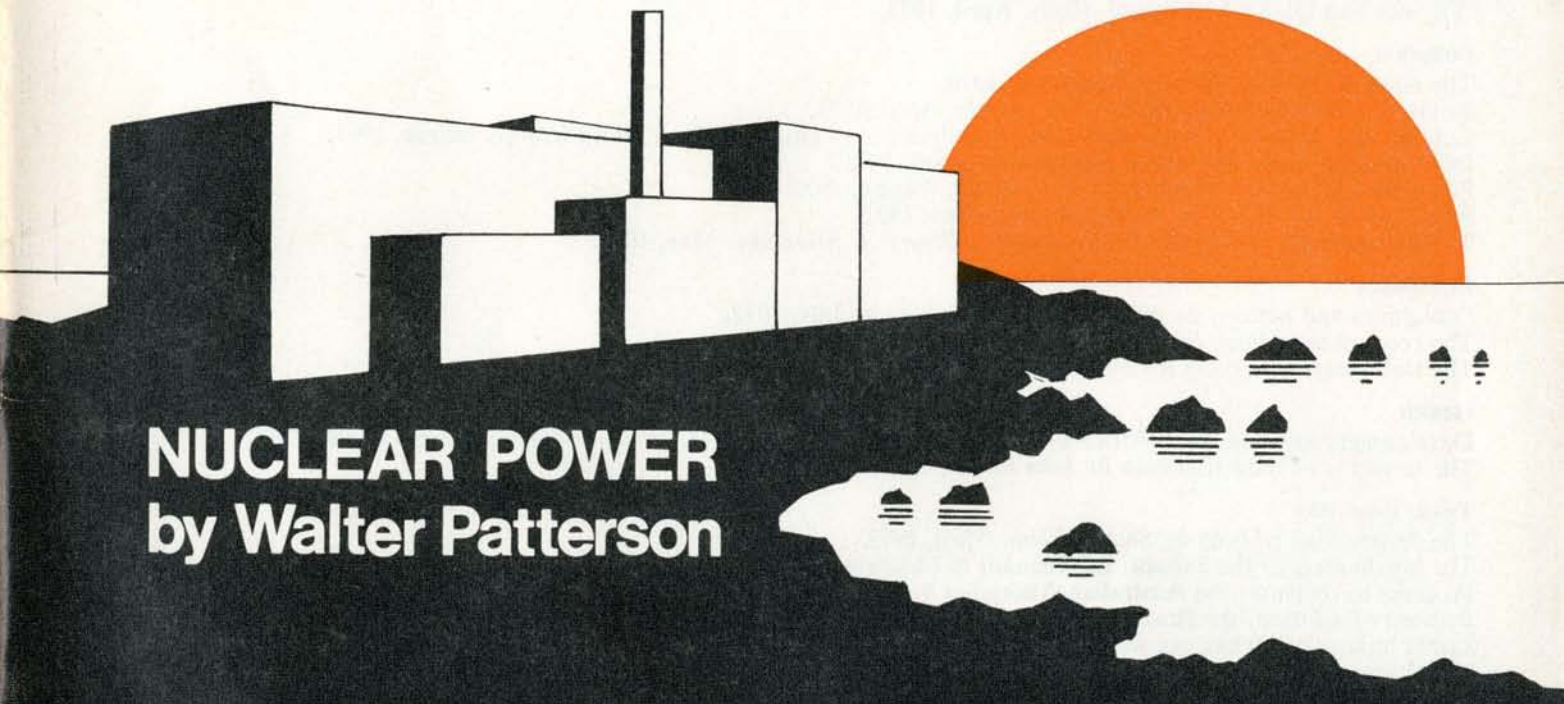
ecologist

Vol. 3 No. 7 July 1973 25p

LIVING OFF THE SUN
by Andrew MacKillop



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by Walter Patterson

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Eco-power to the people

Hesitantly, but with increasing confidence, an alliance is being formed in Washington between poverty and welfare groups, organised labour and conservationists. There has, of course, been much talk about the potential of such alliances. But only in the last few months has the Urban Environment Conference, a grouping of labour, poverty, environmental, church and ethnic organisations, begun to gain serious momentum.

Senator Philip Hart (Democrat, Michigan) can claim some responsibility for mobilising the initiative through the Senate Commerce Commitees Sub-Committee on the Environment, of which he is chairman. But the prime mover behind this national focus of an incipient local alliance is a former National Welfare Rights organiser, Rafe Pomerance. Over the last 12 months Pomerance has patiently engineered an alliance of powerful organisations on a number of urban and workplace environment issues.

The first focus of the Urban Environment Conference was the Federal Highway Trust, Fund, a legislative lockup renewed biennially since 1956, which provides for the re-cycling of petrol tax revenues from motorways. (highways) to build more highways. The Federal Aid Highway Act was up for renewal last year. After an intense lobbying operation by a Highway Action Coalition, the bill to continue the Trust Fund will shortly be introduced by its supporters. But there are at least even chances that the self-feeding fund will be "cracked" this time round, and a part of its $7 billion annual revenue diverted to pay for urban mass transit. Whether or not this can be achieved depends in large measure upon whether the Urban Environment Conference can help existing transport reform coalitions to marshall a united front of conservation, health, poverty, civic, public service, women's and "senior citizens" groups in the 45 critical districts where votes of Congressmen must be changed.

Unions and occupational health

The Highway Trust Fund is only one of a number of issues on which the Urban Environment Conference is organising mutual support. At a major

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Car window-sticker issued by the Committee to Support the Shell Strike

FOE versus RTZ

Over two years ago a handful of people resolved to stop the largest mining company in the world from digging up part of one of the world's best known areas of outstanding landscape value. The company was RTZ, the area the Snowdonia National Park; and the group of people formed the nucleus of Friends of the Earth—the UK cell of the international FOE movement. In fact, it was their resolve to fight for Snowdonia and other National Parks in the UK which first brought FOE press recognition. Reporting in the *Evening Standard* of 20 February 1971, Alan Massam recorded that "if fighting to preserve Snowdonia involves a political rally or action in the High Court, there are now people prepared to go to these lengths". That was before their much better publicised Schweppes activities, before the Friends' Endangered Species and Anti-Whaling Campaigns had been launched and before the UK FOE network of nearly 10,000 supporters had been established. The RTZ Campaign, as it came to be known, was nevertheless "the big one", and the one seen as the most difficult to win.

The campaign became the prime responsibility of four members of the FOE staff: Graham Searle, Director of FOE; Simon Millar, geologist and researcher; Amory Lovins, physicist and researcher; and Phil Evans, photographer—a remarkable mixture of an Anglo-Irishman, an Australian, an American and an Anglo-Welshman. Perhaps not surprisingly the team functioned by each man simply playing to his strengths. Half an Irishman did the talking, the American did most of the technical and quantitative research, the Aussie was the digger—the one who got hold of stories before they broke, the half Welshman was the romantic,

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meeting in Washington on March 1st jointly chaired by the (black) chairman of the National Tenants Organisation and the (white) Executive-Director of the powerful Wilderness Society, we heard representatives of the "heavy" United Steelworkers of America, the Oil, Chemical and Atomic Workers and the United Auto Workers Union present a joint statement with the Environmental Defense Fund on occupational safety and health.

The true horror of the American occupational health story was recently documented in the Department of Health, Education and Welfare's first annual report to Congress, called for under the Occupational Health and Safety Act of 1970. This report estimated that at least 100,000 workers die in the USA each year as a result of prolonged exposure to contaminants in the work-place environment. This does not include the 14,000 workers who die annually of job-related injuries. The 1970 Act was a legislative landmark in its attempt to get a uniform nation-wide basis for safe and healthy working conditions. But in 1971 and '72 it was subjected to a major attack. It is another example of the old American trick of noisily trumpeting a generous, far-reaching piece of legislation then switching to pianissimo piccolos when it comes to backing it with money. There is, for example, less than one Federal Industrial Hygienist to each million workers covered by the law.

A five-point proposal fielded at the meeting by the steel and auto workers and the Environmental Defense Fund demands inclusion of all employers—large and small—in the Federal Occupational Safety and Health Programme. It also calls for aid to workers thrown out of a job due to enforcement of environmental measures, so as to prevent environmental blackmail by employers, and asks support for full coverage of all occupational diseases by Workmen's Compensation. All the member organisations of the Urban Environment Conference present agreed to support this statement.

First environmental strike

Next it was the turn of Anthony Mazzochi of the Oil, Chemical and Atomic Workers' Union. He called for support for his Union in its environ-

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Scientists confront theologists at Geneva "consultation"

The limits to theology?

Such documents as *The Limits to Growth* and *A Blueprint for Survival* challenge the values and assumptions that underlie western, industrial society. Since it is the churches which establish and maintain many of the basic ethical standards of society and since this is one of the functions of religion, they are religious statements, as well as social, economic, political and scientific statements. There is reason to believe that the churches are becoming aware of the need for them to take an active part in the debate on the future of man.

The prospect is exciting, for it opens up the possibility of a resumption of the debate between scientists and theologians that ended in mutual incomprehension and rejection in the nineteenth century.

The World Council of Churches, from its headquarters in Geneva, is sponsoring a series of meetings between scientists and theologians. A former director of its Ecumenical Institute is both lay preacher and professional marine biologist. There is more than just discussion, however, for the WCC has scientists of its own in the field. It is financing a team of ecologists who are studying the problems associated with re-establishing the climax rain forest ecosystem destroyed in Vietnam by US defoliation.

From the 6th to the 12th April the Ecumenical Institute, which is run jointly by the WCC and the University of Geneva, held a consultation on "The Price of Progress". The aim was to explore the ethical and theological implications of the ecological crisis. The forty or so participants came from both industrial and non-industrial countries and included theologians, ministers of religion, students, economists, social scientists and scientists from industry, government and university. They were eager to communicate but, not surprisingly after so long, they found it difficult.

The scientists came for guidance, the theologians for information. Their studies of human ecology had led the scientists to a recognition that the crisis facing man is not susceptible to technological solution. In that sense it is misleading to talk of "problems". Some of the theologians, however, seemed to expect news of technological fixes that would enable us all to go on living as we live now.

There were three half-day plenary sessions devoted to ecology, economics and theology and the ecology and theology did not help. The ecology was too general for an audience that would have welcomed a more profound presentation and the theology was understood by no one, including the theologians. Theology, we learned, is not concerned with answering questions or even with providing straightforward guidance. There is still a good deal of angel-counting going on in the seminaries, which might benefit from the assistance of That Computer.

A crisis for the rich

In spite of, or perhaps because of, this, the crisis exists within the industrial nations. It is they which consume the resources, they which degrade the environment and it is they whose way of life is threatened. *The Limits to Growth* and *A Blueprint for Survival* might have read quite differently had they been written by teams from the Third World. Nor can the crisis be resolved permanently by extensive recycling and the substitution of materials guided by "the market". The economist who spoke of this had no answer for the CERN physicist who asked where the energy might be found.

If they are prepared to be ruthless enough the rich nations and, more particularly, the rich within the rich nations, may be able to sustain their rate of consumption for some time yet, but only at the price of increasing the exploitation of the poor. Is this the kind of world the churches would advocate? The only alternative involves radical changes in our systems of values which will lead to equally radical social changes, so should the churches foment revolution? Some of the churchmen looked glum at the suggestion, but it was discussed at length on the insistence of a group of French students.

The role of religion

Within most cultures, religion plays two roles, the priestly and the prophetic. In times of peace the priest seeks to maintain the status quo within a stable society. He is conservative and abhors change. In troubled times, however, he may become a prophet. The prophet seizes upon instability within society and uses it as an instrument to promote change and improvement. He is visionary and Utopian, looking beyond the present to a future he believes may be attainable. In the face of the ecological crisis, should the churches emphasise their prophetic, rather than their priestly role? Some of those present felt very strongly that they should.

One of the four discussion groups spent some time discussing the two philosophical concepts of time. There is linear time, in the sense of a series of events, and non-linear time which contains within itself the possibility of all events, a pregnant time. If, instead of measuring the number of years that may or may not be left to us, we regard the future as being radically different from the present and therefore offering the hope of improvement, the prospect becomes thrilling.

This group even went so far as to identify some of the elements of what it called "a new theological paradigm". "We must recover a lost sense of wonder, sensuality, spontaneity, and wildness; we must recover our ability to celebrate within constraints; we must accept freedom as the recognition of necessity, as service to the Creator in His creation; we must recover an ascetic sense, an ability to

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Eco-power *continued from page 242*

mental strike against Shell. In this—the first industrial action taken by a major labour union over an environmental issue—Shell refineries have been struck at Anacortes, Washington; Martinez and Long Beach, California; Pasadena, Texas and Norco, Louisiana. The Oil, Chemical and Atomic Workers are demanding periodic surveys by qualified industrial health consultants, approved by the union, to check on workplace hazards, full access by workers to the company's health records, periodic "relevant" physical examinations and medical tests at the company's expense, and compensation for workers' time spent in participating in such health-checking procedures.

Most of the major US oil companies, including American, Arco, Gulf, Texaco, Union, Sohio, Mobil, Cities Service, Exxon, Conoco and Philips have already agreed to the substance of these provisions. Shell has resisted. And since early January Shell management personnel have continued operating its highly automated refineries. They have been helped greatly in this understaffed enterprise by the fact that US air pollution authorities refuse to monitor plant during strikes.

Shell's position is that health is not a matter for bargaining, and must be solely a management decision. The Union claims that it is fighting on a point of fundamental principle: workplace health as a right rather than a privilege. Despite the fact that Shell management appear both obdurate and able to manage their plant without organised labour, the Union feels strongly placed in that 61,000 out of a total of 65,000 US oil refinery workers have already won the concessions that the union seeks from Shell.

Questions were raised at the meeting on the propriety of environmental organisations helping a union in its battles with management when money issues were involved. But Mazzochi convinced all those present that the right of workers to identify pollutants in the workplace is a fundamental aspect of protection of the human environment. As a result, all organisations present signed on the dotted line and agreed to help in a boycott of Shell products in the US, pending settlement of America's first environmental strike.

Action against lead

Finally, amid the polluting of paper coffee cup dregs with cigarette ash, Judy Assmus of the Washington Research Project and Dick Wade of the American Public Health Association offered a statement for Conference support on lead paint poisoning. We were all issued with the statement, already signed by the American Academy of Pediatrics, the American Federation of State, County and Municipal Employees, the American Public Health Association, Environmental Action Inc. and the Washington Research Project Action Council. We were reminded that more than 200 American children die each year from lead poisoning, 8,000 children suffer permanent brain damage each year due to contact with lead-based paint (800 of them being sufficiently mentally retarded to be institutionalised) and an astonishing 400,000 are poisoned to some degree by contact with lead paint. Of course the victims of lead paint poisoning are the most vulnerable children in our society—the poorest, of racial and ethnic minorities and under three years of age. All this still goes on despite the existence of a Lead-based Paint Poisoning Prevention Act under which $30 million was authorised for screening and treating children in January 1971, while $7.5 million was forced upon an unwilling Nixon Administration by Congress, after a senior citizens' campaign. Now the administration has said that it will not request any further Federal money for lead-paint programmes; any further action must be taken by the states.

Again, Pomerance's Conference got behind the proposers, agreeing to campaign for a further Prevention Act, and—more important—the money to produce some results.

Six foot four inches Pomerance, who at 25 is already a seasoned Capitol Hill Lobbyist, sees three objectives for the Urban Environment Conference. It brings together selected national, urban and environmental groups to discuss and act on specific issues, in particular housing, urban transportation and "environmental blackmail". It has also begun to act as a clearing house for ideas and educational materials in which the experiences and priorities of participating groups rub together and engrain themselves in each other. The Conference could also act as a service organisation, helping to put together organisational models for action to deal with interdisciplinary environmental ills.

At present it does well to reach and appeal successfully to the wide range of poverty, labour and environmental bodies that sat together at our March 1st meeting. At the close of that meeting the member organisations agreed to set up a fund-raising committee to support a secretariat which could expand the Conference's work. Pomerance has so far managed his coalition-forming activities virtually on thin air. But when Bob Hayden of the United Steelworkers volunteered to join the fund-raising effort, the cash underpinning that Pomerance needs was virtually assured. This will enable him to move rapidly into higher gear. A recent editorial in the *Washington Post* took note of the awesome cumulative clout of this alliance. In a city where Congressmen's attitudes are directly linked to their postal weighing scales, the Urban Environment Conference, if it can really get rolling, could carry environmental causes a very long way. *Brian Johnson*

FOE v RTZ *continued from page 241*

the aesthete and the whole Englishman (made up from two halves) determined the way in which material could best be presented to the public. That four such men, with remarkably different personalities, could stay together and, although overworked and underpaid, form the nation's data bank on the question of mining in designated areas is in itself no mean feat, but in the course of the Campaign the team did much more than that. In September 1971, they compiled much of the background research for the World In Action programme "A Subject Called Ecology in a Place Called Capel Hermon", the first TV documentary to deal specifically with the Snowdonia question and in which Searle appeared as spokesman. In May 1972, the team provided the material which led to BBC's Horizon programme "Do You Dig National Parks?" Here Lovins played the lead role with Searle joining him in the subsequent talk-in which, in the course of the campaign, proved to be the single greatest embarrassment to Rio Tinto Zinc. In it the pair systematically took apart Mr Roy Wright, RTZ's Vice-Chairman. It began to look as though FOE actually had a chance of winning. Throughout numerous news-slots on TV and radio, documentaries such as "This Island Now", lecture tours (numbering hundreds of lectures to audiences of everything from schoolchildren to DoE planners) and column miles of copy fed to Fleet Street, provincial journals and newspapers, the consistency of FOE's argument was staggeringly effective. Perhaps their most telling line was that if all the copper in RTZ's area in Capel Hermon were dug up it would provide the world with enough of that metal to last four weeks. And the cost of such a metal-mining precedent? The whole concept and reality of British National Parks. The choice was made starkly obvious.

By Easter, 1973, the FOE team had —through Earth Island, their publishing arm—brought out *River of Tears*, an international analysis of RTZ's operations written by Richard West, and, with Allen and Unwin, *Eryri—the Mountains of Longing*, a case study of the dilemmas facing Snowdonia by Lovins and Evans. They had written "Rock Bottom—the limits to metal mining in Britain" (*Ecologist*, May 1972) which formed their evidence to the Zuckerman "independent" commission and had provided 50 pages of material to Sir Roger Stevens' commission on mineral questions and planning control. They had also given evidence to Lord Sandford's team, which is investigating the future of our National Parks.

Of these works, "Rock Bottom" deserves special mention. It was the first time in the UK that a conservation organisation had resolved to tackle the wider implications of such large-scale development within our shores. It was described by Kenneth Allsop as "obligatory reading", received extensive reviews, and prompted wide-ranging discussion of British land use priorities. Later this year, Lovins's book on *Openpit Mining* (Earth Island, 60p) and Searle's work for the Open University (to be published as part of *Politics of Resources* by Penguin) will appear. But in Easter, 1973, the main focus of FOE's attention was RTZ's Annual General Meeting scheduled for 16 May. Once again these one-share shareholders in the largest mining company in the world were preparing to bash heads against the brick wall they had come to know so well.

It was then that someone took the brick wall away. On 19 April, 1973, the day before Good Friday (there were no papers to record the news) RTZ announced that in its Capel Hermon prospect, "estimates based on normal evaluation procedures including environmental factors show that it is extremely doubtful that a mining operation could be economic in the foreseeable future. Accordingly, RTZ has decided that it would not be justified in proceeding further". These bland words disguise what is one of the greatest victories for conservation in the UK.

Why, then, did the FOE team not claim the victory, instead of stressing that this was no more than an important skirmish in a war that has yet to be won? According to Graham Searle: "We were not in it for the plaudits, and we're not even sure we deserve them. Someone had to stay with the controversy from start to finish, and the someone happened to be us. The same and other companies will be back trying to get permission for large scale opencast metal mining in designated areas of the UK. You can bet on that —and while you're at it, you can bet we'll be there to take them on. This was the start of our campaign, not the finish."

Limits to theology *continued from page 243*

sacrifice; we must find new ways in which the Church may die for the life of the world, for, both theologically and ecologically, only as life is lost is life found".

Since he abandoned his hunter-gatherer way of life, man has modified his natural environment to make it sustain larger human populations. As they have grown he has come to regard nature, which seeks always to reduce his numbers to their proper level, as inherently hostile. At the same time he has created social and economic systems within which he has invented injustice, oppression, exploitation and poverty. Throughout our history we have sought ways by which we might live at peace with one another, and we have succeeded only in exporting the more extreme manifestations of our social conflicts to other parts of the world. Until now we have not attempted to mend our damaged relationship to our natural habitat. Yet the social and ecological crises are intertwined, and we cannot solve our environmental problems without creating a just society within which costs and benefits are shared more equitably. If this is so, may not the reverse be true? May social improvement be dependent on ecological reform? Can we construct a society more truly adapted to itself and to the world in which it lives than any we have known since the dawn of history?

It is too early to say whether the Christian churches will be able to rise to the challenge, and whether their leaders will realise that as priests they contribute more to the problem than to the solution.

There is a danger that just as scientists are becoming more religious, theologians are leaving their medieval retreats to embrace materialism. Nevertheless, a dialogue has begun and from it the churches may eventually find a true role for themselves in the modern world.

Michael Allaby

All hail, MacHeath! Bane of Ulster, Harrier of the Maplin Geese, Scourge of Iceland, Defender of the Fish Finger

Comment

The Cod War

British Press reports of the much misunderstood "Cod War" pay little heed to the Icelandic Government's concern for the future of the cod spawning grounds on the Continental shelf surrounding their country. The attitude taken in our newspapers and on radio and TV has been consistently hostile to what is widely regarded as Iceland's greed in the fishing limits dispute. Although her legitimate economic needs, and her dependence on the revenue from her fishing industry are admitted, her just warnings of the disastrous outcome of continued overfishing, both to herself and to foreign fishing boats, have been largely ignored.

If doubt exists about the validity of her fears, a look at the results of overfishing of herring should dispel them. Making allowance for seasonal vagaries of the herring catch the figures still make gloomy reading. Seven years ago the herring catch constituted 50 per cent of all fish taken by Icelandic fishermen; today the herring catch is a negligible 10 per cent and shows little sign of recovery.

