other words, these agencies were told they could not get by simply with a series of impact statements covering bits and pieces of the overall development. By its reversal of the court of appeals, Anderson is afraid that the Supreme Court may have given further encouragement to the natural tendency of agencies to "gerrymander" problems to suit their bureaucratic or political convenience.

Such apprehension on the part of Anderson and other followers of the NEPA process appear well taken. What now seems to have been a classic failure to observe NEPA's letter and spirit can be seen in the Trans Alaska Pipeline (TAPS) project. The Department of the Interior spent $9 million producing a huge 102 statement on TAPS; but it now seems self-evident that the environmental and economic advantages of the trans-Canada alternative were never properly analyzed and presented.

Just as some independent economists were predicting more than 3 years ago, most of the oil from the North Slope will be needed not in California—where the TAPS pipeline-tanker system is supposed to begin delivering it in 1978—but in the Midwest. In fact, officials at the Department of the Interior and the Federal Energy Administration have indicated recently that, ultimately, Alaskan oil may have to be sent to Japan in exchange for other oil to be imported from abroad.

Such an exchange, requiring an amendment to the Trans Alaska Pipeline Act, would be a makeshift and hardly desirable solution to the problem in light of the need to reduce dependence on insecure foreign sources. Friends of NEPA believe that such gross miscarriages in economic and environmental planning could be avoided through better use of this statute and its only partially tapped potential.

—LUTHER J. CARTER

British Science Policy: Assuming a Lower Profile

London. The British government has quietly reorganized its machinery for providing science advice at the top and in the process has abolished the office of Science Adviser to the Government. The action came a few weeks after the resignation of Harold (now Sir Harold) Wilson from the office of Prime Minister and furnishes a pertinent postscript to the Wilson era.

Wilson, Prime Minister for eight of the past dozen years, was his country's dominant political figure during a time when the British set out to employ science and technology more systematically than ever before to achieve economic and social goals. The effort, by and large, proved disappointing, and when Wilson returned to office in 1974, the Labour government's enthusiasm for science and technology had perceptibly flagged.

Abolition of the science adviser's job, therefore, came as no great surprise. The post had not been formally filled since Sir Alan Cottrell left in 1974 for the headship of a Cambridge college. Robert Press, a career government scientist, had performed the duties of science adviser but had not been accorded the title. And in February, Wilson, in response to an inquiry about the post from the chairman of the House of Commons Select Committee on Science and Technology, said that circumstances within government which had prompted creation of the science adviser's job had altered. When Press in turn announced his retirement, it was assumed that changes would be made.

The government's actions have been questioned in Parliament and in the scientific community and the science press, but the reaction in no way compares in intensity with the protest in the United States when President Nixon, in 1973, relegated the White House science office and his science adviser to the National Science Foundation. The response has no doubt been tempered in Britain by a recognition that the government has essentially formalized what was already, de facto, done.

In an official explanation, transmitted to the science subcommittee of the Commons Select Committee on Science and Technology in a memorandum from the Lord Privy Seal—a nice anachronistic touch—the government points to changes in science advisory arrangements in recent years.

A major source of these changes was a controversial report on the organization of science, written in 1971 by Lord Rothschild, then head of the Central Policy Review Staff (CPRS) in the Cabinet Office, which provides staffing for the Cabinet. What stung the scientific community at the time was Rothschild's recommendation that part of the funds then spent by the five semiautonomous research councils for basic research be shifted to the authority of the appropriate departments to finance mission-oriented research (*Science*, 24 May 1974).

There was also some alarm about a Rothschild proposal that more research be commissioned under terms more closely approximating the customer-contractor relationship prevailing in successful industrial research. A major aim of the report was to make departments with R & D responsibilities more accountable in this realm and to strengthen departmental science advisory machinery. Overall, says the Lord Privy Seal's memo, "the principal objective was a decentralized form of organisation and management to improve the efficient planning of R & D within (functional) Departments, but with sufficient cooperation and coordination."

Wilson noted last February that most of the major departments have appointed chief scientists and that, therefore, what was needed was not centralized science advice but stronger central coordination. Wilson added that "creation of the Central Policy Review Staff as a multidisciplinary body of advice to the Cabinet also added a new dimension." The CPRS will apparently be counted on to oversee coordination; the reorganization plan includes appointment of a "chief scientist" to the CPRS.

The CPRS was set up as a think tank in the Cabinet Office by Edward Heath after the Conservatives won office in 1970. Heath apparently disliked formal committees and intricate staff structures, preferring to rely on task forces, which would be asked to work on specific problems and then dissolve themselves, and on CPRS for policy analysis somewhat independent of the civil servants who staff the Cabinet Office. Rothschild seemed a rather unlikely choice for the job of establishing CPRS in a Conservative government, since he was a Labour peer and has a self-confident manner, forged in a successful career in academe and industry, which jarred some mandarins.

