determine the shape of the circumstances that have gotten the subject in his present fix. The success of tests such as this leads Bell to boast, "We can do 6 months worth of psychoanalysis in 10 minutes."

The psychological stress evaluator has an interestingly ambivalent status as both a forensic and a clinical instrument. As the Michigan attorney general wrote in response to a request for clarification of the PSE status under Michigan's polygraph examiners law: "... a very narrow line separates the use of mechanical devices for the purpose of measuring stress and the use of such device to determine truthfulness." (He decided that the act did apply to the PSE in the latter case.) Forensically speaking, the PSE is in a kind of limbo. Nineteen states have laws licensing or regulating polygraph use, and presumably in those states where other instruments are not banned, forensic use of the PSE would be decided on a case-by-case basis. One state, North Carolina, licenses PSE operators (80 hours of training is required); elsewhere, a person armed with nothing but a Dektor training certificate can call himself a PSE operator. The other states, including New York and California, have no laws because of strenuous opposition by labor unions to legislation they think will legitimize the use of lie detectors in employment (six states now ban compulsory preemployment polygraph testing).

One individual who is determined that the PSE shall gain full respectability in the eyes of the law is John W. Heisse, a Burlington, Vermont, otolaryngologist. Heisse is the head of the International Society of Stress Analysts (ISSA), a fledgling organization of 200 PSE, polygraph, and voice analyzer users from the fields of law enforcement, industrial security, business, law, and health. Heisse is perhaps the PSE's most fervid partisan. He has rerun the Kubis study, using the contract's "alternate specifications," and claims the PSE came out with 97 percent reliability. He has used the instrument to prove that people with laryngectomies still register muscle microtremor; he has tested the effects of dozens of drugs on PSE subjects. He has a "death test" to see how anxious people are about death, and a suicide test—five questions relating to death that can be asked over the phone. If the subject shows no stress in answering, it means he is definitely preparing to kill himself. Heisse says in seven cases the test unfortunately proved correct. He has also tried the PSE with hypnotized subjects and discovered that they show *no* muscle microtremor—not because of stress but because they are unusually relaxed. He says the same finding applies to persons who have been brainwashed. (Quick to see an application here, Heisse went off to San Francisco to chart Patty Hearst's tapes, but he won't tell what he found.)

In addition to these activities, Heisse says he has been doing all the lie-detecting work for the city of Burlington—that is, until Vermont passed a law saying only polygraphers can do truthfulness verification work. Heisse believes this law was passed just to protect the jobs of Vermont's three polygraphers. He has raised $100,000, gathered 300 pages of evidence, and is suing the state of Vermont. The outcome of this case could set a significant precedent if and when PSE's proliferate enough to attract the attention of other lawmakers.

Meanwhile Allan Bell wants to go back to the drawing board. "The PSE is to stress analysis of the voice what the Model T is to locomotion," he declares. More work needs to be done on waveform analysis, on quantitative measures of mind-body interaction, and on "flesh mechanics." The stress evaluator, he points out, is measuring something no one has been able to define, so it would be nice to really pin it down, perhaps by locating the specific area of the brain where stress originates. One of the possible "end product configurations" envisaged by Bell's agile mind would be a machine that supplied a continuous meter readout of stress levels to a psychiatrist while his patient lay chatting on the couch. Some might find this a distressing symptom of human willingness to defer to machines. But fortunately, unlike the atom bomb, the PSE is only as effective as he who operates it.—CONSTANCE HOLDEN

Alaskan Gas: The Feds Umpire Another Confused Pipeline Debate

When the fabulous 10-billion-barrel Prudhoe Bay oil field was discovered in 1968 on the Alaskan North Slope a lot of natural gas was known to be present along with the oil. Indeed, as further exploratory drilling would show, there was some 26 trillion cubic feet of gas—or more than a tenth of the nation's present natural gas reserves—just at Prudhoe Bay alone, and this field covered only a small part of a vast province in which other oil and gas fields would no doubt eventually be found.

But not until now, 7 years after the discovery of this major new gas reserve, has the issue of how to get the natural gas out of northern Alaska finally been joined. Yet this issue is every bit as consequential as the one that was in hot dispute until the fall of 1973 over the Trans-Alaska (oil) Pipeline System (TAPS). And, as in the case of the TAPS controversy, at the heart of this new one is the question whether the resource should be moved by pipeline from the North Slope down through Canada to U.S. markets or by a combination system consisting of a trans-Alaska pipeline and a fleet of tankers.