In an interview on Icelandic Television in 1971 Mr Jackson of the FAO said "... the pressures on both national and international fisheries is so intense that many of the stocks of fish ... are now either being over-exploited, or are in serious danger of over-exploitation ... the technological explosion of new gear, new boats, new mobility has to be matched by new international arrangements ..."[1] And in Massachusetts in September, 1971 the legislative committee dealing with fisheries asked for support for new emergency legislation to extend fisheries jurisdiction *200* miles from their nation's shoreline.[2] Only such drastic measures, they claimed would save these living resources from "... virtual annihilation by the fishing nations of the world." David Devine, in an article in the Sunday Times (14 March, 1971) writing of the newest factory ships then coming into service said that they "... move through the water taking out almost everything ... larger than basic plankton. Since they return nothing to the sea, but process everything ... it would appear that they sterilise a new area of the ocean with every passage."

Unlike Great Britain, where exports of fish and fish products constitute about 0.02 per cent of her total exports, Iceland quite simply cannot survive without the fishing industry which provides *81 per cent* of her total exports. Aware of this dependence she has been concerned with control and conservation since early in the century. Admittedly she has also been seen to be prickly, oversensitive and sometimes downright awkward. But these are not the natural characteristics of Icelanders. They are the outward sign of a realistic people maddened by the slow and inadequate results of international agreements, which have proved totally unequal to the problem and pretty well impossible to impose. Compare the equally meaningless quota system for limiting the killing of whales. Each nation was allowed to take a specific number of whales annually, but the quotas were set above the level that the whale population could sustain, and were in any case cynically and systematically ignored. There is no reason to suppose that control of white fish by quotas would be more successful unless the authority to see them imposed is vested in the nation whose coastal area is being fished. Iceland is accused of refusing to co-operate with the NEAFC (North East Atlantic Fisheries Convention). The accusation is true. The reason is that the overfishing of white fish and the ravaging of the ocean is now at crisis level. International concerns fail to recognise the urgency and Iceland has consequently come to stick more and more by her own philosophy that "In the areas adjacent to its coast the coastal state is in the best position to evaluate and enforce the necessary measures, since its own vital interests are at stake."

This seemingly logical argument which turns the faces of European politicians purple with indignation is what all the S. American maritime states[3] and those of most of Afrca[4] as well as the Massachusetts fishermen already quoted, are now seeking. In this context the Icelandic Government point out that it appears to them unrealistic that foreigners can be prevented from pumping oil off another nation's continental shelf, although they may not be prevented from destroying the living resources of the same sea bed. The question of exactly how near crisis level the present stocks in Icelandic waters really are is the subject of argument, but even those marine biologists who contend that present stocks in these areas are good, admit that as other areas of the North East Atlantic are rapidly becoming fished out, pressures on Iceland waters will vastly increase.

Asked for the "official" answer to Iceland's concern for the future of the cod population, a letter from the Foreign and Commonwealth Office (February, 1973) states:

> "Although Iceland seeks to justify her unilateral extension of fishing limits on the grounds that foreign trawlers present a grave danger to the fish stocks of the area, that these stocks are in decline and that conservation measures are therefore urgently required, there does not appear to be sufficient scientific evidence available to support their contention."

and

> "... it is the British Government's view based on scientific assessments ... that cod stocks in the Icelandic area are fundamentally sound and can sustain the present level of exploitation."

A view that can only add to Iceland's suspicion that foreign governments are in no way concerned with the long term. Answering a further question about Iceland's determination to control stocks in her own coastal shelf area the same correspondent explained that because Iceland, Norway and the Soviet Union did not get together to operate a catch limitation scheme in time to save the herring, Iceland must now be treated as unreliable. I quote:

> "Iceland's poor conservation record does not therefore justify the demand for the implementation of conservation measures under exclusive Icelandic control."

To which one must reply that recrimination will certainly not save a single fish. And how poor, in fact, is this record? In his book *Modern Iceland*[5] John Griffiths writes:

"In 1944 the Icelanders turned their attention to the conservation and maintenance of the white fish stocks which, left to breed and multiply in peace, during the war, were subjected after 1945, to an almost militarily mounted harassment... and the return of foreign vessels back to these rich banks."

At the time that Mr Griffiths was writing the "cod war" referred to the dispute over the 12-mile limit, but the following paragraph is equally relevant today.

"It should be emphasised that the new fishing limits were applied in general to Icelandic as well as to foreign trawlers... Iceland was quite genuinely concerned with the conservation of fishing stocks rather than with the opportunity to make quick profits at other nations' expense".

In spite of the British Government's sanguine attitude the effects of overfishing of the breeding grounds on the continental shelf have been amply demonstrated by the mortality figures. The average age of spawning stock has been reduced in recent times from 15 to under 10, and even 10-year-old fish are becoming rare. At present most spawning stock survive only long enough to spawn once, and the erstwhile rich fishing banks are becoming marine wastelands. The situation can only deteriorate unless pressure on the spawning beds is drastically reduced. These are the facts behind the "cod war".

Iceland is not without her share of guilt. The 30 new trawlers recently built to replace the old herring fleet are equipped with modern electronic and navigational aids and it would be naive to suppose that these do not do their share of "sterilising the ocean bed" but restrictions and prohibitions concerning the use of fishing gear in terms of types, areas and closed seasons on the breeding grounds are strictly enforced on Iceland's own fishermen, and the inescapable facts are that unless they take immediate measures *themselves* to control the total catch, they are heading for certain disaster. In the light of the ponderous workings of international agreements such control can only be achieved by allowing Iceland complete jurisdiction over her continental shelf, which is in effect the 50-mile limit. The effectiveness of such a measure can be judged by looking at the remarkable increase in stocks which took place during both world wars when foreign vessels were virtually unseen in the area.

Ruth Lumley-Smith

Notes

1. Geneva Conference, August 1971.
2. New England Governors Conference, September 1971.
3. Lima. Declaration of Latin American States on the Law of the Sea.
4. Scientific Council of Africa, Ibadan, 1971.
5. *Modern Iceland.* John Griffiths. Pall Mall Press, 1969.

See also

Fisheries Jurisdiction in Iceland. February 1972.
Iceland and the Law of the Sea. February 1972.

Is Labour drowning?

The Government's proposal to allow regional water authorities to install water meters is a sensible measure to conserve a resource which is in short supply. If it encourages industry to use water more rationally, and if it encourages the development of alternatives to the more wasteful of our domestic appliances, it will have served a useful purpose. The meters need penalise no one. Clearly, the brunt of the cost will be borne by the major industrial consumers and, if the scheme works, the restrictions placed on private households need not be onerous.

The alternative to rationing early in order to conserve resources is to continue as at present until shortages necessitate more severe controls during dry spells. Since industry must be kept operating, it is not impossible that the major effect of this kind of rationing will be felt by private households.

If we can learn to use less water, we may even be able to save the homes and farms in those English and, especially, Welsh valleys that are threatened by reservoir developments.

It is strange, then, to find a proposal that will increase social justice being attacked viciously by the Labour Opposition. Mr Gordon Oakes called it "totally foreign and alien to tradition", overlooking the fact that his Party is supposed to be wedded to internationalism and progress. He may have disclosed his hand when he went on to call it "a tax on cleanliness; a tax on public health". Perhaps he is so anxious to escape from his own image of Labour as the Party of the Great Unwashed that he is willing to abandon some of its most cherished ideals. Mr Denis Howell said he could not see why water, "one of the great luxuries of life", should be approached in "such a mean-minded manner".

It is unlikely that the Labour Party is sincere, for that would mean it is totally unaware of the existing water shortage and its implications for the future. No, it is choosing to ignore the facts in order to make a short-term political gain.

It is time the Labour Party came to terms with the twentieth century and accepted that if we are to learn to live within the physical and biological limits imposed by our environment, we must find ways of sharing wealth and resources more equitably. The ecological crisis will not disappear if we ignore it, as Labour does, nor will it be resolved by the Crosland-Beckerman brand of Edwardian economics. Unless and until the Labour Party takes the major step of forgetting its nineteenth century obsessions and loses its fear of egalitarianism, such policies as it has will continue to be irrelevant and all too often it will find itself outmanouevred and left as it is left now, clutching a straw.

Michael Allaby

Notebook

Japanese environment?

The Japanese Ministry of Construction has estimated that by 1985 industrial waste will lie in a layer 2.5 cm thick over the whole inhabited area of the country. By the year 2000, Japan will be consuming 76 per cent of the world's iron ore and 92 per cent of its crude oil in a vast cloud of industrial pollution.

Source: *International Journal of Environmental Studies.* Vol. 4. No. 3

The Delaney Clause

It seems reasonable that anything which causes cancer in animals should not be added to our food. In the US there is a law to this effect, the Delaney Clause, which is part of the Food, Drug and Cosmetic Act, 1968. It is contested strongly by many scientists who argue that it is too definitive and leaves no room for scientific judgement.

According to economic forecasters the demand for food additives is rising at the same rate as the demand for convenience foods. The $500 million additives business could reach a turnover of $756 million by 1980. Senator Gaylord Nelson has said the industry itself estimates that "the average American eats five pounds of additives every year".

At a recent meeting organised by the New York Academy of Sciences, 124 scientists, lawyers and representatives of the food industry discussed possible alternatives to the Delaney Clause. One answer might be to establish a threshold for each substance, but how is it to be calculated? As one scientist put it, "I feel, in a biological sense, that there must be a threshold, but it is hard to translate it into specific experimental procedures and limits for analysis. The Delaney Clause is scientifically hard to live with, but morally hard to argue with."

The truth is that it is impossible to devise an experiment that will determine the possible effects of the 3,200 or so chemicals approved as additives by the Food and Drug Administration when they are mixed at random and administered to biological organisms each of which has a different sensitivity.

Source: *Science.* Vol. 179. No. 4074. p. 668 and editorial comment.

Aid for whom?

Aid spent on the construction of infrastructures such as roads benefits primarily the rich in the developing nations.

"Each car which Brazil puts on the road denies 50 people good transportation by bus. Each mechanised refrigerator reduces the chance of building a community freezer. Every dollar spent in Latin America on doctors and hospitals costs 100 lives. Had each dollar been spent on providing safe drinking water, 100 lives could have been saved."

Source: *Development News Digest.* Vol. 1. No. 4.

Our new masters?

According to Dr Levy, a well-known US oil consultant, the US, Europe and Japan will be importing between 53 and 71 billion dollars' worth of petroleum per year by 1980. More amazing is a prediction that the Middle Eastern oil-producing countries will be receiving 40 billion dollars a year in royalties. The US GNP is one trillion dollars. If we value the entire American economy at one third of its turnover, this means that the oil sheiks could buy it, lock, stock and (forgive the pun) barrel with ten years' royalties. They may be able to do this much more quickly, since they seem certain to exploit their hold over the industrial world regularly and radically.

As for the British economy, one year's royalties are sufficient. It seems the sheiks are already investing heavily in Scotland, and why not? Just a few months' royalties will enable them to buy the whole of it.

One can foresee a radical reversal of roles in which the industrialised countries will nationalise their industries so as not to be entirely in the power of the non-industrialised ones.

Can we afford the oil?

Even if the Arabs are willing to sell us oil, the investment required by the oil industry to satisfy world demand in the next decade is staggering. According to the Chase Manhattan Bank's annual survey, the petroleum industry will spend $1,000 billion by 1985. Of this, they will have to borrow $400 billion. "That the petroleum industry could obtain so much money in competition with all other segments of the worldwide economy is by no means certain."

The development race

It will take 131 years for the average man in the poor world to reach the income levels which the rich have now —by which time everyone in Europe and North America will be a dollar millionaire.

Source: Harrison Brown, 1971. *Development News Digest.*

A question of priorities?

The sum spent by American women on cosmetics every year is greater than the combined annual budgets of all African states which have become "independent" since the Second World War.

Source: Felix Greene, 1970. *Development News Digest.*

The growing gap

Through our own fault, we face the year 2000 and an unbelievable world of 6 billion human beings, where, compared to the privileged, earning between $5,000 and $10,000 a year, there will be three times as many poor, consuming 20 to 30 times less, each earning $300.

Source: Maurice Guernier, 1972. *Development News Digest.*

Root and branch

"There are a thousand hacking at the branches of evil to one who is striking at the root, and it may be that he who bestows the greatest amount of time and money on the needy is doing

most, by his mode of life, to produce that misery that he strives in vain to relieve."
Henry David Thoreau.

Wishful thinking

Man's capacity for wishful thinking appears to be limitless. The various criticisms of the *Limits to Growth* study overlook its main message: you cannot maintain infinite economic growth from finite resources. We did not need a computer to tell us that. The main argument used by those who refuse to face this fact is that man's ingenuity *is* infinite, so there are no limits to the technological devices he can invent to help him adapt. To this there are many answers. One is that adaptation is possible only if one is willing to face the situation to which adaptation is required. It will be interesting to see what technological device is envisaged to get us round this problem.

Who's civilised?

Denis de Rougemont, the Swiss sociologist and writer, defines a civilised country as one that protects its forests. On the basis of this definition, Britain (which is 7 per cent forested) is the second least civilised country, next to Ireland. Finland ranks first, with over 60 per cent forests.

Small is sensible

Denis de Rougemont points to the very large number of people involved in running a Swiss village. Everyone has a responsibility in the government of an ideal society. As a society disintegrates, people become concerned only with their own problems and are unwilling to assume such responsibilities. With the massive nation states of today, real democratic government cannot be achieved. As de Rougemont says: "*Plus une communité est vaste, moins il y a des gens responsables*".

Profit and loss

The tax revenue on cars is currently £2,150 million as against an expenditure on roads of about £500 million. This is taken to be "an irrefutable case for more expenditure on roads" by the RAC. If the RAC is really interested in a profit and loss statement for the road industry we will be glad to prepare one for them as soon as we have agreed a cash value for the lives lost in road accidents, the social chaos, crime, delinquency and general despair caused by the destruction of local communities as a result of the excessive mobility the car creates, the destruction of cities mutilated beyond repair to accommodate ever-increasing traffic, and the damage to health from pollution caused by cars. Will the RAC pay the bill?

Nation states

At an international conference in Geneva, Georges Bidault was asked by Molotov where the frontier lay between France and Switzerland. Bidault answered that it ran right through the middle of the lake. "How do the fish know which country they are in?" asked Molotov, quite seriously.

ZPG in the Spiti Valley

Anton J. Mokofsky sent us this interesting note:

The residents of the Spiti Valley in northern India practise a unique scheme of population control. Their valley is near Tibet and resembles it environmentally and culturally. Yaks provide milk and butter, but crops are limited in the high elevation; food is scarce. A population explosion would be immediately disastrous.

What the Spiti residents do is to send all but the eldest sons off to one of the valley's five lamaseries. The vow of celibacy is part of the monastic life. The eldest son marries and inherits his father's land and property in the manner of primogeniture. Should he die prematurely, his next-eldest brother is recalled from the lamasery (paying a release fee) and takes over the deceased eldest brother's role as master of the property and family, marrying his brother's widow, as in the Biblical law of the Levirate.

Unmarried women find a home in one of the convents. The only tempering of the strict scheme is the occasional appearance of polygamy or polyandry.

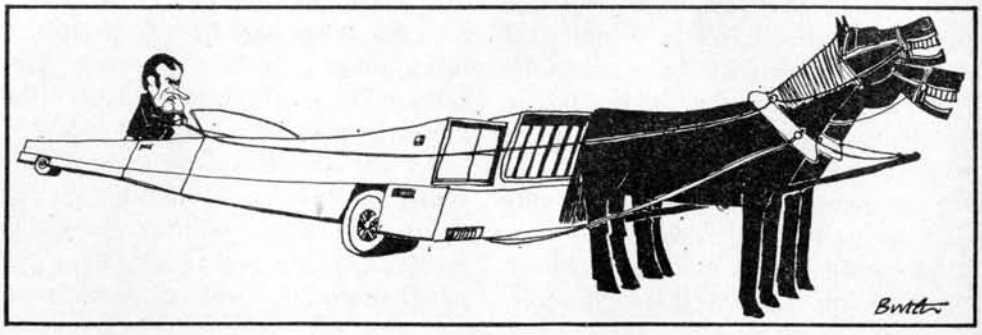
Aside from their abstinence from family life, the religious orders allow a great deal of freedom and a way of life that is, perhaps, preferable to that of the householder: monks are not confined to the buildings. Of the monastic communities at Dungkar, Tabo, Thang-gyud, Kye and Pin, the last two are the most important. The Kye monastery is said to have a great wealth of illuminated scriptural scrolls.

The prediction business

Have you noticed how scientists throw up their hands in horror when asked to make a prediction? It's not at all fashionable in scientific circles. All serious papers must end with something like: "... Samples studied are not sufficient to warrant any but the most tentative conclusions and we suggest that further research be conducted". All scientists agree that they do not know enough to make predictions, yet unless the object of science is to interpret and predict, why bother to collect information? In this respect it is interesting that our paleolithic ancestors, modest unassuming people, had no difficulty in predicting just about all the events likely to influence their daily lives. They could predict that the seasons would follow one another with clock-like regularity. They knew roughly when it would rain and when the sun would shine, when the plants they ate were ready to be gathered, when the game was ready to be hunted.

Poverty of spirit

"You have a welfare state, but I have walked your streets at night and gone into your homes and found people dying unloved. Here you have a different kind of poverty, a poverty of spirit, of loneliness and being unwanted. And that is the worst disease in the world today, not tuberculosis or leprosy."
Mother Theresa of Calcutta.



Gremlin

Limerick's limerick

Iran has initiated its Fifth Development Plan, designed to maintain her present remarkable rate of economic growth. The Plan's special emphasis on agricultural development has started the British Department of Trade and Industry and the British Overseas Trade Board rubbing their hands and licking their chops. They see a nice market for our agricultural equipment, products, and technical assistance.

So they have packed off an agricultural mission under Lord Limerick, Parliamentary Secretary of State for Trade, to "explore the potential for British participation in agrobusiness projects". Lord Limerick is possibly not unaware of the grubby irony of our buying a country's oil, turning it into petro-chemicals and the power for machinery construction, and then flogging those chemicals and machines to that same country to the long term detriment of its soil fertility—using a useful non-renewable resource to destroy a vital renewable one. If he is, he is not letting on, instead claiming the exercise to be "to the mutual advantage of both countries".

Gremlin doesn't know what impression Lord Limerick has made on the Iranians, but offers this alternative Limerick to help clarify his position:

Said Lord Limerick, "it's really quite pleasant
Selling junk to the poor Persian peasant:
We use up his oil
To ruin his soil,
And the spoils we shall keep as a present".

Corporate prophet

Sad news from Ernie Woodroofe, resident doctor in charge of Unilever (who evidently need one). This year his State of the World as it Revolves around Unilever Address contained the following: "We ourselves expect to spend about £50 million on plant to deal with pollution during the next decade. As far as we can judge, the running costs will amount to about £14 million per annum at the end of this period. There is a limit to what a company can afford".

In his recent lecture, cunningly entitled "The State of the World after the Coming of Unilever", Gremlin felt bound to observe that between 1962 and 1972, Unilever's Consolidated Profit (after tax) rose from £52 million to £133 million. Assuming a similar rise in the coming decade, 1982 would bring a pre-tax profit of over £330 million. The profit made in the coming decade would be £2,250 million. A £50 million investment in pollution control would account for 2 per cent of profit. More realistically, it would mean 0.07 per cent of turnover. £14 million for pollution control in 1982 would mean 0.15 per cent of turnover in that year. The same amount expressed as a percentage of likely 1992 turnover doesn't bear thinking about, let alone calculating.

But Ernie's quite right: there's a limit to what a company can afford. Happily, Unilever are nowhere near it.

Jingle jungle

Gremlin is getting increasingly fed up with competition from non-union sources. Walt Patterson, an erstwhile wit on the Friends of the Earth payroll, wrote the following in *Not Man Apart*, the FOE International newsletter: "Schweppes have just announced that they are abandoning their 'Sch . . . you know who' advertising campaign. They are now telling us the answer is 'weppes'. Last month Schweppes bought six copies of the FOE Packaging Report. Presumably they read it and wepped". Getting worse isn't it? With Friends like that who needs Gremmies?

Progress, or power?

Members of the British Nuclear Forum were driven to paroxysms of angry muttering early in May when they were addressed by the Minister of Industry, Mr Tom Boardman. They had listened with approval while the Minister described how important the British nuclear industry was going to be what with impending fuel crises and the like. They had marvelled at his skill in showing that talk of such crises was alarmist nonsense as far as cutting down on energy use was concerned, at the same time as demonstrating their hideous reality as far as concerned the rapid expansion of nuclear power.

Then came Mr Boardman's bombshell: "Without nuclear power as a viable and fully exploited source of energy", he said, "the pace of human progress may slow and our impetus for growth be lost". After the squeakings had died down, one nuclear potentate turned to Gremlin and hissed: "Who said anything about human progress? If we had to trouble ourselves with nonsense like that, we'd close down tomorrow".

Not Morlais, moreat

"There is no overproduction of eggs at the moment, only under consumption". Thus Mr Morgan Morlais, Managing Director of Salisbury Laboratories, who wants egg consumption to increase by at least 50 per cent. According to the National Food Survey and to Food and Agriculture Organisation Statistics, we in Britain already eat more than enough protein to meet our requirements, including excessive amounts of animal protein. Or to put it the Morlais way: nutritional requirements for protein, especially animal protein, have been set far too low.

That should give the protein starved non-industrial countries something to ponder

The wit and wisdom of Eldon Griffiths

Eldon Griffiths, Britain's first environmental mutant, thinks it a wicked waste of sea not to dump our wastes in it. In a foreword to the *Report of a survey of the discharges of foul sewage to the coastal waters of England*, he writes: ". . . . land is scarce and our rivers are used intensively. It would therefore be folly to dispose of wastes to the land, of which we have so little, or to rivers which are needed for water supply and recreation, while refusing to discharge to the seas which surround us and which offer such massive dilution".

In 1970/71, the United Kingdom used 5,286,000 tons of inorganic fertilisers. They are expensive and not the best way of feeding the soil. Failure to return sewage nutrients to the land upsets its regime, as does the addition of those nutrients to that of the sea, which needs them rather less and whose capacity for dilution is exaggerated.

By one of those charming accidents of nature, there happen to be one or two ecologists in the Department of the Environment. Gremlin suggests Mr Griffiths winkle them out and ask for some lessons in basic ecology (ee as in ee by gum; col as in cauliflower; gee as in gee ain't that swell).