CPRS was also initially suspect because Heath apparently saw it as a special resource for the Prime Minister. Heath was suspected of having designs on adapting an American presidential style—as was Wilson when he appointed a "science adviser"—and this was seen as conflicting with the British concept of collective responsibility for Cabinet ministers. The Prime Minister is constitutionally "first among equals." The assumption is that if a minister cannot support a policy decision taken at a Cabinet meeting he will resign from the Cabinet. In practice, ministers do not usually have access to adequate information on subjects outside their own ministerial concerns to seriously oppose their colleagues. A major function of CPRS was to brief ministers and the Prime Minister on major issues coming before it. CPRS apparently made itself sufficiently useful in performing this and other functions that it survived the transition to a Labour government in 1974 and, in a somewhat modified form, seems to be solidly entrenched.

It should be noted that CPRS does not confine itself to analysis of issues involving science and technology but takes on projects on any subject which the government sees as having priority. Needless to say, much CPRS work has been in the economic sector.

The lowered profile of science has caused some complaints in Britain, as it has in the United States. There are some obvious parallels between British and American efforts since the early 1960's to link science and government. In both countries there was a strong assumption that cultivation of science and technology by government was essential to national security and economic growth. Research budgets were increased, training of scientific and technical manpower was emphasized, and the scientific capabilities of government agencies were bolstered. Until well into the 1960's Britain maintained a clear lead over other European countries in government funding of research, particularly basic research. In Britain, as in the United States, however, the late 1960's saw a flattening of the science-funding growth curve, the beginning of a squeeze on university research, and protests from the scientific community about a "downgrading" of science.

In both countries there has been some disenchantment with efforts of government to use science and technology to make industry more productive and more competitive and to attack major national problems. It is fair to say that the economic troubles in Britain in recent years have made the disappointment in Britain more acute.

What has gone wrong? In many respects the British have achieved the science policy goals they set for themselves in the early 1960's. By most common measures—Nobel prizes, research paper citations—Britain has held its own in science. Starting in the early 1960's, the British carried through a program of expansion and reform in higher education which heavily emphasized the training of scientific and technical manpower. Perhaps the British experience with higher education illustrates as clearly as anything the frustration of reasonable expectations.

The rapid expansion of the universities in the 1960's created a market for faculty, particularly science faculty. The university research professor became the model for undergraduate and graduate students, and tendencies toward narrowness and intense specialization in British Ph.D. training were reinforced. There has traditionally been something of a disdain in British universities for applied research and for careers in industry; industry has reciprocated with a suspiciousness of university researchers. The undesirability of these attitudes was amply recognized, but the 1960's saw little progress in healing the breach.

Doubts About Postgraduates

Industry continues to look on university science with a jaundiced eye. A representative view was expressed in a memorandum prepared by EMI Limited, a major international company with a large electronics operation, for a hearing held by the Commons science subcommittee early this year. The memo cited a "growing doubt" about the value of university postgraduate work as preparation for employment. "Too frequently the postgraduate work at University seems to be so closely guided by a senior member of the University that the scope for imagination and original contribution is small. It is also taken at a very slow pace. As a result, after three years the postgraduate is inferior to the first degree man who has spent three years working directly in the industrial research laboratory."

The idea of developing innovative non-university programs in higher education was promoted heavily in the plans of the 1960's. Several so-called "colleges of advanced technology" (CAT's) were established and regarded as promising to provide a better climate for applied research and closer links with industry. By the middle 1960's, many of those involved in the CAT's had developed the sense that they had second-class status and successfully lobbied for conversion of the CAT's into technical universities. By and large, the former CAT's became indistinguishable from other universities.

The polytechnics, sponsored by local authorities and specializing originally in the training of technicians for local industry, also exhibited the yen for upgrading, insisting on transforming themselves into degree granting institutions. One result, say critics, is that the custom of industry paying for part-time education of apprentices in "polys" has declined, thus reducing a source of useful technical manpower.

One effect of the so-called "swing away from science," which was observed in Britain as it was in other countries in the late 1960's, was that literally thousands of places for science and engineering students were left vacant in the universities. Competition for places in the arts and social sciences became much stiffer than for places in science and engineering (although this was not true of medicine, dentistry, and some kinds of biology). One effect has been to draw science students to universities who might otherwise have attended polytechnics and thus to further reduce the potential pool of middle-level technical manpower.

These are random examples of how rational, apparently well-designed scientific manpower policies have had unintended effects and appear to have been self-defeating.

Perhaps too much was expected from the educational reforms launched in the early 1960's. Or perhaps, as some continue to suggest, the British have been unwilling or unable to bring about changes adequate to the challenges they face.

A 1974 Hudson Institute report on "The United Kingdom in 1980," scored official acquiescence to a weakening of the planned emphasis on science in higher education and included the following comment:

> In some respects this failure to provide a more ambitious programme for science teaching at the upper levels reflected a confused official outlook on science policy in general. At the level of applied science in the industrial field, for example, there has never existed a coordinated view of the longer-term purposes

of the national scientific effort, or of how it might interlock with national economic planning.