As everyone has known for at least 3 years, the nation's need to bring on new supplies of natural gas has assumed emergency proportions. And, besides that, once TAPS is completed in late 1977 or early 1978 and the oil begins to flow, it will be only a few years before removal of the gas at Prudhoe will have to begin if the flow of oil to the wells is not to be inhibited. (For the first 2 years or so, all gas extracted incidental to the recovery of oil can simply be reinjected; in this way, the gas need not be flared and the field can be "stabilized" for optimum oil recovery.)

These circumstances, together with the fact that the closely related TAPS issue became a highly visible item on the public agenda as early as 1969, makes it apparent that the federal officials and congressional leaders seriously involved in questions of energy development have overlooked or chosen to ignore some very plain handwriting on the wall.

Until the controversy over TAPS was finally resolved by Congress 2 years ago in favor of this combined pipeline-tanker system, the environmental groups that were opposing the project tried hard but unsuccessfully to have this issue considered jointly with the question of how to transport the gas. Their argument was that it made no sense to consider these matters separately, for it might be appropriate to build the gas and oil pipelines in a common transportation corridor. Reasonable as this argument may seem, it was given short shrift because both the oil companies that

were involved on the North Slope (most notably, Atlantic Richfield, Exxon, and Standard Oil of Ohio) and the Nixon Administration were committed to TAPS.

The situation today with respect to deciding how to transport the natural gas is replete with irony and confusion. And, as in the TAPS situation, the initiative has been left almost entirely to industry, with the government playing nothing more than an awkward kind of umpire's role.

Two competing proposals are now pending before federal agencies. One is by a consortium known as Alaskan Arctic Gas, which the North Slope majors have helped to finance. The other is by El Paso Alaska, a subsidiary of the El Paso Company of Houston, the largest pipeline transmission company in the United States.

The Arctic Gas proposal calls for a 48-inch pipeline to be built from Prudhoe Bay eastward along the North Slope to the MacKenzie River delta in Canada (another potentially rich province for natural gas), then southward to the United States (see map). Except for the fact that the first leg of the pipeline would pass through the Arctic Wildlife Range, this kind of all-overland system across Canada is similar to what the Wilderness Society, Friends of the Earth, and other environmental groups 2 years ago were saying should be considered as an alternative to the TAPS-tanker system.

These groups argued that the latter system would be less efficient economically than a cross-Canada system and that it would be both an unacceptable intrusion into much pristine wilderness and a potential hazard to the marine environment. But now, having lost the fight over the TAPS-tanker system, they are determinedly opposing the Arctic Gas proposal because of the effect it would have on the 9-million-acre Wildlife Range.

The pipeline would be buried, and no permanent haul road would be necessary for its construction and maintenance (construction crews would work in winter from a temporary ice and snow road). But there would be three noisy compressor stations in the Wildlife Range, and these stations, together with the regular low-altitude aircraft overflights needed to ensure proper pipeline security and maintenance, would not be compatible with wilderness values as these are usually defined.