Nuclear power

by Walter Patterson

"Pollution-free nuclear power" is a blanket phrase increasingly used by people who should know better. Apart from inevitable waste heat, nuclear power stations discharge significant amounts of low-level radioactivity, which are dangerous, though how dangerous is controversial. In this article, Walter Patterson, Editor of *Your Environment* and a nuclear physicist, discusses two still more important disadvantages of nuclear power: the danger of reactor accidents—great enough to dissuade those experts in risk assessment, the insurance companies, from covering the nuclear industry against them; and the apparently insoluble problem of the responsible disposal of high-level wastes. The article is taken from *Nuclear Reactors*, the first of the Red Alert books, a series of urgent environmental studies published by Earth Island.

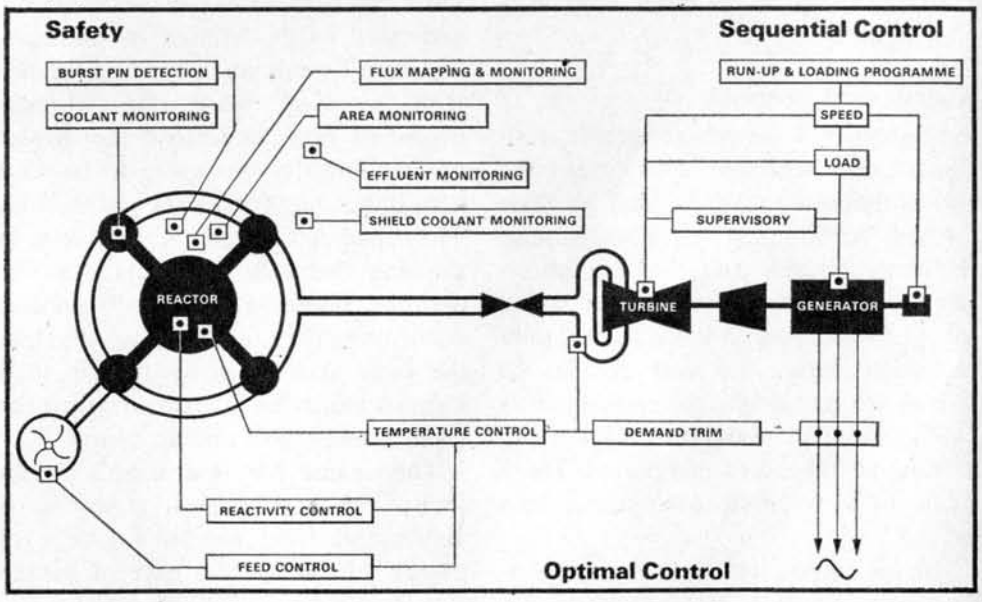
Reactor safety

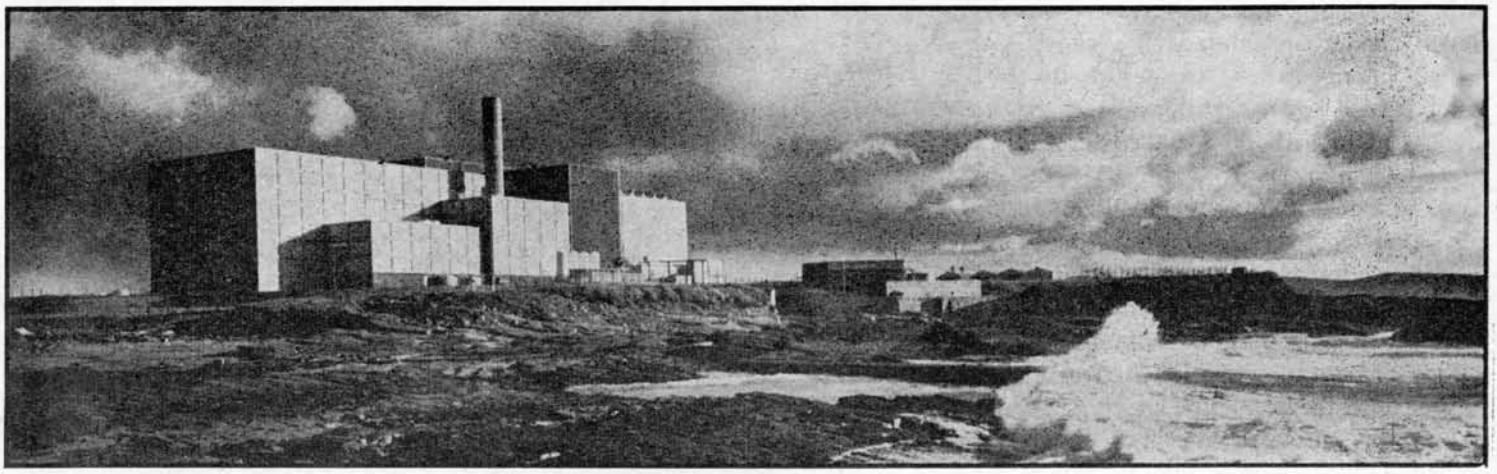
Designers, buildings and operators of nuclear reactors have laboured long and hard to dispel the public suspicion that a nuclear reactor could explode "like an atom bomb". It is worth saying here at the outset that under no circumstances could a thermal neutron reactor of whatever design cause a nuclear explosion. The fissile material is simply too dilute, and could not, by whatever mishap, become sufficiently concentrated. However, like many other types of large industrial installation, a nuclear reactor could conceivably experience, as a result of drastic internal malfunction, a non-nuclear explosion. The consequences would be comparable in every way but one to those of such an accident in any industry: deaths, injury, property damage. What uniquely distinguishes a reactor from other installations is the radioactivity it contains, which in the event of an accident might be released.

After a large power reactor has been in operation for some months, the accumulated fission products in its fuel charge dwarf the amount of radioactivity released over Hiroshima. A 1957 study prepared at Brookhaven National Laboratory by the US Atomic Energy Commission (AEC), called "Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants", or WASH-740 as it is commonly known, predicted that the "maximum credible accident" at their theoretical reactor would lead to 3,400 deaths, 43,000 injuries and property damage of $7,000 million. A study by the University of Michigan, using the same basis forecast as many as 133,000 deaths. (The term "credible accident" occurs frequently in reactor safety studies—the sparseness of operating experience to date does not give a statistical basis for evaluation beyond the assertion of the "incredibility" of certain accidents which have not yet happened.) The AEC, for reasons known only to themselves, have since refused to publish an up-dated study of accident possibilities, although the reactors now operating and under construction will be at least an order of magnitude larger than that assumed in the 1957 study. Clearly, the radioactive contents of a reactor must not, under any circumstances, be allowed to escape.

Such an absolute requirement comes up against three obstacles: technological, economic, and human. Reactors of whatever kind are designed to confine the fission products no matter what credible accident happens. To begin with, the fuel itself, in which the fission products are generated, is hermetically sealed in cladding. Then the fuel elements are enclosed within the sealed volume of the reactor vessel and its cooling circuits. There will then be at least one further shell of so-called containment; say, the reactor building

Control of a nuclear power station can be considered in three parts, safety systems, optimal control, sequential control. Diagram UKAEA





The Prototype Fast Reactor, Dounreay, Caithness, Scotland. Photo: UKAEA

itself, which will be designed so that it can be completely sealed against the escape of gases, providing a third line of defence against release of fission products to the outside air.

It sounds encouraging. But the first line of defence—the fuel cladding—has manifested with disconcerting regularity a tendency to leak. When this happens, gaseous fission products get into the primary coolant (water, carbon dioxide, etc.). In addition, impurities in the coolant may, under the intense neutron bombardment be transmuted into radioactive forms, as may corrosion products formed on the outside of the cladding, adding to the activity in the coolant. So the real "first" line of defence is the reactor vessel itself.

If the coolant is pressurised, as it is in most thermal reactors to a greater or lesser extent, the integrity of the pressure system becomes of the utmost importance. The two most common designs are those which use welded steel (such as light-water reactors, the early Magnox reactors and the European HTGR) and those which use pre-stressed concrete (such as the later Magnox reactors and the AGRs). The heavy-water systems (like the SGHWR and the CANDU reactors) have the coolant passing not through a single large vessel but through a battery of hundreds of parallel pressure-tubes.

A pre-stressed concrete pressure vessel is held in compression by thousands of steel cables, individually secured. The integrity of such a pressure vessel, more than 10 feet thick in every direction, against even the most violent phenomenon conceivable in its interior, seems unquestionable. The same is said, by both British and American reactor builders, about welded steel vessels, at least by implication: because for both industries the "maximum credible accident" they consider is a double-ended break of the input coolant duet between pump and pressure vessel. But a steel pressure vessel is a huge barrel of welded steel, subjected to high pressures, high temperatures and intense neutron bombardment. Boilers in non-nuclear plants have been known to burst. Such boilers, while perhaps subjected to higher pressures or temperatures than a reactor pressure vessel, have not undergone intense neutron bombardment. The reactor vessel has. Neutron bombardment changes crystal structures; the distorting and destructive effects it produces on a smaller scale are well known but continue to reveal new aspects. Thus far, the long-term effects of intense neutron bombardment on large-scale structures are simply outside the realm of practical experience.

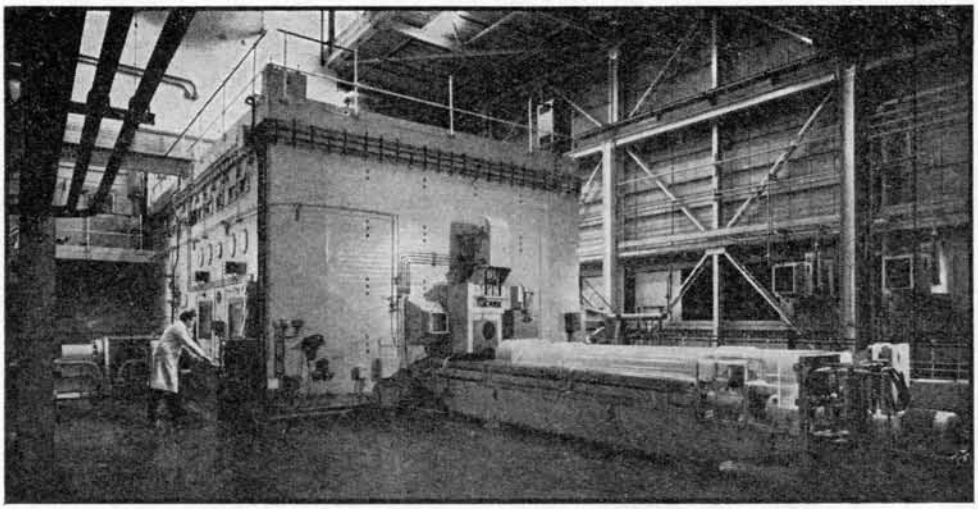
Be that as it may, the maximum credible accident considered by reactor builders is effectively an abrupt and total loss of pressurisation. It is assumed—and this is important—that the immediate consequence of this or any less serious accident is an automatic reactor scram: emergency insertion of control rods to shut down the fission reaction. (This is also known as a "reactor trip".) Emergency scram devices include, for instance, control rods suspended by electromagnets, so that the rods will drop into the core if the magnet current is shut off; sprays of boron solution or powder; and baskets of boron-steel balls electromagnetically suspended, used in graphite-core reactors in case core distortion should interfere with rod insertion. Nonetheless, there have been instances of scram failure—fortunately not in the context of a loss of pressurisation. When, as in such a case, a parallel set of identical safety devices all fail for the same reason (usually a design flaw), the result is called a common-mode failure. Records of reactor operating experience reveal many examples, in a wide variety of contexts—none serious, thus far.

Once a reactor is scrammed, and its fission reaction shut down, the majority of the internal heat generation is cut off—but not all. Some of the heat in the core comes not from fission but from the radioactivity of the fission products themselves; in gas-cooled reactors perhaps 6 per cent in water-cooled reactors with higher power density perhaps 10 per cent or more. This "decay heating" is unaffected by scramming the reactor, although it decreases as the fission products decay. Loss of pressurisation, even if followed within seconds by a reactor scram, means less efficient cooling, leading to a surge of temperature within the core. In a gas-cooled reactor the surge brings with it the possibility of melting or even ignition of Magnox cladding, coupled with serious distortion of the uranium metal; however, stainless steel cladding and uranium dioxide fuel in AGRs will have a margin of safety some hundreds of Centigrade degrees above the probable temperature maximum. Gas-cooled reactors are provided with emergency blowers and emergency supplies of carbon dioxide; even the relatively slow circulation of coolant should be enough to keep the fuel below dangerous temperatures. The mass of graphite moderator itself tends to soak up excess heat. The main requirement is that air be excluded from the core; if air were to enter, it might lead to ignition not only of the fuel but also of the graphite. In 1957 the Windscale

Number One plutonium reactor was destroyed by an internal fire caused when an unexpected surge of heat ignited fuel and graphite in the air coolant. Only filters, installed in the preceding months as a belated precaution on the coolant-discharge stacks, prevented a disastrous spread of radioactivity over the surrounding countryside. As it was, many thousands of gallons of milk contaminated with radioactive iodine 131 had to be poured into the sea.

Loss of pressurisation in a water-cooled reactor, with its higher power density, could have a much more alarming sequel. In the maximum credible accident—a break in a coolant inlet duct just outside the reactor vessel—the whole of the cooling water might be lost in a matter of seconds. Recall that the water is under very high pressure; such a loss-of-coolant accident or LOCA is often referred to as a "blow down". In the first few seconds after blow-down the decay heating from the fuel will cause the core temperature to shoot up; if this surge of temperature is not arrested within 15 seconds the consequences may be very serious indeed. The zircaloy cladding may weaken or melt; the zircaloy may react with the water, releasing hydrogen which may cause a major explosion; the buckling fuel elements may totally block coolant flow; the resulting collapse of the core may lead to a major "melt-down", in which the pool of intensely radioactive molten metal, still generating its own heat, plummets through both pressure vessel and containment, melting, burning and exploding its way downward under gravity, impossible to arrest. Such an eventuality has been sardonically termed, because of its direction of progress, the "China syndrome". The release of radioactivity caused by such an accident at a large modern light-water reactor could have consequences that would make even the Brookhaven figures look comforting.

To forestall such an outcome, light-water reactors are fitted with emergency core cooling systems, or ECCS. In a pressurised water reactor the ECCS is designed to flood the core with emergency cooling water from below; in a BWR the ECCS is designed to spray emergency cooling water from above. However, such systems have never been tested under accident conditions in a full-scale reactor; and, despite prolonged and expensive computer simulations and tests of models, there seems every possibility that the ECCS on both PWRs and BWRs may not work.



The Windscale reprocessing plant can handle 2500 tonnes of irradiated fuel a year. Fuel charging machine, with a transit flash in position. Photo: UKEAE

The intense controversy over ECCS is only one of several themes relating to reactor safety, or the lack thereof, now coming increasingly into prominence. Another was revealed when fuel elements discharged from the Beznau Number One reactor, a PWR in Switzerland, and from the Robert Ginna reactor in Rochester, New York, both proved to have undergone serious deformation during irradiation. The fuel pin cladding was crushed and crumpled, and upon examination was found to be partially empty inside. No reason for this development has thus far been reliably established; but fuel of a similar type is being used in several reactors now in operation in the US, and worries are being expressed that a wholly new phenomenon has been discovered, not necessarily confined to this type of fuel element. The AEC, belatedly informed of the discovery, reacted by issuing an edict that, in effect, nothing be done: that power levels of other reactors using the type of fuel in question be neither increased nor decreased. As edicts go it was comparatively easy to obey. Whether it meets the needs of the situation is more questionable.

Lesser accidents could involve for instance: partial failure of coolant circulation, due to internal blockage or pump failure; failure of control-rod drives; valve failure; electrical failures of many kinds; and—above all—simple human failures. As reactor operation becomes more and more routine, as personnel come to take it for granted, as earlier dedication gives way to every-day job-holding, the probability of operator error grows. There have already been spectacular instances; in 1970 the Dresden 2 BWR near Chicago spent several hours with its water-coolant falling and rising in the pressure vessel like a stormy sea, alternately leaving its core exposed or feeding water into the turbine-line—abetted by both junior and senior operators doing one wrong thing after another. Control was recovered more by luck than management. In questions of reactor safety, luck is much too fickle to count on.

It is necessary to add one more word, with particular reference to the safety of liquid-metal-cooled fast breeder reactors. In contrast to most thermal reactors, the liquid metal coolant of a fast breeder is under near-atmospheric pressure, putting much less strain on the reactor vessel and piping. In addition its thermal conductivity is high, so high that it is claimed that adequate cooling would be achieved even if the coolant circulation failed. Nonetheless, the coolant is flowing at very high speeds; even a slight blockage could impose sudden severe strains on pipework and internal structures. Such a blockage, with the resultant cooling impediment, led to the partial meltdown of the core of the Detroit Edison fast breeder reactor in 1966. If the coolant should be lost, or even be allowed to reach boiling temperature, with formation of bubbles in the core, the consequence would almost certainly be very rapid meltdown. Needless to say, metallic sodium reacts explosively with water and indeed, at these temperatures, with many other substances, even including air; there is no possibility of emergency core cooling in a fast breeder. In addition, to all

the problems associated with equipment malfunction and operator error. there must be added one last *caveat*. The fuel in a fast breeder, unlike that in a thermal reactor, might, during the course of a meltdown, collapse into a shape in which the concentrated fissile nuclei could produce a fast chain reaction: that is, a nuclear explosion.

Which is where we came in.

Reprocessing

One feature distinguishes nuclear power technology from all others: the left-overs. Unlike the ash, say, from a coal-fired station, the used fuel from a nuclear power station contains both very valuable material and uniquely troublesome waste. The first large reactors were built expressly so that, under neutron bombardment, the uranium 238 in the fuel would be transmuted into plutonium 239. This plutonium had to be recovered, as did the unused uranium 235 which was still left after fission products had poisoned the chain reaction. The same requirement holds today; both plutonium and uranium are much too valuable to throw away. Nor must the remainder of the fuel, the fission products, be thrown away—not because of their value but because of their dangerous radioactivity. So the irradiated fuel from a reactor must be "reprocessed".

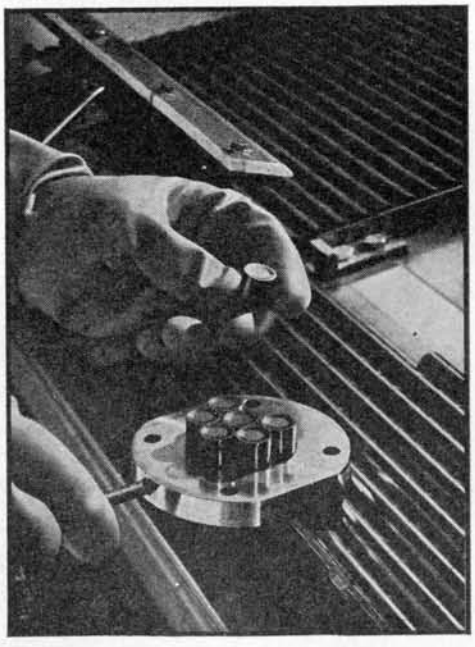
A reprocessing plant is a chemical plant—but no ordinary chemical plant. Because its raw material, irradiated fuel, is intensely radioactive, all the operations must be carried out by remote control, behind shielding. The process-equipment must be highly reliable, and require a minimum of maintenance: once it has been contaminated by the radioactivity, any malfunction will necessitate months, or indeed years, of decontamination before it can be set right. Accordingly the process-line uses a minimum of mechanical parts, and depends instead on gravity-flow and simple valves.

Different designs of fuel require different handling. The British reprocessing plant, at Windscale, was set up to handle fuel elements from the plutonium reactors and the Magnox reactors. Fuel elements enter in shipping casks, which are opened by remote control, while operators watch on closed-circuit television. Transferred to massive shielded transport cases, the fuel elements are lifted 15 storeys to the topmost floor of the plant, and fed into the first of a series of "hot cells". Operators viewing through yard-thick double windows filled with orange-tinted bromine solution pick up the elements by remote control and drop them on to a stripping machine which unzips the metal cladding as easily as peeling a banana. The contaminated cladding drops down a chute into the thick concrete bin which extends from ground level to the tenth storey of the plant, there to remain indefinitely. The bare fuel rod is chopped into short slices and dropped into a vat of acid, which dissolves it.

Zircaloy-clad fuel is treated the same way, except that entire fuel elements, up to nine inches in diameter, are simply chopped into slices without being stripped. The irradiated fuel is dissolved out of the cladding by acid. The Zircaloy remains fall into a bin adjoining that for Magnox. By chemical means the acid solution is separated into three streams: one containing uranium, one containing plutonium, and one containing the fission products. The uranium and plutonium streams each pass through recovery plants and emerge again as solid compounds, ready to be returned for fabrication into new fuel elements (or weapons).

In the course of the process, gases—notably radioactive Krypton 85—and liquids from the hot cells accumulate; they and other dilute radioactive fluids from contaminated areas are discharged through stacks, or out to sea by means of a pipeline two miles long.

