pigeons in the control group returned while not one bird in the test group did. The report says that this result is conclusive proof that homing behaviour in this species of pigeon is controlled by magnetic properties.

Perhaps the two outfits, one in Maryland and the other in New South Wales, should keep in touch. A recipe for pigeon pie might prove a popular item in the Micro Cookbook. □

FOR YEARS I have been reading about the benefits of satellite pictures of the Earth. With clever dodges provided by computers—changing colours at will, for instance—the progress of crops, the spread of pollution, the possibilities of irrigation, the growth of cities and much more could be surveyed for the good of hungry mankind and so on. Not the least to benefit would be what used to be called the poor or backward nations, those now emergent or in the Third World or developing.

But there is a row going on about the French scheme to sell such pictures to be taken by their Spot satellites, due to be orbiting in 1985. Objecting to the plan are Third World, developing and emergent

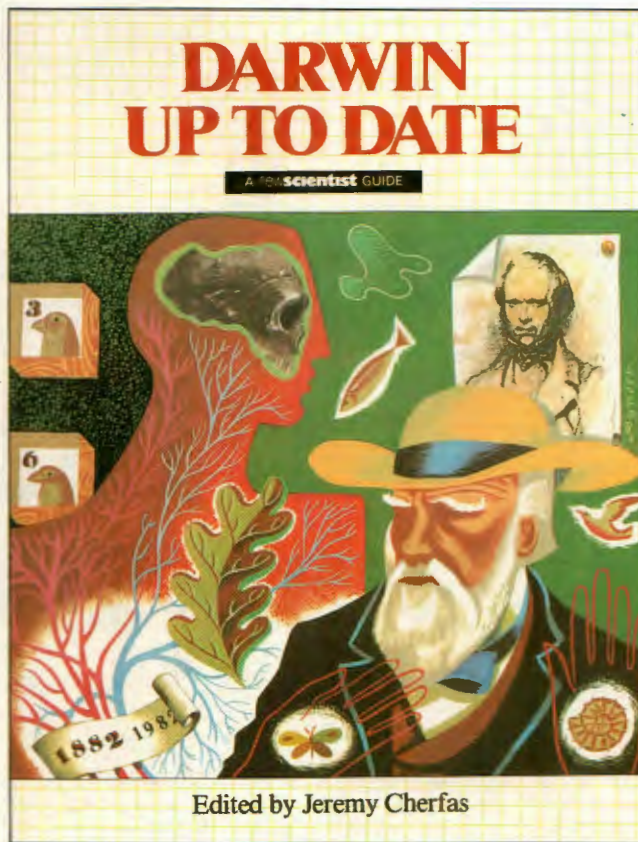
countries, who want the UN to have a go at controlling the production of the photographs, because, they say, it could prejudice their territorial and military security. One of the reasons quoted is that the pictures could show up the state of crops, mineral resources, forests and so on, indeed, all those things that can be surveyed for the good of hungry mankind and so on (see above).

It is not worth going into this subject in any more detail. A dropped jaw will suffice. □

LAST week, Daedalus outlined his scheme for the "accelerated ageing" of prisoners by whole-body nuclear-magnetic-resonance (nmr). Every biochemical has a unique pattern of nmr resonances; by dumping energy specifically into the key chemicals of ageing, their time-evolution could be vastly speeded up. In a few hours, many years could be clipped out of a prisoner's life, while his memory would be simultaneously aged. Long stays in prison could be abolished.

DREADCO biochemists are now seeking more humane applications of the principle. They are irradiating volunteers with controlled patterns of nmr frequencies, to see what bodily and mental changes result. This should give crucial biochemical insights. It will also enable DREADCO to compile tables of therapeutic nmr frequency-patterns, each capable of ageing or equilibrating a specific biochemical process. The first therapy targets will be "limbo experiences": recovery from shock or trauma, acclimatisation to new surroundings, adjustment to loss or disappointment, etc. By rapid nmr-aging of the underlying brain chemistry, these slow and dismal chunks of life could be zipped through in a few minutes, while the associated disturbing memories would be rapidly distanced. Similarly, nmr irradiation, while training for athletic feats or studying for exams, might well speed up the readjustment of body and brain chemistry to the new demands. The tedium of slow reorientation would be neatly avoided.

Another obvious application is to parasite diseases (malaria, liver fluke, etc.) which are still hard to treat. Appropriate nmr frequencies should accelerate the parasites' chemistry without affecting their host. Their delicate life-cycle would be disrupted, and in a few minutes they would all die of old age. But before starting on any of these humanitarian schemes, Daedalus is tackling the most profitable ageing process of all: that of wines and spirits. By rushing whisky and wine through years in a few minutes, he hopes to amass enough money to underwrite the more altruistic aspects of the programme. □



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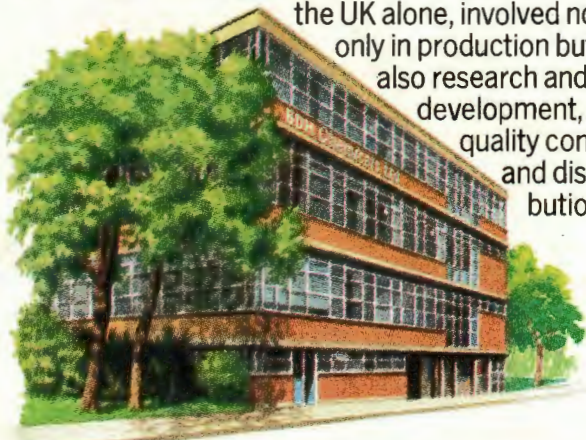
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