A lack of decisive action in this sphere is not too surprising. British national elections since the early 1960's have been won by narrow margins that hardly provided mandates for bold initiatives. The parties themselves have been divided internally on major political and social issues. And the soundest science advice based on the most irreproachable data may be ignored for countervailing political or economic reasons. For example, a recent cogent study by CPRS on the British motor industry laid out a case which the government found it politic to ignore in providing a major subsidy for Chrysler car-building operations in Britain. The political realities of such things as unemployment may make unpalatable decisions unavoidable.

There has been a tendency in both Britain and the United States on the part of those interested in science policy to concentrate on the science-advisory and decision-making machinery in the upper echelons of government and to ponder—rather in the abstract—such questions as that of the proper balance between basic and applied research. The lessons of the last decade teach that this approach provides a one-dimensional view, that it is futile to consider science policy in isolation from the broad political and social context in which national decisions are made.

The new reorganization of the science advisory machinery in Britain seems to reflect a recognition of how complex and formidable the economic and social problems facing Britain really are. When Wilson led his party to victory in the 1964 elections, he pledged an economic renewal forged in the "white heat of the technological revolution." Today's Labour government is less flamboyant with its slogans and more modest and pragmatic with its science policy. The merging of the science advisory apparatus in the Cabinet Office into the CPRS can be seen as simply another logical step in the integration of science into the governmental process. This is a sensible thing to do if the grafting of science up and down the governmental tree in the past decade has really taken.—JOHN WALSH

RESEARCH NEWS

Liquid Membranes: New Techniques for Separation, Purification

Artificial membranes have been a topic of great interest in recent years because of their potential utility in applications ranging from desalination of water to timed release of drugs. One of the most intriguing classes of artificial membranes is liquid membranes, which were first discovered 10 years ago by Norman N. Li of Exxon Research & Engineering Company, Linden, New Jersey. Some of the many possible uses of liquid membranes were the subject of a special symposium at the recent Centennial Meeting of the American Chemical Society. Those uses include several medical applications, the removal of pollutants from waste waters, and the encapsulation of enzymes.

Liquid membranes consist, in simplest terms, of an emulsion suspended in a liquid that does not destroy the emulsion. In a typical application, small droplets of aqueous solution are encapsulated in a thin film of oil; this emulsion is then suspended in another aqueous solution. Alternatively, small droplets of oil can be emulsified with water and the emulsion suspended in oil. In the first case, the oil phase is the liquid membrane; in the second case, the water is the liquid membrane. A typical droplet might be about 100 micrometers in diameter. These coalesce into aggregates averaging about 1 millimeter in diameter. The thickness of the liquid membrane itself varies from roughly 1 to 10 micrometers. The membrane is thus thinner by at least a factor of 10 than most other types of artificial membranes, and transport across the membrane is correspondingly faster.

The emulsions can be made very stable by the addition of surfactants (detergents) and other additives to the liquid membrane (LM) phase. The LM systems can easily be prepared with a shelf life of a year or longer, Li says. They can also be prepared so that the emulsion is degraded very rapidly for applications where the contents are to be released. Additives can also be mixed into the membrane phase to vary the membrane's permeability to various substances, to control the rate of diffusion through the membrane, and to control membrane absorption and adsorption.

Most applications of LM systems depend on the membrane's selective permeability to various substances. If a substance is soluble in the membrane and in the internal and external phases, for example, it can pass readily from phase to phase. But if it is not soluble in the membrane, it is effectively trapped in either the interior or the exterior phase. Li has demonstrated this effect by encapsulating lethal doses of sodium cyanide into LM systems and feeding it to rats. The rats are not harmed by this experience because the cyanide ions will not pass through the membrane.

If one component of a mixture is soluble in the membrane and the second is less soluble or insoluble, the two can be separated. Li has shown that many surfactants provide differential permeability for hydrocarbons that are similar in molecular weight and boiling point. If, for instance, a mixture of benzene and hexane are encapsulated in an aqueous solution of saponin, and the emulsion is suspended in a hydrocarbon solvent, the benzene will permeate into the solvent much faster than the hexane. Similar results are obtained with other mixtures.

Other additives can be used to facilitate the separation. Hexane and hexene, for example, diffuse through a surfactant membrane at about the same rate. But if cuprous ammonium sulfate is added to the membrane, it will form a weak complex with the double bond of hexene. This makes hexene more soluble in the membrane, so that it is transported faster. In a similar fashion, sulfuric acid facilitates the transport of aromatic hydrocarbons, strong bases facilitate that of mercaptans, and weak acids that of amines.

The LM systems have many potential medical applications. One use might be in the emergency treatment of drug overdoses. Poisoning by drugs and other chemicals is a major problem in the United States. There are more than 10,000 deaths and an estimated 1 million poisoning episodes in this country each year. Some 70 percent of the accidental poisonings involve children under the