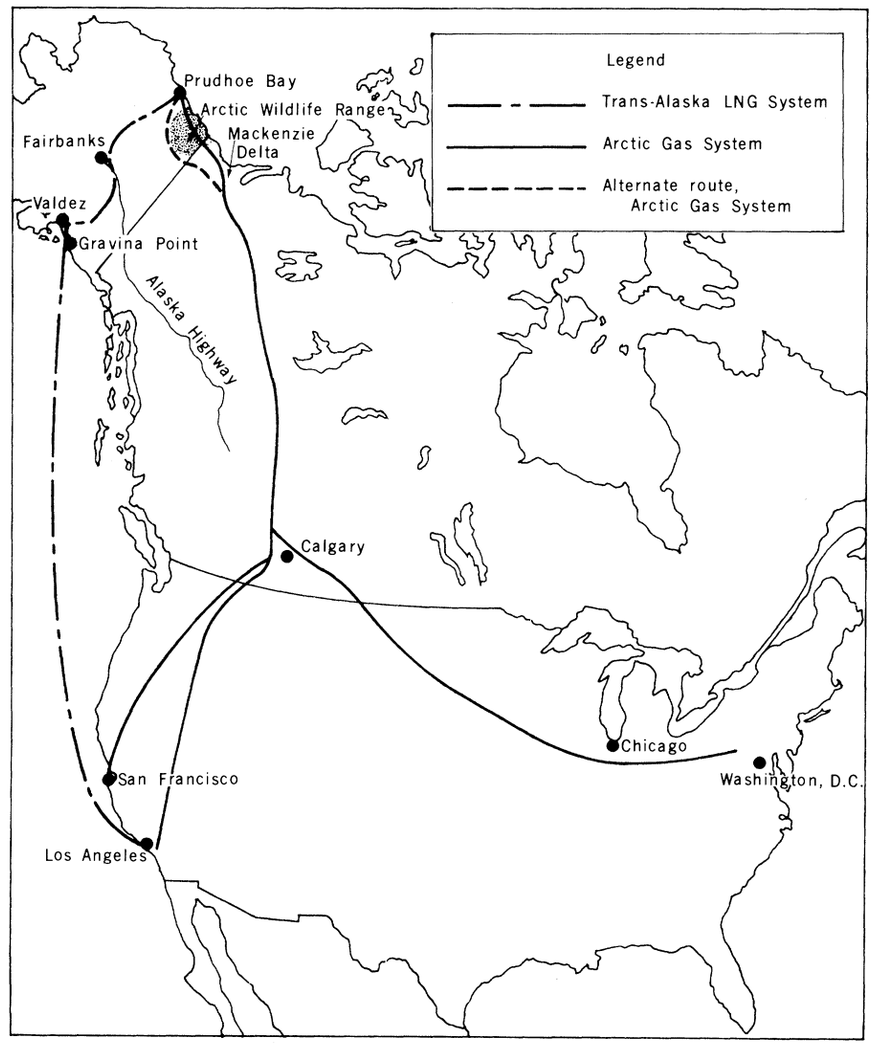
Apart from this, the Arctic Gas proposal is subject to the same objection raised in connection with proposals for a cross-Canada oil pipeline. With some 2430 miles of the pipeline under Canadian ownership and jurisdiction, burdensome taxes or other unacceptable demands might conceivably be imposed. But the Canadian government could decide that the Arctic Gas system is needed to transport MacKenzie delta gas to market, and thus be willing to enter into mutually acceptable guarantees. Also, it is usually noted that some Canadian pipelines cross U.S. soil and thus could be used as hostages.

Although the rival El Paso Alaska proposal has not been endorsed by the environmental groups, up to this point it seems to have largely escaped their criticism. It calls for a 42-inch pipeline to be built parallel to TAPS from Prudhoe Bay to a point near Valdez (the southern terminus of TAPS), whence it would swing some 42 miles southeastward to a tanker terminal that would be built at Gravina Point.

The gas would be chilled (to −260°F) and liquefied, then shipped by liquefied natural gas (LNG) tankers to a regasification and distribution terminal in southern California. These tankers would be huge (1002 feet in length and 165,000 cubic meters in capacity), and, eventually, there would be as many as 11 of them. Together, their cost would run to about $2 billion, an investment even larger than that necessary for the liquefaction plant at Gravina Point.

The 809-mile overland leg of the El Paso pipeline-LNG tanker system has the merit of fitting by and large into the kind of common corridor which the environmental groups have long advocated. The system's soft underbelly would seem to lie partly in the high costs and possible operational difficulties associated with the LNG system and partly in the uncertainties as to how dependably the gas would be distributed beyond California to midwestern and eastern markets. The distribution would be largely indirect, by an elaborate system of "displacement," with the entry of the Alaskan gas into the overall national distribution system making it possible to reassign other gas from one market to another.

The LNG technology is not new, and there has never been a major accident involving a LNG vessel in 10 years of worldwide operating experience. But experience has been limited; in 1974, there were only 14 LNG tankers in operation, and these vessels were small compared to the behemoths El Paso plans to order. A LNG tanker is not the "floating bomb" it is sometimes alleged to be, but, while the consequences of a large spill remain a matter of conjecture and debate even among experts, there is no question but what dis-



astrous fires or even explosions (given a spill in a confined space) could result. All living organisms caught in a massive, unconfined LNG spill would undoubtedly be killed by asphyxiation, freezing, burning, or boiling.

Either the El Paso or the Arctic gas system would require a huge capital investment. A study made by the Aerospace Corporation for the U.S. Department of the Interior put the total investment necessary for the Arctic Gas system at $6.1 billion and the investment required for the El Paso system at $5.6 billion (still higher figures can be cited, depending on what is counted as an integral part of the distribution systems).

The Aerospace Corporation study concluded that both systems were technically and economically feasible. The Arctic Gas system was given a marked edge over the El Paso system in terms of the net economic benefits to the United States under the most optimistic set of assumptions as to the volume of gas transported, Canadian tax policies, and the like. Under the most pessimistic assumptions, the El Paso system was seen to have a modest advantage.