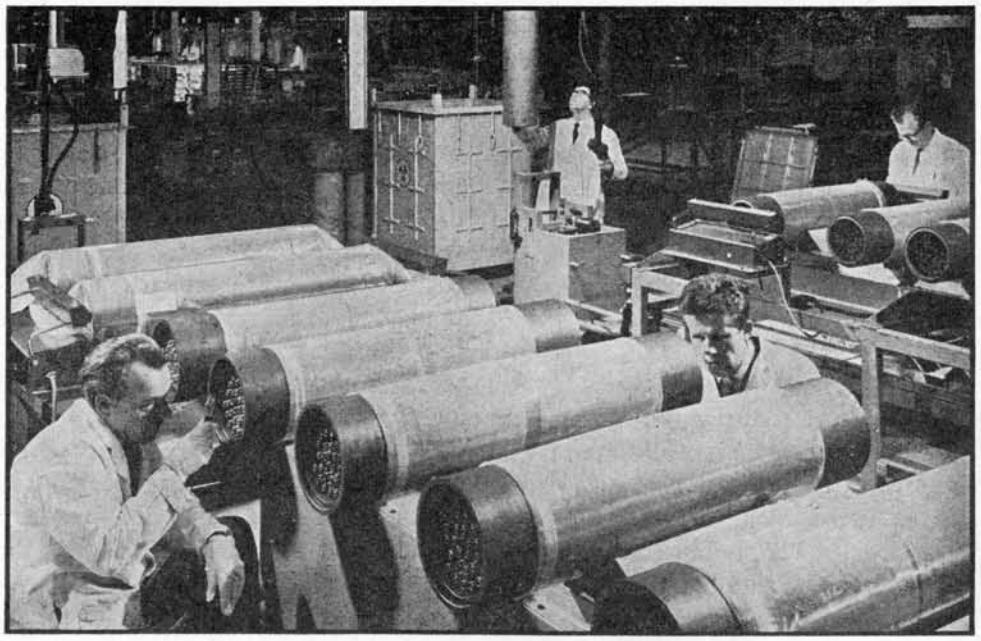
Uranium oxide fuel pins. A cluster of 36 pins makes a 12ft long fuel element. Photo: UKAEA



The fission-product stream is concentrated as much as feasible, to reduce its volume, after which it passes through a 2-inch pipe encased in a 12-foot concrete conduit to another building nearby, in which are the waste storage tanks. To call these vessels "storage tanks" is to do them less than justice. They are in fact elaborate refrigerators: double-walled stainless steel chambers, about the size of a small room containing seven separate circuits of cooling pipes. Each tank is situated in a concrete cubicle, lined on the floor and up to head-level with stainless steel. There are at present nine tanks each of 70 m^3 capacity, and three of 150 m^3 capacity. The most recent tanks are still under construction, and accessible; but the tanks in use are permanently walled in behind thick concrete shielding, never to be seen again. If a tank in use should develop a flaw, its contents can be pumped into standby tanks kept for the purpose.

Similar facilities are in operation in several other parts of the world. The most famous is at Hanford, where the waste from the military plutonium production is stored in some 150 huge tanks, of which some have already begun to leak.

The problem of the high-activity waste from fuel reprocessing is probably the most daunting of all the problems posed by nuclear reactor operation. A significant proportion of the radioisotopes in the storage tanks are long-lived; their activity will not fall below dangerous levels for decades, or, in some cases, centuries and indeed millenia. The fission product radio-activity, once created, can never be destroyed; it must die away of its own accord, in its own time. Occasional suggestions refer to the possibility of transmuting long-lived waste to short-lived; but this would require more energy than the nuclear fuel itself could ever produce. It has been seriously proposed that high-level waste might be fired from the earth by rocket to the sun; but once again the cost would be—excuse the expression—astronomical: requiring eventually several launches per week with the ever-present danger of a rocket failure dumping the waste back to earth. Other equally futuristic proposals include the notion of dumping such waste in casks on the ocean bottom, where geological movement might gradually swallow them into the earth's interior. But a realistic view is that we are stuck with however much high-activity waste we create—and so are our children, and our children's children for centuries hence.



Inspecting CAGR fuel element for Dungeness B. Photo: UKAEA

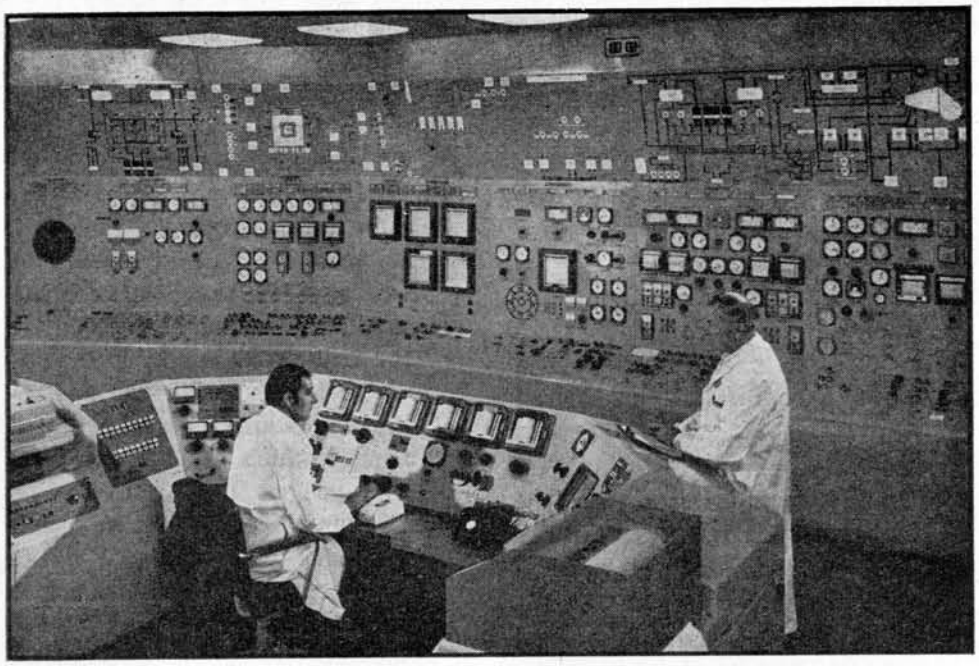
The waste cannot be simply left to itself. Under the action of the hot acid, tanks will corrode and must be replaced. The cooling must be maintained, lest the liquid boil and burst the tank. Accordingly, attempts are now under way to find a way to solidify the waste and at least simplify the storage problem. It has been found possible to "glassify" the waste: to evaporate it and melt the solid into a—hopefully—impermeable glass brick, which can then be stored, perhaps, underground. But the annual waste from a single 1000-MWe power reactor would still require about 15 cylinders some 30 cm in diameter and 3 m long: and these cylinders would be both hot and highly radioactive. Hopes are being pinned on the possibility of storing such cylinders in salt caverns underground. It is believed that the salt, heated to melting by the radioactivity, would provide protection against contact with ground water, and adjust itself into snug heat-conductive packing around the cylinders. But one attempt at least, at Lyons, Kansas, came to grief when the salt beds proved to have unexpected fissures. Canada has flatly announced that her high-level waste is to be stored above ground in tanks until a fully proven technique has been established for any alternative method.

Nuclear insurance

Energy economics is becoming a major discipline in its own rght. One of its most urgently needed areas of study is that of the comparative costs (and benefits) of nuclear as against non-nuclear energy sources. Is it too much to hope that any such study would accept as a third alternative the more fundamental possibility of simply using less energy? As it is, the ascertaining of true costs, capital and running, taking account of research and development, reasonable amortisation of plant, subsidised services, and countless other niceties, is a challenge crying to be met.

The most blatant example of dishonest financing of nuclear technology occurs in the field of insurance. In the US in the mid-1950s it became apparent, especially after publication of WASH-740, that electrical utilities were shying noticeably away from the "promise of cheap, inexhaustible power" ostensibly there for the taking. The problem was simply that no insurance company, indeed not even a huge consortium of insurance companies, could be persuaded to provide coverage against the possibility of a major reactor accident. Although insurance could be obtained for almost any other conceivable eventuality, the mind-numbing consequences of a massive release of radioactivity froze the insurance companies in their tracks.

Accordingly, two members of the Joint Congressional Committee on Atomic Energy (JCAE), Price and Anderson by name, drafted, and in 1957 won Congressional backing for, the Act which now bears their names:



SGHWR, Winfrith, Dorset. Reactor control room. Photo: UKAEA

The Price-Anderson Act specifies, in effect, that reactor operators shall chase up as much coverage as they can persuade private insurance to offer—even now only some $66 million. To this the US Government adds another $500 million. Beyond this—remember that WASH-740 foresaw property damage alone reaching $7,000 million—it's every man for himself. Furthermore, if no claims have to be covered, even the grossly inadequate premiums paid by the operators are eventually refunded —which must make other industries, not to mention ordinary householders, more than somewhat envious. In 1965, two years before the Price-Anderson Act was due for renewal, the renewal was hustled through, lest later objections prove an embarrassment to the suddenly uncovered nuclear industry. Accordingly, 1977 will be an interesting year in the US nuclear business.

Meanwhile, a similar pantomime was taking place in Europe, both nationally and internationally. In Britain, for instance, according to the Nuclear Installations Acts of 1965, a reactor operator need provide coverage for only £5 million liability; the government adds another £43 million —and that's the lot, which makes even Price-Anderson look generous. Furthermore, there have been efforts since before 1960 to reach international agreement on insurance against nuclear hazards; the vagrant habits of radioactive clouds are all too well documented. But the efforts have been thus far quite in vain. Draft documents have been calculated several times, but not ratified.

Nuclear economics

Despite the feather-bedding, the nuclear industry has long made great play with the economies to be gained by nuclear generation of electricity. In the early days—the late 1950s in Britain, the early 1960s in the US—it was not unusual to be told that nuclear power would be so cheap that it would totally wipe out the coal industry. Within a decade the nuclear proponents have done a somersault. Indeed, in the past two years the warning has gone out that supplies of uranium are growing scarce; that the fast breeders are arriving in the nick of time to generate new fissile fuel, since natural supplies cannot otherwise last out the century. Neither extreme position bears close examination.

The early euphoria has, of course, been long since discredited. Nuclear fuel may have its advantages, but its manufacture is a lot more complicated than breaking coal. Nuclear plant, too, involves capitalisation perhaps five times as high per kilowatt of output as does fossil-fuel plant. When the nuclear plant involves new and otherwise untried technology, and must be debugged as it is built, the costs have a tendency to spiral skyward, and construction schedules seem the stuff of fantasy, even without external hindrance from neighbourhood doubters.

Nonetheless, having displayed their inability to forecast the current situation accurately, the forecasters are moving enthusiastically onwards, and insisting that energy "demands" "requirements" "needs"—vigorously encouraged by advertising and promotional rates—can only be met by a crash programme to construct commercial fast breeder reactors. Otherwise the supplies of uranium presently mined, costing (in the US) only some $6 to $8 per pound of yellowcake, will soon be exhausted, and more expensive uranium must be mined. This argument ought to be examined minutely. The cost of fuel—that is, of ore—for a reactor is a much smaller proportion of its total cost than is the cost of fuel for a fossil-fuelled station. Accordingly, an increase in the cost of uranium, even an increase by a factor of 10 or more, will produce only a trivial increase in the cost of the electricity generated. The supplies of cheap uranium, at least those in proven reserves, are indeed not likely to last very long; but moving to more expensive uranium (that is, to lower-grade ores requiring more processing) extends the available reserves by centuries. That being the case, the urgency of fast-breeder development looks more than somewhat specious, especially since—as usual—the taxpayers are taking all the risks, both financial and physical.

Cross-examining your friendly neighbourhood reactor

One way and another, the international nuclear industry, though pampered by governments, is more and more facing informed dissent, and problems are less and less readily possible to conceal or deny. In the early days a reactor was a military installation: it could be set up anywhere, and protests were not only unpatriotic but futile. This is no longer so. Since the historic opposition to the plan for a power reactor on the California coast at Bodega Bay succeeded, nearly 10 years ago, in stopping its construction, reactor-siting has become a matter not only of economics, geology, and hydrology, but of politics; and the opponents may also have a good deal to say about the geology and hydrology. In the US and on the European continent there has in the past five years been an unending series of confrontations over planned construction of reactors—although it is true that there has been, thus far, virtually no opposition to reactor-siting proposals in the UK. But signs are increasingly evident that the international fellowship of reactor-adherents will soon be matched by an international coalition of opponents.

The whole life-cycle of a reactor is now being questioned. The cross-examination includes at least the following questions:

1. Why is it to be built? If for power, is nuclear power clearly the best choice? Is the power itself clearly needed?
2. Why is it to be built at that location? Has note been taken of possible seismic hazards? (If a reactor were to encounter an earthquake, even a pre-stressed concrete containment might not survive intact.) What about tornados? Hurricanes? Floods? What about cooling? What about local ecology? Aesthetics? Should it be so close to centres of population? In the event of an air crash, might it be underneath? Should it be underground?
3. Who is to pay for it and how? (This is never easy to find out, but even in the most aggressively "free enterprise" context it is a near-certainty that the tax-payers' money will be in there somewhere—and not just via his electric bills).
4. What are the benefits, and who gets them? (Orders for plant and machinery, local employment on construction, and similar factors will be cited, and will be significant. But remember the answers to question 3.)
5. Who will run the facility? (By this is meant not "what board of directors?"—although that is relevant—but "what qualified staff, and how qualified?" Does a junior technician know what a mistake on his part might lead to? Does he care? Do his superiors?)
6. What safety features does the plant embody? Do they work? Who says so—merely a computer?
7. What contingency plans and emergency procedures are envisioned? Will they be adequate to limit the consequences of an accident? Or will they just make the consequences better documented?
8. What insurance cover will the plant carry? How will it be financed? By whom?
9. What running releases of radioactivity will take place during normal plant operation? Who will measure them? What will be their effects? Are they necessary? That is, would the extra cost of not releasing radioactivity make the nuclear option less economically enticing?
10. What services will the plant require? In particular what fuel shipments will be involved? By what means? Along what routes?
11. What will become of the plant at the end of its useful life? (nowhere in the world has anyone thus far dismantled a large power reactor which has been running for years. The problem of "decommissioning" even small reactors is considerable. The fuel and coolant can be removed, but nothing can be done about the radioactivity of the core materials. It seems probable that a site on which a large reactor has operated will have to be "dedicated in perpetuity"—that is, left with the hulk of the reactor, possibly entombed in concrete, as an everlasting monument to, say, 30 years of electrical output.)
12. What security can be offered, at every stage, against damage which is not accidental but wilful?—that is, against sabotage?

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Living off the Sun

by Andrew MacKillop

The amount of solar energy reaching the earth exceeds by 20,000 times the total energy being used by human populations. As the demand for fuels begins to exceed the supply available to the industrial nations, envious eyes are being cast on this perpetual source of energy that costs nothing to generate and causes no pollution.

However, the difficulty of concentrating solar energy means it is unlikely that it will ever provide power for industry and attempts to harness it in this way overlook the real contribution it can make by subsidising the large energy requirement for space and water heating.

At the earth's edge the power of sunlight is a constant 1.3 kW per square metre, but at the surface few regions experience daylight constants of greater than 600 Watts per square metre. In such regions (the tropics and equatorial zones) yearly total solar energy receipt is about 2000 kWh/square metre. The poleward fall-off is partly buffered by seasonal variation in the earth's orbit. Thus the UK, in its summer, receives as much as *12 per cent more* solar energy than equatorial places, and even the Arctic and Antarctic have periods with very high levels of solar energy (see Table 1). The values shown are of common average levels. In many regions, notably the areas around cities, the effects of particulate haze, man-induced cloud, and other human climate perturbations is to reduce these values by as much as one-half.

At the tropical and equatorial constant of a yearly 2000 kWh/square metre, with much of the radiation being direct, it can be seen that the solar energy falling on 80 square kilometres is as great as present global human energy use. This of course has led to much misplaced optimism on the role that solar energy might play in the easing of the coming "energy crunch". Superficially, a power rate of 600 Watts per square metre may seem of use for many human activities. This of course assumes 100 per cent conversion, and ignores the fact that many domestic, and most commercial and industrial machines are very powerful. An average car engine, for example, may often have a power density of 20,000-50,000 Watts/square metre of surface, and many other items, from kettles to power tools, have similar or higher power densities.

There is thus an immediate limit on the use of solar energy because of its *low intensity*, even in the most favoured regions. In real terms this means that even in equatorial areas it is very difficult to extract more than about 150 Watts/square metre for power applications. Thus a large car would require, if solar driven, collection equipment of about 600 square metres in size—equivalent to the roof area of about six UK suburban homes! Away from the low latitude regions the economic use of solar energy is limited by diurnal and seasonal variation. Even greater variations in the supply of direct radiation are caused by cloud conditions, particulate haze, shading by tall buildings, and so on. In total these factors have run riot with the concept of applied solar energy. Nevertheless, the inexhaustibility and cleanliness of solar energy are very attractive, as is the increasingly important fact that its use for human support could cause no climatic-thermodynamic problems, since the supply of solar energy is inevitable and more or less fixed.

Translation of solar energy

There are three basic translations of solar energy: to heat; to work; and conversion of solar energy to electricity, by thermoelectric, photochemical and other processes. All these methods have advantages and disadvantages, but it is safe to conclude that conversion to heat requires the lowest level of applied technology, is the most cost-effective, and has most relevance to cloudy sites, e.g. in the UK. Energy almost always has to be translated from one form or another to be made useful. Often, when this is not strictly necessary, a translation is undertaken to produce a more socially or economically-desirable form of energy. A range of solar energy: useful energy translations are shown in Table 2, but it is important to note that some of the processes are not strictly comparable. For instance photosynthesis is a wholly-natural process that needs no support whatsoever from man, and has no need to be efficient. When the support systems for various conversions are analysed it can be seen that, within limits, high efficiency is not the only goal. Translations should be *effective* by many criteria, including environmental impact, resource demand, social acceptability, economic cost, and so on.

Heat versus power

The translation of solar energy to heat is inherently more efficient than conversion to mechanical energy because of fundamental physical constraints. Limits of conversion are set by the Second Law of Thermodynamics. This basically states that energy flow in this universe is directional. Thus if a quantity of solar energy flows into a conversion system at a certain rate, and from the system comes heat at a certain rate, we *cannot* reverse the flow, and get back exactly what was put in.

In a heat engine, such as that of a

car, fuel is burnt to produce heat, that transfers energy (heats) to a "working fluid" (which in this case is a mixture of gases) and these then go on to produce mechanical energy by transferring energy to pistons. If we apply energy to the pistons we *can* cause gas to heat up, but it is fundamentally impossible to produce *as much* heat energy as the mechanical energy applied. And with any fuel-burning engine it is of course completely impossible to apply mechanical energy, to produce *fuel*, with its *chemical energy*, once more. A heat engine therefore shows the directionality of energy flow that the Second Law requires. In any heat engine the working fluid (gas or liquid) transfers energy from an input to an output system. This is done by heating the fluid to a high temperature, and allowing it to cool. Ignoring losses from friction, and other mechanical losses of energy, the efficiency is still absolutely limited by the difference between the temperature of the *working fluid*, and that of the *external environment*. If the heat source temperature is T (degrees Kelvin), and the sink temperature is S (degrees Kelvin) then the ultimate efficiency can never be more than:

$$1 - \frac{S}{T}$$

We find, therefore, that efficiency of a heat engine must go down as the difference between heat source and heat sink temperature narrows. If we try to maximise working fluid temperatures to get high efficiencies the conversion rapidly becomes limited by factors like metal fatigue. About 75 per cent is the conceivable upper limit, and real engines usually convert between one-fifth and one-half of this.

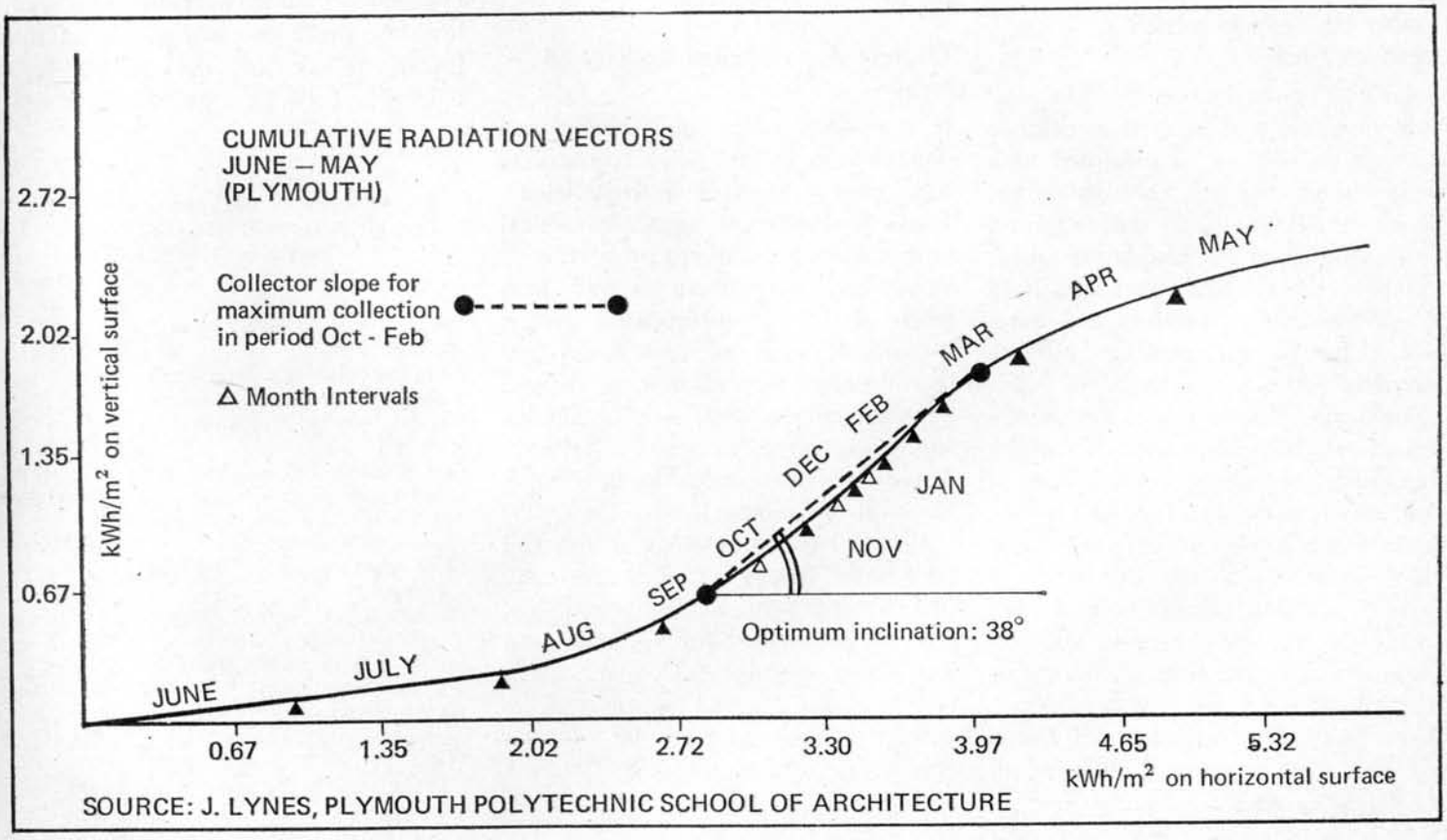
When we heat a body with solar energy it will tend to lose heat in *all* directions, and the loss rate depends on the *fourth* power of temperature. We therefore have a double limit on the conversion of solar energy to mechanical power. A working fluid must first be heated, with *losses increasing as temperature goes up.* This heated working fluid must then give up the maximum of heat in an engine (to give mechanical power) with *efficiency going up as temperature is increased.*

Therefore it is not surprising to find that a dynamo running off a turbine using water heated by a flat-plate collector will give little more than 25 Watts of power for each square metre of collector in an ambient of more than 600 Watts per square metre of solar energy. In the UK we could therefore expect no more than about 15 Watts of power from a solar: mechanical power system of this kind, for each square metre of collector surface, even on bright summer days.