In a study made for the California State Assembly Committee on Resources, Land Use, and Energy, the Rand Corporation compared the two systems according to direct and indirect costs, reliability, timely completion, safety, and environmental effects (within California), and concluded that the Arctic Gas system appeared as good or better than the El Paso system on all counts, at least as judged on the basis of California's interests. But Alaska's Governor Jay S. Hammond strongly favors the proposed El Paso system largely because southern Alaska would be able to tap into it and obtain whatever gas might be needed to meet future demands. Also, the Western Governors Conference recently adopted a qualified endorsement of the El Paso proposal; of the 13 governors, however, 2 dissented, 1 abstained, and 2 were absent.

Although it may now seem self-evident that the federal government should have begun shortly after the initial Prudhoe Bay discovery to determine what kind of transport system would best serve the public interest, what it actually did of course was simply to await industry proposals to which it would react. And, while the oil pipeline proposal by Alyeska (the consortium made up of the North Slope majors and others) came early, the proposals by Arctic Gas and El Paso did not come until 1974.

To make matters more confused, the two federal agencies that are now making environmental and economic studies of these rival proposals are proceeding separately instead of in concert. The Federal Power Commission (FPC) will make the "threshold" decision in the case, because it is the agency to which both Arctic Gas and El Paso have had to apply for a "certificate of public convenience and necessity." Its draft impact study is not expected to be completed before early next spring.

Meanwhile, the Department of the Interior already has issued a massive draft impact study—a study which was made because Arctic Gas applied for a pipeline right-of-way. In this study the El Paso system is discussed only as an "alternative" because El Paso quite reasonably chose not to apply for its right-of-way permit pending the FPC decision. Had it applied, it would have had to join Arctic Gas in putting up the three to four million dollars which the study is expected to cost. An attempt by Interior and the FPC last year to get together and do a single impact study came to nothing.

Running to 17 volumes and 9000 pages, the Interior impact study seems largely a monument to irrelevancy. Nowhere in it can one find a succinct analysis of the choice that must be made, even as between the two rival proposals officially pending, much less as between them and others that could be advanced (some environmentalists favor an all overland system that would follow TAPS from Prudhoe Bay to Fairbanks, then follow the Alaska Highway on into Canada.)

In a recent letter to Acting Secretary of the Interior Kent Frizzell, the chairman of the Council on Environmental Quality, Russell W. Peterson, gently suggested that the very purpose of the Arctic Gas impact statement had been defeated by the statement's huge bulk and lack of analytic clarity. But the basic shortcoming with respect to official decision-making about the Alaskan oil and gas development probably rests more with the government's having confined itself to the umpire's role rather than laying out the game plan.

—LUTHER J. CARTER

Scientific Opportunities Syndrome: Invoking the British Experience

An irony of recent economic history is that Britain, which was one of the victors in World War II, has lagged in postwar economic development, while nations which suffered military defeat or occupation have surged ahead. Germany, Japan, France, and Italy recorded their economic "miracles," while Britain, the dowager of trading nations, suffered chronic troubles with its balance of payments position and watched its relative economic rank among nations steadily decline.

An analysis of the British experience in the 1960's, combined with an attempt to point a moral for American policymakers, is the substance of a report* for the National Science Foundation (NSF) by Alan G. Mencher, a former U.S. science attaché, whose 7 years in the London embassy roughly spanned the years during which the British moved from faith to skepticism on the question of the sovereign power of R & D in the economy.

There would seem to be lessons here for other nations to consider, since the first British government headed by Prime Minister Harold Wilson came into office in 1964 brandishing a campaign commitment to use science and technology to improve the international competitiveness of British industry. The political stakes were, therefore, unusually high and the priorities given the effort were set accordingly.

Mencher and his collaborator, Michael Beesley, professor at the London Graduate School of Business Studies, have contributed to a strong revisionist trend in science policy literature which has been gaining ground in recent years. Their salient point, that an unexamined assumption that science and technology can be deployed to solve virtually any problem confronting government, has led to a number of signal—and inevitable—failures, is not original. The same point is made, for example, in the recently completed three-part study *Research Systems* from the Organization for Economic Cooperation and Devel-

Lessons for American Policy Making From the British Labor Government's 1964-70 Experience In Applying Technology to Economic Objectives. A limited number of copies are available from the London Graduate School of Business Studies. The study was supported by the Office of Exploratory Research and Problem Assessment in NSF's Research Applications Directorate. No decision has been made on whether NSF will publish the report.