Focusing collectors, which work only on direct (bright light) solar energy, can raise temperatures of bodies at their focus to much higher levels than can flat plate collectors. In areas such as low-latitude deserts with little cloud, and some mountain regions, this equipment can be used to focus solar energy on pipes containing water (or other working fluids) that lie along the focus of concave or parabolo-concave mirrors. The need to have square miles of such units for large power stations, their very high capital costs, and the inevitable generation and transmission losses of the desired electricity highlight a basic "problem" with solar energy. Solar energy is widely-distributed and of low intensity: it is therefore *not suited* to centralisation.

Refrigerators and heat pumps

These transfer heat from a cooler body to a hotter one by adding work to a transfer fluid. Thus, heat is "pushed uphill" by added work, which in no way conflicts with the Second Law. In a common refrigerator/heat pump arrangement, diagram p. 263, the working fluid is a substance such as ammonia, or more complex refrigerants such as halogenated hydrocarbons. This is evaporated in a coil, absorbing heat; this gas is then taken to a condenser, after passing through a compressor, where condensation with release of heat takes place. Heat is thus *transferred* from one system to another, rather than heat being converted into



work as in a heat engine. The performance of refrigerators and heat pumps is measured by the ratio of extracted heat to input work. Not surprisingly the performance ratio *goes up* as the difference in temperature between the "hot" and "cold" systems *decreases*. In a normal domestic refrigerator the cold body (internal) temperature can be 0°C (273°K), and the heat of the warm body (the kitchen 18°C (291°K)). The theoretical maximum performance ratio is then given by:

$$\text{Performance ratio (max)} = \frac{273}{291 - 273}$$
$$= 15.2$$

In theory, therefore, a perfect refrigerator in these conditions could extract 15.2 units of heat from the cold space for each unit of work applied to the system. Needless to say such performance ratios are unapproachable in practice, more common ones being 2.5–4.

In regions of high solar energy a direct focus collector can be used to provide the power required to operate a refrigerator. Because of the high performance ratios of refrigerators the solar-powered air cooler, or refrigerator, can extract as much as 750 Watts of heat for each square metre of collector surface in an ambient of 800 Watts/square metre. Even in the UK a solar source heat pump can give quite useful performances.

Solar energy: electricity conversion

Solar energy can be converted to electricity by using it to heat a cathode causing an outflow of electrons to a cooler anode nearby. Through an external circuit this gives useful power. Good emitters of electrons are required, notably such relatively rare and hard to work metals as caesium and tungsten. The highest possible cathode temperatures are required in such equipment, known as thermionic generators. A further need is for the minimum separation between anode and cathode, the most desirable distance being a few dozen nanometres (10^{-9} metres). In sum this leads to great production difficulties, and high costs, with the equipment in addition being very delicate. Further, the maximum possible efficiency is only about 25 per cent, or an output of 150 Watts for each square metre of collector, in the UK's summer.

TABLE 1
RADIATION AT VARIOUS LATITUDES—NON-TURBID CONDITIONS
(kWh/square metre)

		Daily Maxima		*Daily Minima*		*Annual Total*	
Location	*Latitude*	*Direct*	*Total*	*Direct*	*Total*	*Direct*	*Total*
Equator	0	6.5	7.5	5.8	6.8	2,200	2,300
Tropics	23½	7.1	8.3	3.4	4.2	1,900	2,300
Central—UK	52	7.0	8.4	0.5	0.8	1,400	1,700
Polar Circles	66½	6.5	7.9	0	0	1,200	1,400

Direct heating of some materials, notably the semiconductors selenium and germanium, can also give electricity. Using these, thermoelectric generators can be produced, but again at high capital cost and resource demand. Much the same problems attend photoelectric generators, where certain compounds of, notably, germanium and silicon are exposed to direct sunlight. Electron flow is caused by energy absorbed from photons of light. Although the theoretical maximum efficiency is about 45 per cent (light energy to power) it is extremely difficult to produce photocells giving more than about 10 per cent conversion.

The resource demand and efficiency characteristics of thermionic, thermoelectric and photocell generators are in themselves not attractive. A much more convincing problem is their high cost: £150-£250 per square metre at 1973 costs. A domestic immersion heater of 2 kW run off such equipment in the UK would therefore require an outlay of £5,000-£12,000.

Conversion of solar energy to heat

It has been noted how costly and difficult it is, in the main, to translate solar energy to work and electricity. These problems are especially critical in the UK because of the proportion of cloudy days when there are very high ratios of diffuse: direct solar energy. Equipment such as thermionic and thermoelectric generators that depend on high temperatures, only obtainable from solar energy in bright conditions, would be of little or no use in our diffusely-lit environment.

By placing bodies which absorb and emit solar energy easily in the path of incoming light and heat radiation, and by channelling the resultant heat into some useful store, solar energy can be made to give useful heat. A perfect absorber and emitter of solar energy is called a "black body", but many common and low cost materials have comparable absorbance and emittance characteristics. Unfortunately, high emittance of absorbed solar energy also implies that the material will emit heat in *all*, rather than preferred, directions. This problem is solved by placing a plate of glass (transparent plastics can be used) above the collector surface. The glass is transparent to short-wave (direct), and some more diffuse wavelengths of light, but is practically opaque to re-radiated (longer wave), heat radiation. By placing tubes or channels in close contact with the absorber plate the heat emitted from the absorber can be used to heat a working fluid (usually water). Insulating the base of the unit increases performance by reducing conduction losses. In such a way flat plate collectors are produced, with attention also being required to reduce wind and collector-edge heat losses.

In the UK in summer such units can heat water to more than 55°C, which is fairly close to theoretical limits imposed by Stefan's rule. Because of this law (heat loss increases with the fourth power of the temperature difference between a heated body and

TABLE 2
TRANSLATION EFFICIENCIES FOR SOME SOLAR ENERGY: USEFUL ENERGY CONVERSIONS

Process	*Efficiency percentage*
Direct focus collector (solar energy: heat)	60–75
Flat plate collector turbine operated by direct-focus collector (solar energy: mechanical power)	30–60
Low pressure (2–5 atmospheres) (solar energy: electricity)	15–30
Thermoelectric generator (solar energy: electricity)	4–10
Solar photocell (solar energy: electricity)	2–12
Photosynthesis (solar energy: chemical energy)	0.2– 2
Forest growth giving firewood (solar energy: heat)	0.1– 1.1
Plant growth used for food (solar energy: muscular energy)	0.01– 0.1
Wind and water power (solar energy: kinetic energy)	0.000001–0.002

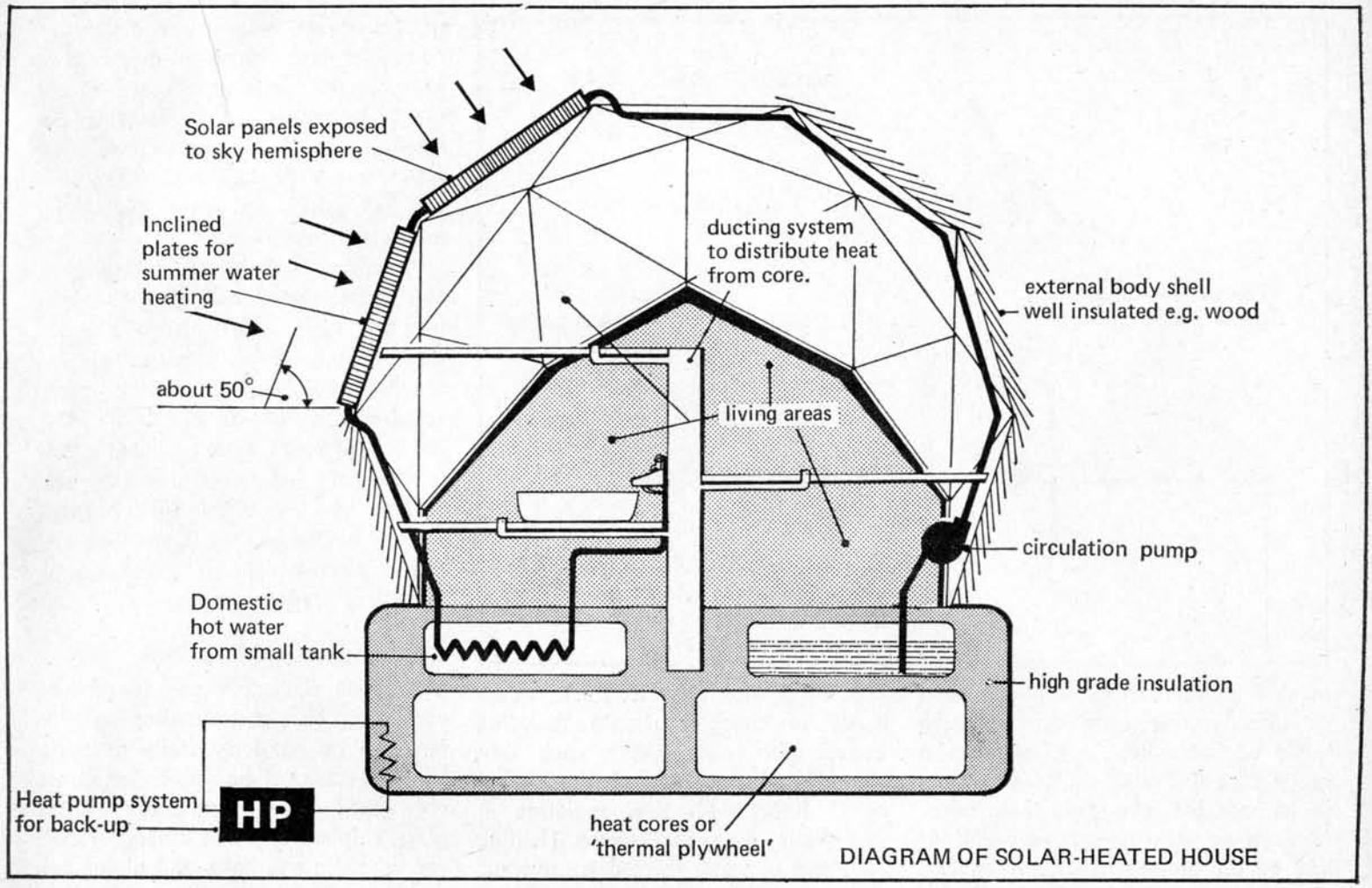


DIAGRAM OF SOLAR-HEATED HOUSE

its environment) the effective power (efficiency) of flat plates fall off very rapidly with increasing temperature. Performance can be improved by reducing heat emittance in directions away from the working fluid channels. This calls for materials that do not emit in all directions, and such materials are produced by covering a polished metal plate with black matt paints or, more efficiently, but at higher economic and resource cost, with metal oxides. Materials which emit in such a manner are called *selective* absorbers, whilst lower-cost materials not possessing this characteristic are called *neutral* absorbers.

Efficiency of flat plate collectors

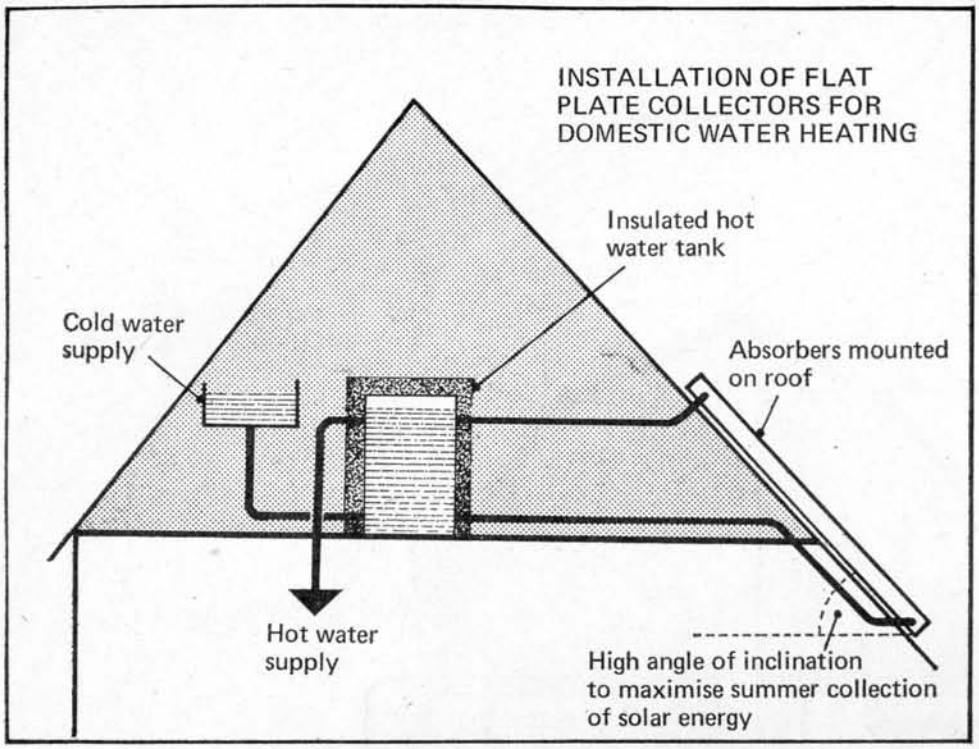
The power of heat put out by flat plate collectors with neutral and selective surfaces can be calculated thus: For collectors with neutral plates: $P_e = (0.9\ P_i) - (5.8\ T_o)$. Where the power extracted is P_e, outlet temperature is T_o (degrees centigrade), and incoming power of solar energy is P_i, in compatible units. When the flat plate is constructed with a selective surface the output power is considerably greater, because of reduced losses. The output power can be determined from the following: $P_e = (0.9P_i) - (3.5\ T_o)$. In the UK's summer it is feasible to extract water from a flat plate at about 45°C, with tolerably high efficiencies, on the majority of days. But in winter the performance of a flat plate, particularly those with neutral surfaces, falls off very rapidly with outlet temperature. As shown in the graph, a flat plate extracting at 40°C will have difficulty in giving an efficiency of more than 45 per cent with a selective surface, and 30 per cent with a neutral plate, for more than two or three hours a day. Further, this is the state in *clear* conditions; with cloud and haze these figures can be reduced again, indicating that extracting water at more than about 20°C in winter will on the majority of occasions be inefficient, and on many days will be impossible. This has important implications for solar water and space heating.

Installation of flat plate collectors

For obtaining the best possible performance from flat plate collectors the units should be as near as possible to the hot water store; situated below the store (to preclude the need for circulating pumps); oriented and inclined optimally to the sun. Shading by other buildings and vegetation should of course be minimised, and so also should exposure of the plates to high winds, that can greatly reduce performance. Roof mounting usually satisfies these conditions; typical installations are shown in the diagrams.

Orientation and inclination of the collectors depends on a number of variables, that are to some extent incompatible. Maximum receipt of solar energy in the UK is experienced by bodies facing slightly west of south (180°–190°). However, to maximise collection of diffuse radiation a body should be exposed to the entire sky hemisphere.

The proportion of diffuse solar energy found at the site in question has very strong implications for optimum inclination, as well as orientation. Thus cloudiness, days of hazy and turbid conditions, and the design constraints requiring summer only (or yearly) collection of solar energy, all affect the final decision on optimum inclination. At a site with high levels of direct solar energy there is little question that an inclination equal or greater than the latitude of the place will produce the maximum collection



of solar energy. An interesting method of directly measuring the optimum angle of inclination is to produce a graph of cumulative radiation vectors as on page 261. The slope of the curve between any two chosen time periods will be the optimum collector inclination for that period. Thus the optimum angle for solar collection in the period October–February is 35°–45°, which agrees well with results from other methods.

It is at present hard to economically-justify solar aided space heating, and summer water heating will be the most usual use of solar energy in the UK. For this purpose collector inclination of about 35° will give the maximum performance, because of relatively high levels of direct radiation in summer. Ensuring that collectors are optimally oriented and inclined will reduce capital costs to a minimum by minimising the collector size needs.

Collector size needs

Assuming well-constructed plates fabricated from neutral materials, with one-thickness glass covers, and water as the heat transfer medium it can be estimated what area of collector surface is required for a normal domestic household in the UK. Average households use about 220 litres of heated water each day; by extracting water from the flat plates at 45°C, with an ambient radiation of about 500 Watts per square metre in the period April/September, the power extracted will be about: $P_e = 450 - 230 =$ 220 Watts/square metre. Each square metre of collector should therefore deliver about 1.32 kWh each day, assuming an averaged radiation period of 12 hours with total radiation at 500 Watts per square metre. Heating 220 litres of water through an average of about 32°C (supply temperature to 45°C) requires 8.5 kWh. An array of 6 square metres in area should easily supply this amount of heating in most areas of the UK south of Yorkshire-Lancashire, in the April–September period provided the background constraints are satisfied. North of northern England slightly larger arrays would be required, but in mid-summer in most areas of Britain the high levels of solar energy—up to 850 Watts/square metre—will ensure that this heating demand is more than satisfied, producing water heated to more than 45°C, with ease for much of the summer.

As previously mentioned, the low solar power available in the UK's autumn and winter would make higher extraction temperatures inefficient, and often impossible. Because of this it would be impossible to have space heating by solar energy alone in the UK. However, solar energy can be relied on to provide at least some of the heating demand in many domestic and some commercial conditions. Because of the much weaker winter sun such solar-aided space heating systems would require large collector arrays. Thus an array of 35 square metres in a winter average ambient solar energy of 150 Watts/square metre, for 10 hours per day, with water extracted at 17.5°C should give an effective power of: $P_e = 135 - 101 = 34$ Watts per square metre. A 35 square metre array should therefore deliver about 12 kWh per day, which although small is by no means insignificant.

Assuming high levels of insulation, and well-designed buildings, the contribution from such a array in a 33-week heating period could provide as much as 20–25 per cent of total heating requirements of about 8500 kWh. Additional heat can be provided at low environment and resource cost by heat pumps, efficient solid fuel burners, alcohol fuelled heating equipment, and other alternatives to conventional, inefficient heating systems.

Economic considerations

Flat plate collectors are the lowest cost solar energy translating systems and can be relatively easily installed. Flat plates can be fabricated from corrugated iron, agricultural grade glass, chipboard, ply or other materials for the sides and base, and piping can employ mild steel, or pvc. Materials costs of such plates are in the region £4—£6 per square metre, implying a retail cost of about £12. An array installed for summer water heating in the UK, complete with tank and pipe, could therefore be installed for about £150. Including heating from the plates in March, October and some other times of the year, the total useful energy provided by such a system will be about 2200 kWh per year. The minimum cost of providing this amount of heating from average-efficiency electrical immersion heaters will (at 1973 electricity costs) be about £27.50.

The use of selective plates, although giving much higher performances, cannot be indicated because of higher resource demand, and very much higher economic cost. Solar-aided space heating is also hard to justify with economic criteria, although this will probably not be true in the future. The system is undoubtedly elegant, and is also environmentally desirable. Purpose-designed roof collectors fabricated from low cost materials is an important, but at present neglected area. Low Impact Technology Ltd is assessing the possibility of producing such flat plates to retail at around £15-£18 per square metre, as opposed

to current costs of collectors elsewhere of more than £25 per square metre.

Other considerations

There are no architectural or building problems of a high order related to the installation of flat plate collectors. However, in existing situations there can be many real constraints limiting the use of such equipment. These include high building and vegetation shade; few south-facing surfaces; local environmental conditions reducing solar energy, such as air pollution haze; flat-roofed buildings requiring circulation pumps or special heat store installation; and so on. From this reasoning we can assume that in urban areas as much as 60 per cent of dwelling units (particularly flats) will be unable to use solar energy for any effective purpose. In suburban and rural areas there will be far less incidence of these limits on the use of solar energy, and it is safe to conclude that as many as three-quarters of dwelling units will be able to utilise solar energy at least for water heating. Overall, we can assume that up to seven million, or about 42 per cent of UK dwelling units could use solar energy, to provide up to 2500 kWh per year of water heating. This is equivalent to about 17.5 x 10^9 kWh per year.

Although this is only about 4 per cent of present UK domestic energy use, this total is overlarge, because of the highly inefficient systems that are employed. In an energy-efficient economy solar energy can be of very great assistance.

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ERRATA

In Malcolm Slesser's article "How many can we feed?" (*Ecologist*, June, 1973), p.218, col. 2, line 9, "3.45" should read "3.85". In the Appendix (1) the protein formula should read $\log_{10}(P) = 0.718 \log_{10}(ES) + 0.15$, with a standard error of 0.094. Table 2 should be disregarded.

Coming events

17–20 July—Conference on Pollution Criteria for Estuaries. Further details from Mr M A. McSweeney, Department of Civil Engineering, The University of Southampton, Southampton SO9 5NH.

10–14 September—Residential week to begin Technology, Ecology and Conservation course for teachers at Trent Polytechnic followed by a series of day and evening sessions at Nottingham College of Education and a residential long weekend at Matlock College of Education 5–8 April 1974. Further information from the Secretary for Short Courses, School of Education, University of Nottingham, University Park, Nottingham NG7 2RD.

12–16 September—Conference on Landscape for People to be held in the grounds of The University of Birmingham. Further details from The Institute of Landscape Architects, 12 Carlton House Terrace, London SW1Y 5AH.

14–16 September—Countryside Interpretation Conference to be held at Southampton University. Further details from Mrs B. J. Dixon, 30 The Pastures, Kings Worthy, Winchester, Hants.

20–21 September—A two day symposium on the relation between world population and food resources, and the individual and his diet in health and disease, to be held at The Royal Institution, London. Further details from Michael Van Straten, Symposium Secretary, Stratenport House, Tring, Hertfordshire. Telephone Tring 4004.

20 October—One day conference on Environmental Problems to be held at the Brighton Polytechnic. Further details from Peter J Bates, 21 Lower Faircox, Henfield, Sussex BN5 9UT. Telephone Henfield 3172.

Scientists or magicians?

by Jim Platts

Do we live in a magical, rather than a religious culture? We are forced by our language, itself a product of our culture, to think of ourselves as separate individuals caught up in a network of simple cause and effect relationships to people and things outside ourselves. This prevents us from developing a sense of community as strong as those enjoyed by members of some other cultures and it encourages us to believe that forces we cannot understand may be controlled or banished by our technology. This is a magical world-view, in which scientists and technologists are our magicians who alone understand and have power over nature.

One thing which is difficult for the western mind to grasp is that the idea of self is not a natural nor a universally used notion. In our attempts to describe the events of the world we westerners have developed languages that describe the world as a collection of separate things which together cause events. We say "*I do it*". I (a separate thing) do it (cause an event). Our language is a language of causes and events.

It may come as a surprise that small children, learning to express their experiences of the world, do not necessarily find this a natural way of splitting up their experiences. They are quite prepared to link events which to us are quite separate (because we are adult know-alls). It may be quite difficult to persuade them that some trauma of theirs does not have its counterpart in an external event. It may come as an even greater surprise that there are whole cultures in this world who would basically agree with our children instead of agreeing with us. They are not stupid or ignorant. It is simply that in their development they have come to describe the world in terms of a flow of events which occur in different places but which certainly do not have individual causes. For instance the American Indian language, Hopi[1], would replace the simple English sentence used above by "It happens through me" or something to that effect. This describes an event and a location, but the event is an event without having to have its cause described.

Certainly it is convenient in many instances to use the concept of a self and other selves as a starting point of an action: it serves as a convenient shorthand. But it is not necessarily true that an event had its sole cause in me. Usually there will have been a sequence of events leading up to (or requiring) my action so that the Hopi sentence is in some ways a better description of what is going on. Our own language is misleading in these instances. The concept of self suggests the idea of independence (the individual will). A second problem arising from our language structure is that by making a distinction and saying what is self we also make a distinction and say what is not self. The idea of self automatically involves isolation.

The second approach views the world all the time in terms of occurrences that come to fruition in me or you but are always part of a larger network of events. Even the terms "me" and "you" are convenient ways of describing a location that are blurred and less definitive than our own uses of the words. This leads to a much weaker notion of self, of self-will and of independence. It also reduces the sense of separation and isolation that comes with feeling your individuality. The sense of being part of a larger pattern is firmly embedded in your consciousness—the American Indians (for instance) have a very strong tribal identity which exceeds anything *we* might hope for in the way of a normal community spirit. They also have very little personal identity in terms of personal possessions and effects. This has led to considerable problems of adaptation in an American civilisation based on the acquisitive tendencies of the individual.[2]

These world views are very important. We in the west have a lot to learn from our oriental and also our far western friends. Our language, which forces us to think in terms of the self, makes it difficult for us to feel or to see any larger network in which our actions are bound up. The bigger network is familiar to us as what we call God or at least what we call the Holy Spirit. But our mythical history reminds us that when Adam and Eve ate of the fruit of the tree of knowledge (i.e. became conscious, i.e. developed a language with which to be conscious) they saw them*selves* and were ashamed and hid from the face of God and were subsequently banished from Eden. This tells us again in symbolic terms that the idea of self that the west has developed is an idea involving division and distinction. It automatically bars us from experiencing the continuity that exists throughout everything. It is a notion built into the very centre of our language structure (and therefore our consciousness), isolating us from many of the experiences that life has to offer.

So one of the ideas we try to get

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beyond in meditation is the idea of self, so that we can reach again the sense of being part of an enlarged whole. Christian language is barely able to describe this experience. In postulating God as a "he" (who is therefore another self) life is discussed in terms of the relationships between individual entities (us and them and him). It is not a good way of describing the interpenetrations and the interdependence of things. It is a paradox to talk of God as a "him" and also as being everywhere and in everything. Here we come up against the self-imposed limitations of our language structure. To feel the flow in us we have to think of God as an it, as stuff, as the pattern of events that is life, the river of life, or any other abstract image that comes to mind (oriental religions are full of them). These analogies can help open our conscious minds beyond the limiting concept of self so that we can begin to consciously see and feel again the pulse of the larger network of events that has been underlying our own actions without our knowing all the time.

Technology of meditation

This particularly useful lesson is coming to us from the east. Over centuries the Orient has developed a technology of meditation embracing many physical and mental rituals and the use of various chemical aids. This has had an effect on their culture which can only be compared in magnitude with the effect that the external technology of manipulating the world around us has had on the western civilisations that have developed it. We must not decry this technology. It is far too simple to consider marijuana (for instance) as a drug. It could be regarded as a tool of the technology of meditation. Conversely power from petroleum, part of the manipulating technology of the west, is used as a means of escaping from various problems, becomes habit forming and finally creates total dependency on its supply—a drug if ever there was one. In the past we thought that our technical prowess, our singular ability to control nature more successfully than other cultures, our "white man's magic" gave us a superiority that deserved emulation. That simple picture is now beginning to fade.

Frazer[3] discusses cultures in terms of their attitudes towards two aspects of their life, the known and the unknown. This is a useful division. He describes those of a religious nature as cultures which try to reconcile themselves with the unknown. There is always an unknown element in life and religion is an attempt to face this by maintaining some flexibility, an anticipatory awareness, ready at all times to accept an unpredicted event and to try and understand it. To practise religion is to acknowledge your own smallness. A religious culture cannot by its very nature be self-ish.

On the other hand a magical culture is. Magic stems from a desire to banish the unknown altogether, a desire to hide from the darkness of not knowing and live within a secure, predictable and therefore controllable environment. Magic, by suggesting that the surrounding world is familiar to the magician and can be controlled, provides a sense of stability and security by stressing man's own authority over a subservient nature. Science, with its emphasis on understanding and predicting nature, and technology, with its aim of "directing the forces of nature for the use of man"[4] produces magic of a very high order. Despite the religious fervour we effect from time to time we in the west are a magical, not a religious civilisation. "Self" is too well maintained in our mentality for it to be otherwise.

Both these elements of life are needed in balance. But in western eyes the difference is often seen as the difference between active and passive. The "under-developed" countries are urged to do all sorts of things that they are not doing. Rarely is the rejoinder heard of urging western man to be quiet and listen, and experience all sorts of things that he, in his turn, is not experiencing. The nub is the choice of words. Active and passive are two words loaded with prejudgement. If you see the world as an interrelated whole and you seek to experience this world within yourself to its utmost, then to make yourself insignificant, silent and still, and to meditate is to be active in pursuing your goal, whilst to be rushing around insensitively would be to neglect it and therefore be passive towards it. A better description is given by the twin ideas of doing something and experiencing something. Other pairs spring to mind. Give: receive, express: absorb, influence: be influenced, breathe out: breathe in. The two ideas are represented by a friend of mine as Demonaic (MINE is the kingdom). But perhaps the Buddhist idea of breathing out and breathing in is the most expressive image because it links the two things instead of setting them against each other. It suggests that the two combined togther in alteration, are one of the fundamental rhythms of life.

From this vantage point it is easy to see through the environmental problems that dog our technological progress. They always will. The "cure" is not in terms of more action. A continued emphasis on extending our ability to "control" nature is simply to persist in wearing blinkers to keep us from seeing the dark voids at our sides. The "cure" has to come in terms of a different philosophy, and possibly a different language to describe the world, accepting our position as receptive as well as active participants, reconciling ourselves with the unknown elements in our surroundings instead of hoping that they will go away if we ignore them.

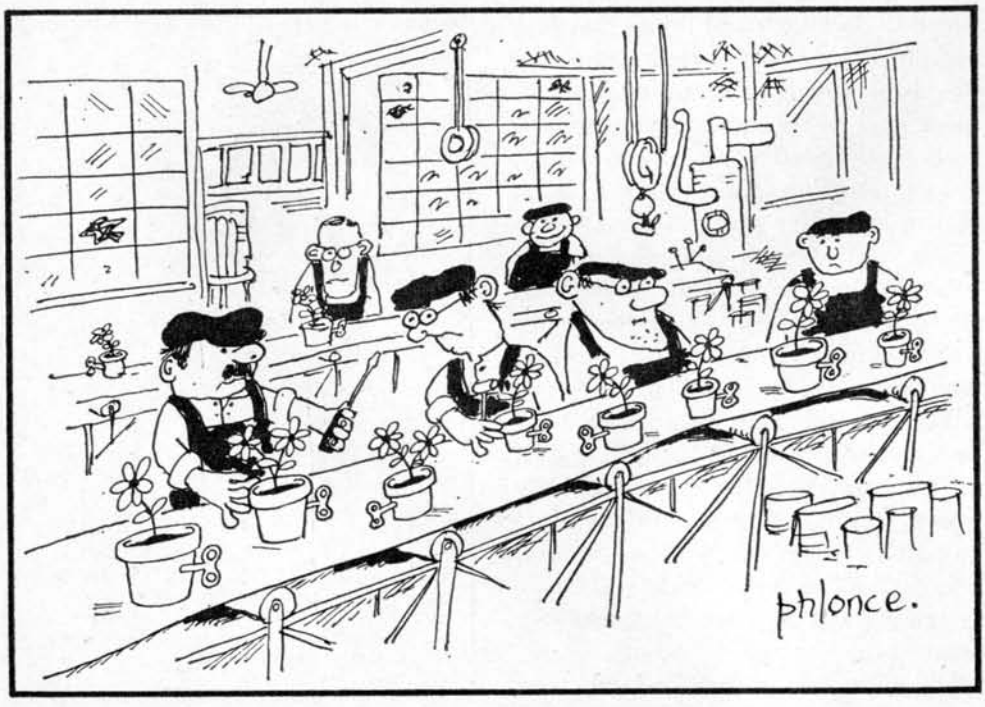
We need to re-examine our own religion

God made us in his own image—the Bible says so. But it does not mean that God made us "like" him, or that he has a human form. God is not a he but an it. God is in all things, within us and around us and we know that as we grow our internal character, even our physical character, is moulded by our surroundings. God is constantly moulding us in its image—not an exact image or replica, but an internal image

that matches and fits into our external surroundings. A photograph is an image of a tree, but it is not the same as a tree. It is simply that a thin sheet of acetate bears the imprint of a tree in a silver nitrate. In a similar way we bear within us the imprinted image of those aspects of God that surround us, and when a light shines through us we transmit that image. When we ACT we express the external image of that of God within us—something that has grown and matured within. We imprint it in our surroundings.

This reciprocity of in and out, the pulsing interplay between the two, is at the core of our living experience. But in the west we have come to emphasise the creative aspect, the half of the cycle where we act on and control our environment. We strive hard to do it and we are pleased when we succeed. The message that the east has for us is that there is a similar pleasure in trying to feel the general inflow of experiences from outside; a similar striving and a similar anticipation in seeing all the elements of your personality, or all the elements of a particular idea, flowing together over a period of time, a similar joy to be experienced when the pattern is felt to be complete. To develop these two abilities in balance is to be at one with God, to be in the flow. To recognise the pulsing in of influences before your own ability (and duty) to act is established is just as important as being able to act. Indeed the most creative people in our society, who are generally thought of as having the greatest powers of self-expression, are often the most self-less people when they discuss their work. A sculptor talks of "releasing" the figure that is already embodied in the wood or the stone. Any creative person is familiar with the sequence of events when he is "caught" by an idea and hours of conscious time disappear whilst the idea plays itself out through his mind and hands. In Chuang Tzu,[5] a carpenter describes how he makes a music stand (being Chinese his art takes a practical turn). He spends seven days putting himself in the correct frame of mind before going off to look for the piece of wood which contains the requisite forms, which he elaborates, bringing his "own native capacity into relation with that of the wood". This is the essential meaning of "inspiration", and "inspiration" is the technical term for breathing in.

Viewing the world in a receptive manner is not always simple. The influences are not always easy to delight in. We can appreciate the delight in the rhythm of a craftsman or in the invigorating stride of a walker. Nevertheless few of us are ready to relinquish the known benefits of our tools and our care for the unknown experiences that would accompany doing things another way. But technology is too easy to decry. What delight (and I mean delight in its profoundest sense) do we find in the rhythm of life? Let us consider the problems of illness, disease, disabilities and finally death itself. These are experiences of life. Yet it is a well known fact that the "white man's magic" of medicine sees as its ultimate aim the entire abolition of all these burdens that nature gives us. It is our avowed intention not to be receptive to these experiences of life. Why?



Now some burdens are hard to bear. But there is a point in growing up when to be sheltered and to hide from a particular burden is to fail to grow any more. After a point the responsibility of carrying that burden is not a hindrance and a pain but is actually the cause of developing maturity and deeper happiness. To see illness, disease, disabilities and death as individual failures is to fail to comprehend the depth and wholeness of life. The "Law of the Jungle" is a well contrived law. With each generation nature casts a spectrum of different abilities able to face a spectrum of different tests. Some, those who carry the burden of some disease or disability, might be thought of as wasted. Far from it. The only thing that enables a species to progress in time, and to adapt to changes in its environment, is for this spectrum of abilities to be cast and sifted at regular intervals. In this manner the way forward is covered. Those with suitable abilities progress—those with less suitable do not.

As a law of nature this law is not cruel, it is essential. It is when this same law is made a law of man that it is considered cruel. The illness, disease, disabilities and untimely deaths carried by each generation are the price it pays for ensured development in the future. It is an insurance premium. If we could predict what would be required in future generations we could steer ourselves in that direction, but how could we be sure of our decisions? We do not know what will be required, so the matter is far better left in the hands of God.

Of medicine today we boast at the prolonging of life for the less able. In fact all we are doing is polluting the genetic pool that nature had designed to be self-cleaning. In earlier times a man who had reached thirty could expect a reasonably long life. Today a man of thirty does not have his health so well guaranteed.[6] We carry the weaker at the expense of the stronger. It is nice to do so but is it right?

The Christian version of selfless action has led us to care for and protect a host of other selves. But this is merely selfish action on a larger

scale. We do not focus our attention on the network of events beyond the individual and we do not help the ill and the dying to consider themselves secure in its depth. Our action merely reinforces the grip that the idea of self already has on their minds.

And so to death

We so neglect this most important part of life. Demonaic (MINE is the kingdom) is what we are.

Let us consider an individual as a flame, kindled from the sparks of others. This is true both in a physical sense (growing from the parental seed) and a spiritual sense (growing in character from the influence and example of others). Merely by existing, each individual continues this same pattern of passing on sparks to others. In the sequence of lives what should warrant our attention? Should it be the individual that rises, brightly burns and then so quickly disappears? This is what our selfish western culture stresses. Yet in the Olympic ceremony maintained as a symbol since Greek times we focus our attention on the flame as it passes from hand to hand. The individual runners pass without concern.

So the flame of life continues, burning in a myriad places at one and the same time in an ever-changing pattern. No individual flame is ever lost. It simply diffuses away having already created its image in other places. Its heat remains alive in those fires. No one lives without being part of the whole and without leaving their image behind them. The end of a life is only the end of a distinct self, and bearing in mind our earlier discussions on the idea of self is this to be feared? If in meditation we are attempting to take our consciousness beyond the boundary of self can we peacefully contemplate going into the apparent darkness that lies beyond? As a supreme experience in the loss of self and as an experience of the continuity, the flow of life, death is to be welcomed. If the teachings of the eastern mystics are to be believed, death is by far the deepest and most rewarding experience life has to offer us if we will view it as a positive experience to be embraced rather than a supposed end to experience. Death is only an event to be feared in a selfish society. It is no accident that preparation for death is an important part of eastern religious teaching?[7]

But western man is afraid of the dark. Above all things he needs to know to be secure. His vision is focal, focused on those aspects of life that he himself has coloured in. He needs to develop diffuse vision, open up his senses to enable him to experience to the full all the other facets of the picture of life that are hidden just beyond the fringes of his narrow vision. When he has learnt to listen he will then know how to act. It is a hard lesson for western man to learn. Leary[8] went as far as to say that no one should study the manipulation of nature until they have completed the whole life-cycle of growing up and being a parent. They should learn to attune to their surroundings and give respect before being properly fitted to create things themselves. Perhaps such a long rhythm between breathing in and out is excessive, but the difficulty still remains of weaning western man away from obsessively displaying his virility.

Curiously, we do have a word to describe this man we would prize, and that word is "gentle-man". To listen, to be attentive and to measure time and to wait is not a soft virtue. It is something far more difficult to achieve and control than a simple display of technological virtuosity. Western civilisation today maintains an approach to life which can only be described as brute force and ignorance. We are proud that we have significant sway over nature yet we are unable to use it wisely, unable to use it in rhythm—and when we fail to hear we also fail to grow. Is this approach the best we can achieve or will we learn the gentle use of power?

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Double standards in conservation morality

by D. F. Owen

British conservationists have succeeded in securing a high degree of protection for many species of birds and they are highly critical of those countries in southern Europe which permit the shooting of migratory song birds. Yet this concern masks a double standard, for Britain continues to allow the shooting of "game" birds, which include some species more rare than the song birds. Can Britain hope to persuade other countries to preserve the habitat for birds that will be shot for sport when they reach our shores?

Most of the wild birds occurring in Britain enjoy complete protection by law: it is illegal to take or kill them and to collect their eggs. A few species designated as pests may be killed, while game birds and some waterfowl may be shot for sport during certain seasons of the year. Game birds (pheasants and various native and introduced species of grouse and partridges) are resident and non-migratory, their numbers are artificially maintained by feeding and protection, and indeed some of them are for all intents and purpose domesticated. Waterfowl (ducks, geese and swans) are both resident and migrant. Some species, such as the mallard, breed in Britain and also migrate to and from Britain; others, like the pink-footed goose, are winter visitors and do not breed in Britain. Some species of waterfowl, such as the barnacle goose, are now fully protected by law, but others like the grey geese and many of the surface feeding ducks, are not protected and may be shot for sport during the winter.

Because of its mild climate Britain provides one of the most important wintering grounds for ducks and geese in Europe. Each autumn there is an enormous influx of birds from breeding areas in Iceland, Scandinavia and eastern Europe, including Russia. With few exceptions these birds are fully protected in the countries in which they breed, not only by law, but perhaps more importantly by people who simply enjoy seeing the birds around them.

Wild birds probably enjoy greater protection in Britain than in any other country. The Royal Society for the Protection of Birds, with its large membership and considerable resources, has for years been doing a splendid job, especially by acquiring and maintaining nature reserves, providing special protection for rare species like the osprey, and initiating campaigns against cruelty and against egg collecting. Thousands of people in Britain are enthusiastic and ardent bird protectionists. Many of them are quick to condemn the people and governments of other countries (especially the "Latin" countries of Europe) for failing to create and implement laws that protect wild birds. In particular there is much criticism of the habit of catching and killing migratory song birds in countries like France, Italy, Malta, and Cyprus. And yet in Britain and in other northern countries migratory ducks and geese are considered as legitimate quarry, many people feel that shooting them for sport is totally acceptable and justifiable and in no sense to be compared with the killing of migratory song birds in southern Europe.

My aim in this article is to argue that conservationists in northern Europe are at the moment applying what I call double standards of conservation morality when speaking of bird protection, and that the time has come to examine the ethics of shooting migratory ducks and geese. I am not here concerned about the ethics of shooting semi-domesticated and non-migratory game birds; what I have to say is relevant only to those migratory species which may be legally shot in Britain at the present time. Moreover it does not matter whether these migratory birds are rare or common or whether they are endangered: the issue is simply that conservationists who criticised the people in other countries should be able to do so from a position of moral strength, a position which is impossible to hold so long as migratory birds may be legally shot in Britain.

The position of the RSPB

The charter of the Royal Society for the Protection of Birds contains a number of clauses setting out the objects of the Society. These are almost without exception admirable and cover the whole field of bird protection and conservation. But part of item 4 (f) leaves cause for worry. It says:

> "To discourage the wanton destruction of birds and the wearing of feathers of any bird not killed for the purpose of food, other than the ostrich, but to take no part in the question of the killing of game birds and legitimate sport of that character."

This means that the Society recognises a category of birds under the heading of "legitimate sport", although it is unclear as to what is meant by the word "legitimate", except that under present British law these birds can be killed in an approved way. But despite its charter it seems that the Society can consider species at present regarded as legitimate sport if there is any question of them becoming

endangered (see a letter in *The Times*, 16 September 1972).

The threat to the pink-footed goose

The pink-footed goose, a relatively rare bird by world standards, is an example of a species classified as legitimate sport. Its chief breeding ground is in Iceland and about half the world population breeds at Thjorsarver, an area scheduled for flooding in 1974 or 1975 with the development of a hydro-electric power scheme which is needed to promote industrial growth in Iceland. Unless the birds move to another breeding site as many as 11,000 pairs may disappear. Pink-footed geese are birds of tradition and the disruption of a well-established breeding site could easily prove disastrous. Most of the world's population of pink-footed geese winter in Britain, chiefly in and around several of the larger estuaries such as the Solway and The Wash. No one seems to know for certain but it is thought that between five and ten thousand are shot each winter. The Wildfowl Trust has studied the wintering population and estimates that there has been an increase from about 30,000 birds in 1950 to about 65,000 in 1971. No one knows what has caused this increase (although it has presumably not been caused by shooting) but the RSPB, The Wildfowl Trust, and the Wildfowlers' Association are evidently quite happy to continue to see the geese "cropped" and to speak in terms of harvesting a "surplus". At the same time all three of these organisations are putting pressure on the Icelandic authorities to abandon or change their development plans for Thjorsarver because of the threat to the breeding grounds of the geese. It should come as no surprise if Iceland remains unimpressed by requests from those who tacitly support the shooting of geese in winter. Indeed it would be quite reasonable if Iceland were to interpret the situation as an attempt to inhibit economic development because of shooting interests in Britain.

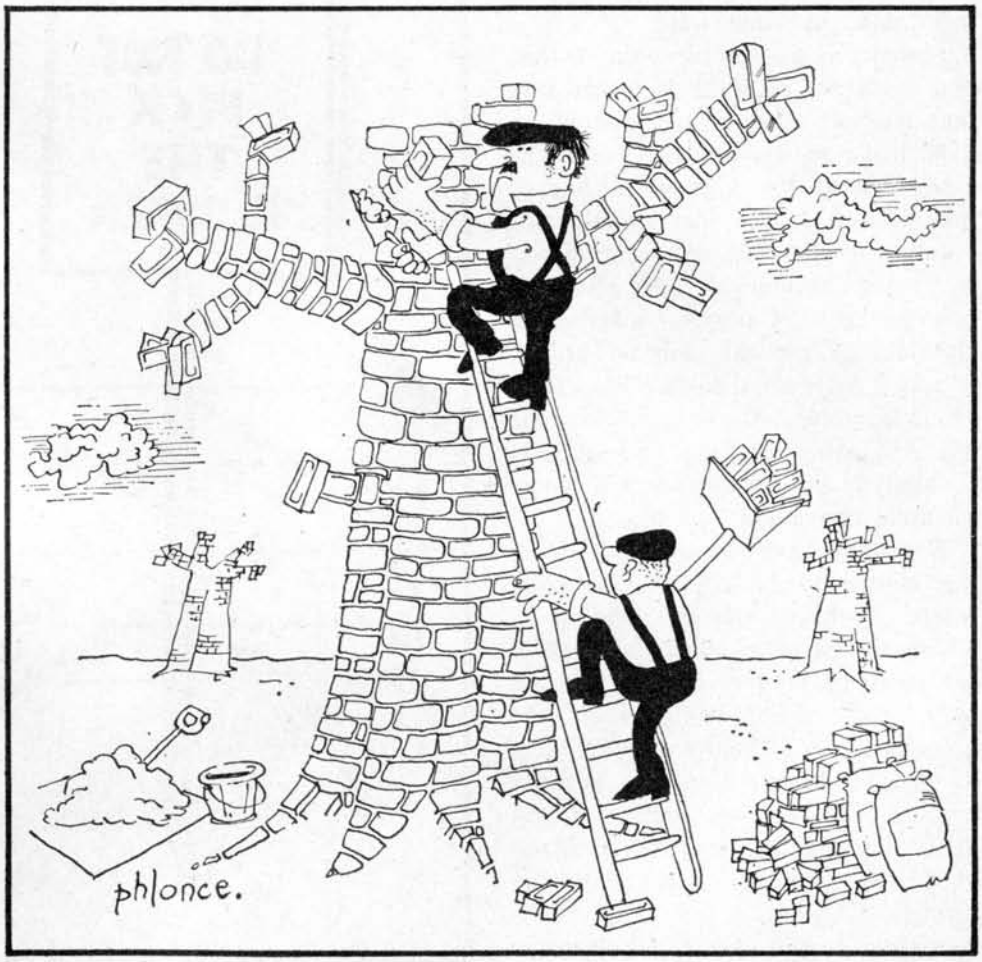
What can be done?

There is no justification whatsoever for the continued shooting of the pink-footed goose in Britain. The bird is relatively rare by world standards and its chief breeding ground is threatened. No one could possibly pretend that the geese provide food for the needy, indeed goose shooting is usually an activity of the relatively affluent. There is far less justification for shooting the geese than for killing small song birds in southern Europe: most of the species of song birds killed are common and their breeding areas are secure. If those concerned with bird protection and conservation wait to see what happens to pink-footed goose numbers when Thjorsarver is flooded they may be too late, an all too common experience in the conservation movement. If on the other hand action is taken now while the geese are still increasing in numbers, bird conservationists will gain a certain amount of credibility and will at least give the impression to countries like Iceland that Britain is serious about bird protection and will not indulge in double standards.

The pink-footed goose is only one of several species which breed outside Britain and enjoy full protection when breeding, but while wintering may be shot. It should not be difficult to agitate for a change in the law and the issue should be discussed openly by the membership of the RSPB who are in the best position to apply pressure for a change. As things stand at the moment the charter of the RSPB does not encourage open discussion of this topic. Furthermore it appears that so far as any future legislation for the protection of waterfowl is concerned the RSPB relies on information provided by the Wildfowl Trust who in turn (I am informed) receive advice from the Wildfowlers' Association, whose members are partly responsible for shooting ducks and geese in Britain.

The shooting or "cropping" of wild geese and ducks is paralleled by whaling but if anything is less justifiable. Conservationists face a dilemma if on the one hand they condemn other people and governments for killing and exploiting wild animals (such as whales and song birds) and yet do nothing to prevent the exploitation for sport of relatively rare species like the pink-footed goose. I hope that we shall not have to wait until this and other waterfowl become really rare before we take strong action.

Finally, I must add that I have immense admiration for the work of the RSPB. It is only because there is such an organisation that it would be worth raising the issue I have discussed in this article.



Down to earth

Mercury in the garden

In 1970, one of the 2,000 or so compost gardener members of the Henry Doubleday Research Association saw his neighbour using mercurised lawnsand. To his horror he was told that all the mowings he had been given for the past two years had been from the mercury treated lawn. So he sent a sample of his potatoes grown with compost that included the mowings to the Association and analysis showed that they contained 0.5 p.p.m. of mercury, the upper safety limit on the tinned tuna that the US Government took off the market.

The spuds were safe but only just, and because potatoes are the main winter source of Vitamin C in an age of chips with everything, this level is in fact dangerous. We may eat two tins of tuna a year, but we average nearly 3000lb of potatoes each. To make sure, the HDRA tried again and this time found no mercury—the potatoes were from a row with compost from another part of the heap to where the tainted mowings went.

Mercury is dangerous in tiny traces, and these are so difficult to measure that analysis costs £50 a sample, so £100 had gone on just two tests. The HDRA tried for a grant to finance investigation, and for samples of potatoes to test. The second item was easy for thousands of allotment holders use Calomel (Mercurous chloride) to prevent clubroot attack, and it is here that danger lies. They found samples but no grant, so the experiment had to wait, with at least 10 analysis figures necessary to carry scientific conviction.

Now they have the co-operation of the University of British Columbia, where Professor Henry Warren is willing to test up to 20 potato samples for mercury free of charge, so the only cost will be drying the samples at 40°C before posting them to Canada. Now it is at last possible for the HDRA to do some work on this rather urgent aspect of pollution.

Organic mercury passes quickly through the body, though it is dangerous to the liver and kidneys in large quantities, but when it is concentrated and converted to organic forms by bacteria, these collect in the proteins and fats of the body cells and stay there for a half life of 70 days. Half will leave the body in that time, half of what is left goes in the next 70 and so on. If two milligrams a day of organic mercury are taken, the body cannot get rid of enough in time and it builds up to over 100 milligrams in six months, which is a killing dose.

Bacteria that do this concentrating are found in the sea, which is how mercury has always got into tuna fish, and in pond mud, and this was responsible for its presence in freshwater mussels in the USA and Japanese rice. There may be a *soil* bacteria that could change the relatively safe mercury in chemicals to deadly methyl mercury. We do not know, but the HDRA has now a chance to begin finding out, and the first step is to establish the existence of a link between mercury compounds used in horticulture and its presence in vegetables.

Very few gardeners who make compost use mercurised lawnsand, but if any have, samples of this compost, and of any root vegetables grown with it, would be of great value to this research. Still more important are potatoes grown in gardens or allotments where calomel has been used against clubroot year after year, making it possible for heavy concentrations to have built up. It would be safer not to bake potatoes from these gardens in their skins, for just as peeling potatoes is reputed to throw away the "goodness", in the shape of nutritionally valuable minerals just under the skins, the "badness" of toxic metals could be there too.

Write first, offering what material you can donate towards research on mercury pollution so we can find out before some British village becomes as famous as Minamata in Japan, where this deadly metal struck first. The address is: The Henry Doubleday Research Association, Bocking, Braintree. Essex.

Lawrence D. Hills

US Report

Half a lake is better than one

The least-known story of the month concerns one of the greatest battlegrounds of the American conservation movement, the Colorado River.

The Colorado is the second longest river system in the United States, running nearly the breadth of the country, from Montana to the Gulf of Mexico and it has lighted a gleam in many an engineer's eye.

The river cuts through the great sandstone plateau of the American West, between the Rockies and the Sierra Nevada. After the last ice age, there was a gradual uplifting of the desert floor, and as it rose to form the present plateau, the Colorado was busily cutting it down to size. The resultant series of canyons is unequalled anywhere in the world. There are Flaming Gorge, Echo Park, Grey Canyon, Desolation Canyon, Cataract Canyon, Stillwater Canyon, Glen Canyon and finally, the climax of climaxes, Grand Canyon. Or I should say *were*. Flaming Gorge is now a reservoir, likewise Glen. And only superhuman effort by many dedicated people who laid the ground for the recent rise in general public concern for conservation staved off dams that would have flooded Echo Park and the Grand itself.

The battle over Echo Park was the first, and it produced a compromise between the conservationists, led by the Sierra Club, and the Bureau of Reclamation, the government's main river-stopper (referred to by Club members as the Bureau of Wrecklamation). In order to keep a dam out of Echo Park (part of Dinosaur National Monument) the Club agreed not to oppose the proposal to build the Glen Canyon dam—provided that the government guarantee that none of the various reservoirs on the Colorado would be allowed to back up into any national parks or monuments. This proviso was sought to protect Dinosaur from any sneaky schemes that might crop up to build a dam right outside the Monument boundary, and also to protect Rainbow Bridge National Monument, which lies in a tributary stream canyon to the Colorado not far upstream from Glen Canyon Dam (see picture).

Glen Canyon Dam was completed just 10 years ago, and nothing has been done to protect Rainbow Bridge—the stipulation of the very compromise that allowed the dam to be built at all has been abrogated. (Some effort was made several years ago to have a protective dam built near the monument boundary to hold water from Lake Powell out of the Monument, but Congress refused to provide money to build the dam).

Accordingly, Friends of the Earth, the Salt Lake City based Wasatch Mountain Club, and river guide Kenneth Sleight filed suit, asking the court to make the government obey its own law. It took the judge two years to make up his mind, and in February he ruled in favour of the plaintiffs. The effect of the ruling is that Lake Powell, the body of water backed up by Glen Canyon Dam, which after 10 years is just barely half full, will have to be kept half full.

This decision of course, involves a hell of a lot more than one small national monument. It involves terrific economic pressure from public utilities that are afraid the decision will affect their ability to build and cool coal-fired electricity plants and coal gasification plants, (and which will lose some generating potential at Glen Canyon's generators), political pride, and the pure absurdity of suggesting that we leave a gigantic reservoir half full. Why, it would be like building the SST and then not flying it! Preposterous! Probably radical!

There is, of course, another side of the question, which FOE in the US is strongly promoting. David Brower, FOE's president, has been doing battle over the Colorado for 20 years. He led the Sierra Club's effort to save Echo Park and the Grand Canyon, and now he's back into the thick of it. In a letter to the Secretary of the Interior, Mr Morton, Brower outlined the benefits of the judge's decision. A great deal of water, which would otherwise be lost to evaporation and seepage, will be saved. At fairly conservative estimates, the amount of water saved could approach 4 million acre-feet per year, and would represent a monetary saving which would more than off-set any loss of revenue due to loss in power generating potential. Keeping Lake Powell at the level it is at now will also spare thousands of acres of magnificent sandstone canyons from death by drowning; the sanctity of the national park system will be saved from a damaging precedent; and the power head at Lake Mead (downstream from Glen Canyon) will be able to regain the level and generating capacity it lost because of overstorage at Lake Powell. And, though this is not likely to make too much difference to most people in Washington, Mexico will get somewhat purer water than the brackish stuff that's been coming down the river for the past several years.

The government has asked the judge to stay his order, and legislators from Utah have introduced bills in Washington to repeal the proviso on which the lawsuit was based.

It promises to be a sizeable battle—we'll keep you apprised.

Tom Turner

Rainbow Bridge, the largest known natural bridge on earth. It is 278 ft. wide, 309 ft. high, more than 40 ft. thick and 30 ft. wide at its thinnest point. It is about half a mile from Lake Powell. Were the lake to be filled to capacity, the water would reach a depth of 56 ft. beneath the bridge.

Books

Lucky dip

BICYCLING: A HISTORY by Frederick Alderston, David and Charles, Newton Abbot, 1972. 214 pp. £2.95.
THERE'S A SEAL IN MY SLEEPING BAG by Lyn Hancock, Collins, London, 1972. 292 pp. £2.75.
TRANSPORT: PROBLEMS AND PROSPECTS by Bill Gunston, Thames and Hudson, London 1972. (cloth) 216 pp. £2.25. (paper) 216 pp. £1.25.
LIFESCAPE: THE WAY THINGS ARE by Pat Haikin, Architectural Press, London, 1972. £1.50. (For set of six or more £1.20).
THE GOYT VALLEY TRAFFIC EXPERIMENT by J. C. C. Miles. Countryside Commission, 1 Cambridge Gate, London NW1. 114 pp. £0.95.

The history of the bicycle is a dip into that extraordinary world of Victorian mechanical ingenuity. Nothing was too preposterous for those zany inventors to attempt and two-wheeled vehicles attracted their share of them. But the bicycle was more than just an opportunity for restless inventiveness; it was an essential element in the breakdown of the old social order. The bicycle and the train began the annihilation of distance for the masses. They liberated the ordinary person from the confines of the small area he could cover on foot and gave him the taste of freedom and movement. And it gave the ordinary young lady a taste of something else; a desperate rearguard action against that was the foundation in 1896 of the Chaperon Cyclists Association.

Frederick Alderston's amiable history covers the story from the fad of the hobby-horse, through the subsequent "boneshaker" and the penny-farthing (called the "ordinary") to the pneumatic tyred bicycle we know today. In many ways the bicycle was the true precursor of the motor car, providing the early motor manufacturers with pneumatic tyres, welded tubing, spoked wheels, variable gears and other devices in a reliable form. This segment of social history, amusing and informative, is another piece in the huge jigsaw of understanding why we are what we are today.

Large animals are frightening and unreliable and I have always viewed them with a mixture of fear and dislike. They are stupid and they can be unpleasantly rough even when attempting to be friendly. Their habits of uncontrolled excretion may bring joy to the heart of a low-impact technologist looking for fodder for his methane generator but they make me feel sick.

Lyn Hancock is married to a wildlife biologist and clearly does not share my feelings about animals. She has a kindred spirit in my 10-year-old daughter Katie who read *There is a Seal in my Sleeping Bag* with considerable interest and enjoyment. When I asked her to put her comments in writing she gave me the following review, which leaves me with nothing to add.

"This is an enchanting book by Lyn Hancock. It describes her adventures with her husband David on a remote island. The book also describes the amusing things the sea-lion Sam does, like the time they found him in a sleeping bag. This book is ideal for those who would like to know more about ecology and what is happening to the world, with a bit of fun put in now and then."

In a book on the problems and prospects of transport one might legitimately look for something more than just a recital of the mechanical development of transport equipment over the past couple of hundred years. Transport has immense social and political implications. It has profoundly modified the natural environment of man and his fellow inhabitants of the planet. It is a major consumer of natural resources, in particular petroleum.

Bill Gunston's view is that bigger and faster and more is better and going is better than arriving. True, we have a nudge here and there in the direction of the environment. There is even a suggestion that we will have to stop using petroleum early in the next century but the fact that "there is little evidence of what alternative form of energy we will use" does not dampen the basic technological optimism of this book. There is even a touch now and again of that paranoia we have come to associate with the commercially self-interested and self-defeatingly hysterical lobbying of the British Road Federation—"the vast sums the motorist was made to contribute in taxes ostensibly for the construction and improvement of roads but in most countries misappropriated for other governmental purposes" (like hospitals for treating some of the nearly 400,000 annual casualties on the roads?) is one place where what may well be the real Bill Gunston shows through. In another place he says: "non-motorists are still numerous—even in the United States —and an important enough lobby to make a nuisance of themselves. . ."

If you can trust the man who sees the world like that enough to be your guide this is a competently written, none too deep, nicely illustrated book about trains, planes, hovercraft, rockets and the rest. You might even find yourself convinced that "the supersonic transport today is in the same disputed position that steam railways were in 1820, cars in 1895 and airlines in 1919".

Lifescape wrapped up in a polythene bag with grainy photos and archigraphics makes life a bit too complicated for itself. Untangled from this the idea is quite good. Quite simply it is a classroom kit consisting of pictures which raise social or environmental issues and cards associated with them which ask questions arising from the pictures. The teacher hands round the cards and asks the questions. Discussions, development of the topics and projects work follow according to time, taste and ability.

The range of topics covered is wide, including social deprivation in high-rise accommodation, problems arising from overcrowding and over-population, preservation of the countryside and the provision of transport in cities. The questions span a wide range of abilities without ever falling into banality or condescension. The age group is about 11 to 15 or 16. Use of

this kit will do more than just fill an empty slot in the timetable with harmless activity. It will actually get youngsters—and teachers—thinking about real and relevant issues.

The hordes of pleasure-bound motorists can actually be turned back without causing a riot or a revolution. This is the lesson of the Goyt Valley Traffic Experiment in the Peak District. Motorists were made to leave their cars at car-parks and were transported from there to picnic spots, nature trails and scenic attractions by mini-buses. This report gives full details including traffic counts and costs and could be usefully studied by authorities in other areas of natural beauty where motorists are steadily destroying the attractions that bring them there.

Gerald Foley.

Feast and famine

TIMES OF FEAST, TIMES OF FAMINE by Emmanuel Le Roy Ladurie, Allen & Unwin, £7.35; THE URBAN COUNTRYSIDE by Robin H. Best and Alan W. Rogers, Faber & Faber, £3.50; PATRIOTISM WITH PROFIT by Kenneth Hudson, Hugh Evelyn, £5.25; WORLD AGRICULTURE IN DISARRAY by D. Gale Johnson, Macmillan, £3.50 (also as a Fontana paperback £1.25); THE HUNGRY PLANET by Georg Borgstrom, Collier-Macmillan, £1.25.

We have heard rather less lately about the possibility that through his interference with the processes of the biosphere man may be affecting global processes that could trigger climatic change. The possibility remains, of course, but although we know that the mean surface temperature has been falling, it is impossible to discern any causal relationship between this phenomenon and human activity. Nor can we make any long-term prediction about the kind of climates our great-grandchildren may enjoy.

The difficulties remain, but Professor Le Roy Ladurie helps us to see them in a context wider than that of a single century. We know, for example, that the present cooling follows a period of warming which began about the middle of the last century. Temperatures never reached those of the early Middle Ages but nor have they yet fallen to those of the long "Fernau" or Little Ice Age. He has explored all the records of climate for the last nine hundred years. The task is far from simple, since references to the weather were highly subjective until accurate measurements began to be made. He relies on three techniques: dendrochronology, which is the interpretation of the rings of trees known to be particularly sensitive to fluctuations in seasonal weather; on phenology, which is the study of the dates of wine harvests; and on the movements of glaciers. To this he adds such information as is available about cereal harvest derived from contemporary impressions.

His conclusions are interesting. He dismisses as simplistic the notion that climate changes provoked political crises in historical times and he finds no evidence to support the theory that climatic change proceeds through clearly discernible cycles.

The book is long and contains so much detail that at times it seems somewhat repetitive, yet Prof. Le Roy Ladurie's love for his material and his zest for unravelling a good mystery combine to give us impeccable scholarship in a book that is a pleasure to read.

While climate determines the fortunes of farmers it is no longer true that the fortunes of farmers shape our rural communities. Populations today are highly mobile, the number of farm workers continues to fall and villages are redeveloped or taken over by weekenders or commuters.

Small towns and villages are such a prominent feature of the English countryside that it is surprising that until recently little was known of their structure. The first work to rectify this deficiency was begun in the early 1950s by Professor Gerald Wibberley at Wye College and since then there has been the Second Land Utilisation Survey. Dr Best and Mr Rogers rely on these sources as they describe the statistical methods involved in studies of this kind and outline some of the general conclusions that can be drawn from them. They provide guidelines that will be of great value to planners, but their book is too technical to be of much interest to the general reader.

To a large extent, modern farming practices have been shaped by the work of the Agricultural Societies, bodies formed during the eighteenth and nineteenth centuries to improve standards of husbandry. Today they are known only for the shows they mount in most counties and even those are declining, but for many years they were instrumental in persuading farmers to adopt scientific methods as well as in sponsoring research. If they have much to answer for on this score, they also achieved much. They opened schools, taught farmers to keep records and accounts and they promoted the building of the farm cottages so sought after today as holiday cottages, to replace what were often little better than mud huts. And it was at the Royal Lancashire Show of 1862 that the President of the Royal North Lancashire Society, the Earl of Derby, said that "muck is money". He meant that farmers should return animal manures to the land!

Kenneth Hudson traces the development of the Societies from their formation to the present day. He presents a wealth of information in so short a book and the numerous illustrations and extensive quotations from contemporary sources give a fascinating insight into a way of life that disappeared very recently. Did you know that in 1879 the Royal Show was held in Kilburn, on a vast site on the fields either side of Maida Vale? Today Kilburn is part of Central London.

The lot of the farm worker has improved in the last century but we live in a grimmer age. Agriculture is part of a global production and marketing process, and the world is short of food. Professor Johnson is right in maintaining that world agriculture is in a state of economic disarray. He shows how it is that the industrial nations, with high-cost farming systems, are able to undercut the lowest prices the farmers of the non-industrial countries can charge. The trick is to subsidise production, subsidise exports and then add a dash of protectionism to create a system that cannot help but discriminate against the poor. This discrimination is maintained within the rich countries and Prof. Johnson's second main point is that increasing the amount of capital invested in farming cannot benefit the farm worker. It serves only to increase the value of land and the profits accruing to the owner. According to Johnson, the only way to improve real wages in agriculture is to

reduce the size of the labour force continually. This brings us back to the problems of the non-industrial economies which cannot absorb labour in factory industry. There must be a better solution and there is, but Johnson does not find it.

He explains, too, what happened when America tried to become the granary of the world, dumping its surpluses on the non-industrial countries as food aid and bankrupting many of their poorer farmers. Food aid is administered much more cautiously nowadays, but the point is well made that there can be no solution to the world food problem based on perpetual subsidy from the areas of plenty.

Not that Prof. Johnson is too concerned about the world food problem as we understand it. In his view, if the economics of world food trading could be got right hunger would disappear very quickly. He is much more worried about what will happen when Latin America, Africa and Asia all produce vast surpluses which they must export in order to earn the foreign exchange that will enable their industrial economics to take off. Unfortunately, he understands a great deal about rather dated economic theory, but little about agriculture and nothing whatever about demography. He believes that the world can feed a population many times its present size, but that in any case the demographic transition is already reducing population growth rates. The result is a valuable book in many ways, but to some extent one whose arguments are constructed with great elegance on a foundation of wishful thinking.

Perhaps he should read Borgstrom. Perhaps everyone should read Borgstrom. *The Hungry Planet* was the book which brought his name to the fore as the world's number two "doom merchant", a reputation he consolidated with *Too Many. The Hungry Planet* has been revised and the statistics updated and now it is available as a paperback. In places it is shrill, but it is a long book and I defy anyone to sustain a note of near-hysteria for more than 500 pages! For the most part it is a closely-argued plea for a global population policy. It pays tribute where tribute is due—to China and the Soviet Union in particular. Siberia, says Borgstrom, is the planet's last frontier, and the Sino-Soviet political confrontation falls into place. Nevertheless, while a few populations can expand, most cannot and areas that appear empty, like Australia, may be full to overflowing when the character of their land and climate are taken into account.

At times over-pessimistic, at times incredibly over-optimistic, nevertheless no one who wishes to understand the nature of the world food situation can afford not to read this book.

Michael Allaby

Paraprimitive Utopia

RETHINK: A PARAPRIMITIVE SOLUTION. Gordon Rattray Taylor, Secker and Warburg, £2.50.

Gordon Rattray Taylor is a *generalist* —that is, the opposite of a specialist. Instead of trying in vain to know everything about something, he has succeeded in knowing something about everything. Consequently, he is able to survey broadly the dark wood in which we live, rather than devote a lifetime to a minute study of one tree. In recent books he has dealt with the problems of biological "advances" and the crisis in the physical environment: in his latest work he turns to psychology, sociology and politics, offers a diagnosis of our predicament and suggests a cure. But this is not a glib one-track-minded panacea, one of those stowaways on the ecological bandwaggon which it regrettably seems to be profitable for publishers to produce at present. Taylor is no tub-thumper: he argues his case carefully, and does not assume that he is preaching to the converted; all he asks of his reader is an open, critical mind.

Most of us live today, he maintains, in a "psychological slum". There are a few basic life-styles, for some one of which every human being feels a preference—examples are the life of action, of contemplation, of creation, of service to others. But "Western society fails to offer slots in the same numerical proportion as the number of people in each group". Thus, in Management there are more vacancies than people able and willing to fill them; in Creativity far less; and some basic types do not fit in at all, for instance Nomads—ask any gipsy.

"The mass of men", said Thoreau, "lead lives of quiet desperation". A century later, the desperation is just as great, but a lot less quiet. Taylor quotes the alarming statistics of crime, suicide, alcoholism and mental illness. All these symptoms of a sick society are increasing exponentially: none is found on anything like our scale in primitive societies (until we introduce them, with such other benefits of civilisation as rifles, influenza and brassieres). The early Socialists thought that when material needs were satisfied, men would be happy and virtuous: and there's only one thing wrong with that—*it ain't so.* Rather, as Taylor points out, the very industrialism which provides abundant goods, seems inevitably to harass and frustrate its beneficiaries to the point of breakdown. It gives them work which cannot satisfy, herds them into cities where they lose their individuality, makes them mobile and thereby destroys communities, and imposes such rapid and incessant change that anxiety becomes the only permanent feature of their lives.

In Taylor's view, the situation is not hopeless. We need, first, to recognise that we have passed a "turnover point at which effort needs to be transferred from material to non-material needs." We need not reject *all* the benefits of technology: "no one but a saint or an ascetic would willingly do without running water and electric lights, or anaesthetics and antibiotics." Taylor's Utopia is not primitive, but *paraprimitive*—combining the advantages of primitive social structures, work patterns and values with as much of our technology as is not incompatible with them. "The change we have to make . . . is to reorder priorities, to shift the weight we attach to different values. There are grounds for cautious optimism in the fact that such a shift does seem to be occurring."

Such, in barest outline, is the theme of this book. But no review can do justice to the vigour and variety of Taylor's insights. The price mechanism, child rearing, the standard of living, work, education, historical fluctuations in social values—even if you don't agree with him on everything, you will gain in understanding by reading what he has to say. And as a final bonus, the book is by today's standards surprisingly cheap: you could easily pay a lot more to learn a lot less.

Nicholas Gould

Letters

Should we forbid smoking ?

Sir,

Recent publicity given by *The Times* to your report on tobacco smoking has suggested that smoking cigarettes made from fermented tobacco of the type sold in France and Eastern European countries is, if not actually safe, at least far safer than smoking British cigarettes. The assumption seems to be that as there is less sugar in fermented tobacco, there is less danger to the smoker, as the comments on your report appeared to equate the sugar content rather than the tar content with death from carcinoma of the lung.

This premise tends to denigrate the cigarette brand league table of tar content published by Her Majesty's Government and to belittle the advice given that, if people are foolhardy enough to continue smoking at all, they should smoke cigarettes with low tar content.

There is a wealth of evidence to suggest that tar is carcinogenic, and that a reduction in the quantity of tar leads to a reduction of cancer. Standard laboratory tests for carcinogenicity are daily confirming this, and confirmation in the human field can be obtained from the American statistics where it has been shown that smokers who have changed from plain to filter tipped cigarettes with a lower tar yield have a lower instance of lung cancer.

Extensive laboratory work has been carried out on the tar prepared from fermented tobacco (the French type) which, although it has a low sugar content, has been proved to be more dangerous and more carcinogenic than the type produced from tobacco in English cigarettes with a high sugar content. At first sight the French statistics may seem to run counter to this scientific evidence, but the figures have to be looked at more critically than the article suggested. There are many factors in the development of a cancer of the lung secondary to cigarette smoking. The numbers smoked by any individual, and the way in which he does so must also be borne in mind along with the brand. These figures are further confused by the fact that there is a long latent period before any change in smoking habits will be reflected in admission to the chest wards. There is evidence to show that the French, although their national overall consumption is similar to our own, have fewer heavy smokers, fewer smokers who actually inhale, and most discard a longer stub than we do. When these points are taken into consideration the lung cancer risks of the two countries are comparable.

The facts so far collected by the Royal College of Physicians among others, make a convincing case against tar in tobacco, and there must be a strong presumption that a reduction in tar yield is the overriding first need for safer cigarette smoking for those who are regrettably unable to give it up altogether.

However a reduction in the tar yield will have no effect on the appalling mortality rate due to heart and vascular diseases occasioned by cigarette smoking, which may well be the prime hazard for readers of *The Times*!

Yours faithfully,

Dr Tom Stuttaford MP,
House of Commons,
London SW1

Sir,

Dr Chatelier's and Mr Waller's (December 1972) idea that banning "oven dried" tobaccos and allowing only cigarettes made from air-cured or "enzymatically fermented" tobaccos to be sold would reduce the cigarette smokers' risk of lung cancer is based chiefly on their statement, unsupported by any reference to published work that there is a low lung cancer mortality in Russia and Poland. The published figures tell a different tale. Lung cancer mortality in men in both these countries is similar to that in other western countries where cigarettes made from over-dried tobaccos are used.[1, 2] In Poland a retrospective study has shown a relationship between the amount smoked and lung cancer risk similar to that reported in this country and the USA.[3] These authors report a Russian study indicating that the condensate of smoke from Russian cigarettes is not carcinogenic to animals but give no reference to this work from which the experimental technique could be judged: they ignore British and American studies showing that the condensate from pipe and cigar tobaccos (enzymatically fermented) is more carcinogenic to animals than condensates from oven-dried cigarette tobaccos.[4, 5]

They also state that doctors in this country have accepted a "single factor explanation" of smoking as a cause of lung cancer in a manner that is "unworthy of their standards of excellence and the rigour of proof". This statement is hardly compatible with the numerous publications on the many other well-documented causes of lung cancer that have been reviewed by doctors.[6, 7] The whole question of the relationship of lung cancer mortality to smoking of different kinds of tobaccos in different ways is extremely complex,[8] but there are certainly no grounds to suppose that the use of Russian and Polish types of cigarettes would have any effect on lung cancer deaths in this country when they cause such a high mortality where they are now smoked.

Dr Chatelier and Mr Waller certainly disdain "rigour of proof" themselves, for they choose to ignore all the evidence that conflicts with their personal opinions and to present only one aspect of a complex case. This is a poor basis from which to make pronouncements on important matters of public health, and it is disturbing that the editor of a journal concerned with human welfare should publish an article of this kind without seeking expert opinion about the validity of the evidence presented. Are you not concerned that public health policy should be based on a complete rather than a one-sided and even erroneous assessment of medical evidence?

Yours faithfully,

C. M. Fletcher, MD, FRCP,
Royal Postgraduate Medical School
Hammersmith Hospital, London W12.

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6. Royal College of Physicians. (1971) *Smoking and Health Now.* Pitman Medical and Scientific Publishing Co. Ltd. London. P. 58.
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Sir,

To suggest that there is no connection between flue curing of tobacco and cancer of the lung as Dr Fletcher avers, is to fly in the face of the evidence.

1. In the years 1959–60–61, the death rate from cancer in Poland was 7.4–8.0– and 9.7 respectively. In the USA the corresponding rates were 21.2, 21.9 and 22.8. Whereas in England and Wales, the rates were 46.2, 44.8 and 45.4. In Poland at that time, all cigarette tobacco was air cured, while in England and Wales it was all flue cured by that time. US tobaccos were a mixture of the two.
2. During the period 1949–1967, deaths among males from lung cancer in England and Wales rose from 2,213 to 16,382 per annum i.e. an eight-fold increase, whereas the consumption of cigarette tobacco rose only from 177.9 million pounds to 223.3 million pounds. But during the period 1920–1939, consumption rose from 80.3 million pounds to 162.8 million pounds. During these two decades, all cigarette tobacco was naturally fermented. During this period, as the evidence from chest clinics amply demonstrates, cancer of the lung was a rare disease.
3. During the period 1920–1939 consumption of Derv was negligible while during the period 1954–1967 it rose from 1,413 thousand tons to 4,286 thousand tons per annum. Comparing this to the number of deaths from lung cancer in England and Wales, which rose from 10,703 to 16,382 deaths per annum, one discloses a correlation coefficient of 0.98 i.e. verging upon unity. Derv was the only atmospheric contaminent which increased relatively and absolutely during that period.

The death rate from lung cancer among males in outer Belfast during 1960–62 was 40. In the rural district of Ulster it was 10 (over 35 years of age)

In 1952–1962 in the highly industrialised areas of East Stockton, the death rate was 199 and 180 respectively, while in the adjoining rural areas it was 69.

4. The late Ronald Fisher quoted figures demonstrating an important hereditary factor in the instance of lung cancer.
5. The above data was obtained from the Registrar General's library at Somerset House; from a paper circulated privately by Dr Jan Beffinger, who is a Polish agronomist and obtained his figures from publications of the Tobacco Research Council and most important of all from the Ministry of Fuel and Power. The data are readily available to anyone who takes the trouble to refer to them. My own view is that there are three important factors in the incidence of lung cancer; 1. the hereditary factor; 2. the change in the method of curing cigarette tobacco and 3. the increase in the consumption of the fuel Derv, commonly referred to as diesel.

Mr Robert Waller inclines to the view that the second factor is the most important. For myself, I would place prime importance on the third.

Yours etc.,

Dr Allan Chatelier,
80 Loampit Vale,
London SE 13.

Stabilising the economy ?

Sir,

Herman Daly's exposition in the March *Ecologist* proposes means as to "how to stabilise the economy". One is necessarily impressed by anyone attempting to produce constructive proposals for a stable ecological condition in society but one also hopes not to become blinded to the inequities of the proposed system by its good intentions.

Daly's reliance on "institutions" in his prescription for society appears to be in antithesis to his stated belief that "Major faith, however, must be placed in basic regenerative powers of life rather than in an ability to consciously plan a specific future according to some detailed rational blueprint". Institutions are very consciously planned.

If Daly really thinks that licensed parenthood will help build a sane, free, balanced social condition then he is surely naive or stupid. Someone, somewhere has to produce the licences, someone, somewhere has to decide how many to produce, this necessarily implies a totally centralised overriding authority and a bureaucracy of present-day Herculean proportions. The argument that the advantages for the rich to have children are decreased (not negated) revolves around the tenet that the difference between being rich and poor in our society is such that relative incomes are substantially effected by the cost of having kids, that this is not the case is evident today. Boulding virtually makes children a marketable commodity and as with any marketable commodity the rich are vastly advantaged.

When Daly discusses enforcing the licensing system he really goes too far. If the survival of the human species depends upon such authoritarianism and deprivation of personal freedom as the envisaged licensing system and attendant legal enforcement procedures suggest, then is it really to the good for mankind to survive? Boulding's plan may not attempt to manipulate peoples' preferences directly but it certainly supplies the tools for the job!

The desire to maintain the life-giving functions of our planet must not presuppose the development of repressive measures to enforce that concern, rather we must allow the powerful and ultimately self-sustaining forces of humanity to percolate society and those that can must educate people and give hope, not contaminate the concepts of ecology with scare-mongering and not to confuse the proliferation of people as something to be controlled in the way a proliferation of cars might be.

Sincerely,

Paul F. Downton,
16 Connaught Road,
Roath, Cardiff,
Glamorgan.

Sir,

Herman E. Daly's article "How to

stabilise the economy" in the March edition of the *Ecologist* is an outstanding contribution to thought on *A Blueprint for Survival*. He refers to Kenneth Boulding's ingenious institution for maintaining a constant population, but the great difficulty in this proposal is enforcement. I would like to suggest that sterilisation of women after the birth of the third child would be a more practical solution and acceptable to a very large number of married couples.

Yours sincerely,
W. Kintland Hinton,
Woodgarth,
115 Guisborough Road,
Nunthorpe,
Middlesbrough,
Teesside.

Blueprint for Survival

Sir,

Several of your recent contributors have identified two major obstacles to the achievement of a "stable society" in Britain as insufficient resources for our present population and the lack of a political climate in which measures to restrict consumption would be acceptable to our citizens. In this context, I would argue for a policy of redistribution of wealth to be included in your *Blueprint for Survival*.

Successive governments have propagated the myth that economic expansion is the key to the prosperity of our citizens. In order to maintain capitalist industries, resources are being wasted by artificially-created consumption: goods which were once luxuries become psychological necessities in the race to catch up with the materialist pacemakers. If an equality of income could be brought about throughout society, the feeling that everybody was "in the same boat" would make citizens more prepared to tolerate a reduction in living standards or at least in consumption.

It has been claimed that without differential rewards there would be no incentive to work hard or to shoulder responsibility. However, our highly-educated younger generation is increasingly frustrated with jobs which offer no challenge. In our ideal "stable society", executive positions would be assumed by individuals who were seeking challenging responsibilities and not merely financial rewards. This would lead to greater efficiency.

I hesitate to indict the *Blueprint* for displaying elitism, but it comes close to it in paragraph 346 which asserts that achievements in the fields of fine arts and architecture would earn both money and prestige. Should such creativity require financial incentives? In the final analysis, it is difficult to justify any social system in which some citizens are privileged to enjoy better living standards than others.

Yours faithfully,
David K. J. Withrington,
Chief Editor,
International Youth Bulletin on the Environment,
6 Sutton Court Mansions,
Grove Park Terrace,
London W4.

The need to redistribute wealth both within and between nations is accepted and policies to achieve it are suggested in the expanded Blueprint study at present in preparation. *Ed.*

Is ecology elitist ?

Sir,

Well balanced and reasoned arguments were presented by David Pearce in his article, "Is Ecology Elitist?" in the February issue of the *Ecologist*. As an economist, I particularly appreciated his statement about "... the curious way in which economists simplify the world in order to analyse it".

Maurice F. Strong, Secretary General of the United Nation's Conference on the Human Environment and now Executive Director of the United Nations Environment Programme, illustrated this point when he lectured at Colorado College last November:

> "There are serious shortcomings to any such procedures (the use of standard cost-benefit analyses for evaluating environmental implications). Indeed, if you carry these to their logical conclusion, you would find that, given current interest rates, it would not be good economics to preserve the oceans, the atmosphere or other precious resources of our 'only one Earth' for the next generation. In fact, on a purely cost-benefit basis, it just wouldn't pay to save the Planet Earth!"

Much is being said about the need to bring together economics and ecology, but little is being done judging by the outpouring of polarised rhetoric from the growth debate in Britain and the United States. Perhaps broad gauged economists like Mr Pearce could contribute by publicising further the limits to cost-benefit analysis.

Sincerely,
John G. Welles, Head.
Industrial Economics Division,
University of Denver,
Denver, Colorado, USA.

French nuclear test

Sir,

The lack of concern by the British Government over the issue of French atmospheric nuclear tests in the Pacific is most deplorable.

There are a million British migrants in Australia, thousands more in New Zealand, and besides there are several Pacific Dependencies for whose welfare Britain is still directly responsible. Are we to understand that the British people are quite indifferent to the fate of their own grandchildren, or is it simply a question that the Common Market is more important? Does one also need to remind the Heath Government that thousands of servicemen from the antipodes gave up their lives in defence of Britain in two world wars?

Regrettably Australia has its own fifth column too. For years a group of local scientists has been guilty of putting out soothing reports of nuclear fall-out with the assurance that the population was in no danger whatever. At present there are strong rumours of Franco-Australian collaboration in atomic technology, and so one presumes that atomic scientists do not want to offend the French. Unless our own scientists can also show more social responsibility, it is unlikely that the French will take much notice of our protests.

Yours sincerely,
Dr Peter Springell
President, Rockhampton Society for Social Responsibility in Science.
49 Ross Street,
Rockhampton,
Queensland 4700. Australia.

The Haughley Experiment

Sir,

May I have space to answer Lady Eve Balfour's criticisms of my "Sanitation for Conservation" in your March issue?

She states that the Haughley sections are only 20 years old not 30 but in

1962 the Soil Association produced a report entitled "The Haughley Experiment—The First Twenty-Five Years". So we are both wrong. It should be 35 years of organic cultivation.

The statement concerning the fall in yields is based on the letter in *Span* (December 1970) from Mr R. W. Paine, Entomologist, Biological Control Project, Haughley Research Farms. In it, this Member of the Soil Association Staff states that ten plant samples were washed free of soil and weighed in 1970. Those from the stockless section, (with chemical fertilisers) averaged 18 oz each, those from the organic 2½ oz. That looks to me like a fall in yield, when the two fields were near equal fertility when the experiment began.

My opinion is supported by the fact that Mr Paine wrote in reply to Dr Yellowlees (*Span* November 1970), who wanted to know why the manurial system at Haughley had been changed. We were told then it was because of the fall in yield to which I referred.

I have been a Soil Association Member for about 25 years, and so has my wife. Through the years we have responded to the frequent appeals for funds to keep the Haughley Experiment going, and we are still hoping for an accurate, detailed and *informative* account of exactly what happened, what went right and what went wrong.

Yours faithfully,
Lawrence D. Hills,
20 Convent Lane,
Bocking,
Braintree, Essex.

Vapona strips

Sir,

Vapona strips containing dichlorvos are advertised for and widely used in intensive units where animals and birds destined for meat or laying eggs are constantly inhaling the insecticide. This in spite of the warning on the container "Do not use in larders or cupboards where food is stored." In view of the mutagenicity of these strips to bacteria, this would seem to add quite substantially to the potential dangers in factory-farmed meat and eggs.

Yours faithfully,
Mrs J. Bower,
Hon. Secretary,
Farm and Food Society,
37 Tanza Road,
London, NW3.

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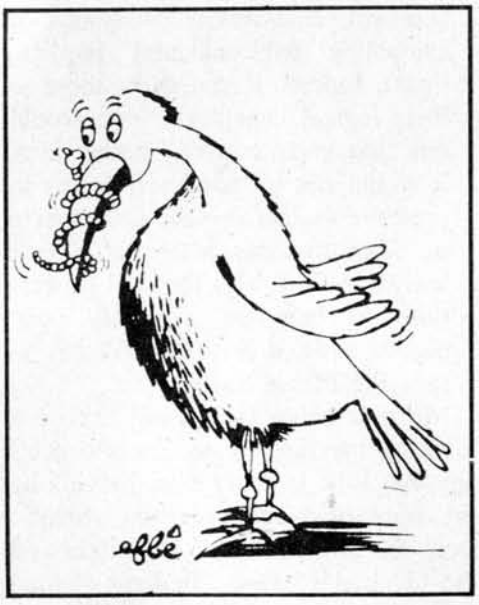

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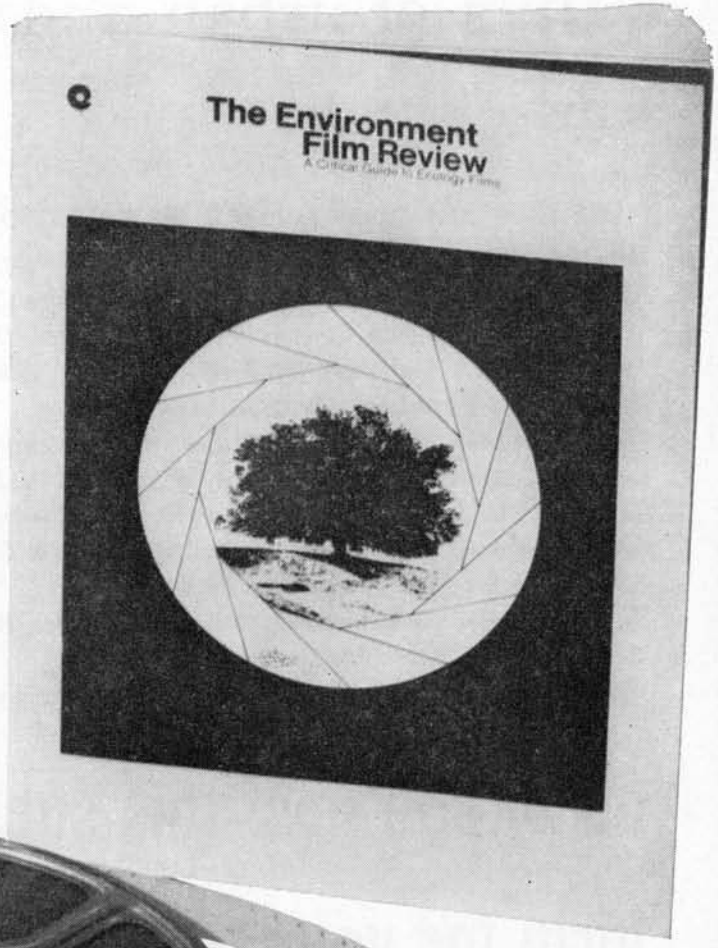

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