ident Carter's less than revolutionary plan faces strong opposition and is likely to be weakened in Congress.

Yet circumstances may in fact be such as to bring the nation to accept changes far greater and more sweeping than is now readily conceivable. In early February, when the environmental leaders' *Unfinished Agenda* report was being discussed at a conference in Washington, Robert O. Anderson, chairman of the board of Atlantic Richfield, observed: "The change that's proposed here, if put all together, is rather massive, and really we're talking about a more austere way of life. . . . Now this is an election society has to make; no leader can be asked to make a change of that magnitude. I can only think maybe this is the time that the rather affluent life of Athens is going to be supplanted by the more austere life of Sparta. It happened in Greece, and maybe that's the way we are going."

—LUTHER J. CARTER

Drinking Water: Getting Rid of the Carbon Tetrachloride

Protecting the purity and safety of drinking water is a lot more complicated than it used to be. An illustration is the recent case of contamination of the Kanawha and Ohio rivers with carbon tetrachloride, a suspected carcinogen and known liver poison. On 18 February, the Environmental Protection Agency (EPA) reported that agency scientists had detected unusually high concentrations of the chemical in the rivers near Huntington; the contaminated area extended for about 45 miles up the Ohio and another 30 miles or so into the Kanawha River. The scientists calculated that 70 tons of carbon tetrachloride had somehow found their way into the rivers.

When making the announcement, the EPA managed to make a short-lived but big mistake when estimating how fast the "slug" of carbon tetrachloride was moving down the Ohio. The agency told the residents of Cincinnati that the slug would arrive at that city about 22 February, and that they should boil their water in order to get rid of the chemical. Unfortunately, the slug had already passed the intakes of the Cincinnati water company by the time the EPA made its announcement. Reports of what had happened on the river and how the mistake had occurred were often confusing and consequently, a number of people, including Thomas A. Luken, the freshman Democrat Representative from Cincinnati, are still asking what happened.

The answer is not entirely clear. For example, EPA officials are careful to point out that they still do not know the source of the 70 tons of carbon tetrachloride. But the slug was only the most spectacular incident in a series of events that the agency had been investigating for several months. One consequence of the investigation was the first use of the emergency provisions of the Water Pollution Control Act of 1972 and the Safe Drinking Water Act of 1974, which enable the EPA to shut down a suspected polluter if there appears to be an imminent hazard to human health. In this case, EPA forced the closing of the West Charleston plant of the FMC Corporation. The plant, located on the Kanawha about 60 miles from where it flows into the Ohio, makes carbon tetrachloride.

Chemicals Found in Drinking Water

The fact that the EPA was looking for carbon tetrachloride in river and drinking water in the first place is an outgrowth of the discovery in 1974 of small quantities of many organic chemicals, including carbon tetrachloride, in the drinking water of New Orleans. This discovery was one of the stimuli that prompted Congress to pass the Safe Drinking Water Act.

After the release of the New Orleans data, the EPA began to analyze the water supplies of some 80 cities around the country, including Huntington and Cincinnati, to see whether they, too, contained the chemicals. They did. But according to James Manwaring, chief of EPA's Water Supply Branch in region III, which includes West Virginia, the concentrations of carbon tetrachloride were always very low, a few parts per billion (ppb) or less. Then, in September of 1976, 10 ppb of the chemical turned up in the Huntington water supply. Manwaring says that EPA officials considered this to be a high value at the time, although not for long as things developed. The agency subsequently found much higher concentrations in Cincinnati drinking water and in the slug itself.

Nevertheless, the Huntington figures were sufficiently alarming that the EPA began looking for industrial plants above the city on the Ohio and Kanawha rivers that produce or use large quantities of carbon tetrachloride. (The rivers provide the water for 18 water companies serving some 1.8 million people.) The agency identified four plants—owned by Allied Chemical Corporation, Diamond-Shamrock Corporation, FMC Corporation, and PPG Industries, Inc.—and invoked section 308 of the Water Pollution Control Act against them. This section requires that the industries (i) supply the EPA with data on their discharges of the pollutant in question, and (ii) participate in a 45-day survey, during which the industries monitor the pollutant in their effluents while EPA monitors the concentration of the chemical in the rivers.

Manwaring says that the start of the survey was delayed, partly because of the unusually cold winter that hit the East and Midwest, but was scheduled to begin on 7 February. On that date, the FMC Corporation refused to participate in the survey and turned the EPA inspectors away from the gate of their West Charleston plant. The other three companies cooperated as planned in the survey.

According to Rich Blewitt, a spokesman for the FMC Corporation, the company refused to participate at that time because of hazardous conditions on the riverbanks where the effluent pipes are located. The banks were covered with ice and poorly lighted (monitoring is a 24-hour-per-day job). The FMC management did not want to subject company or EPA personnel to those conditions. They asked the agency to postpone the survey but the request was not granted, although a previous one had been.

On 8 February, the United States attorney in West Virginia obtained an injunction requiring FMC Corporation to participate in the survey, and on the same day, EPA inspectors were admitted to the plant. The hearing on the injunction was scheduled for 18 February in Parkersburg.

At this point life became hectic for EPA officials and scientists, for the next day (9 February), analysis of the Cincinnati drinking water showed that it con-

tained 86 ppb of carbon tetrachloride. This contamination preceded that in the slug by several days and suggests that an earlier large spill may have occurred somewhere on the river. After making certain that no industrial plants between Cincinnati and Huntington could be the source of such large quantities of the chemical, the officials decided to look for carbon tetrachloride in the entire 265 miles of river between Cincinnati and Charleston. Analyses of the 24 samples of river water, taken on 11 and 12 February (Friday and Saturday), were not completed until 18 February, a day most of the EPA personnel concerned with the water safety situation were at the Parkersburg courthouse for the injunction hearing.

Since FMC had already begun to monitor the plant effluents on 15 February, the injunction issue was resolved by a consent decree in which the corporation agreed to continue participating in the survey. But now, the EPA officials were confronted with the news that a large slug containing very high concentrations of carbon tetrachloride was moving down the Ohio. The analyses showed that the concentration of the chemical was very low from Cincinnati to Huntington where it increased sharply to more than 240 ppb; the concentration remained high—hitting a maximum of 340 ppb—for about 30 miles into the Kanawha River, and then it fell off abruptly. The point of the decrease was roughly 25 miles downriver from the West Charlestown plants of the FMC Corporation and Diamond-Shamrock; the EPA could not determine the source of the river contaminant.

Manwaring says that the EPA decided to release the data to the public with the admonition that drinking water in the af-

NAE Elects 92 New Members

The National Academy of Engineering, established to share the responsibility given the National Academy of Sciences under its congressional charter to examine questions of science and technology at the request of the federal government, has elected 92 new members. This brings the total membership to 769. The election of 20 foreign associates brings that membership to 40. The new members are as follows:

Andreas Acrivos, Stanford University; **Turner Alfrey, Jr.**, Dow Chemical Company; **Arthur R. Anderson**, ABAM Engineers, Inc.; **Maurice Apstein**, George Washington University; **Nathaniel Arbiter**, Vail, Arizona; **John W. Backus**, IBM Corporation; **Thomas Baron**, Shell Development Company; **Roy H. Beaton**, General Electric Company; **C. Gordon Bell**, Digital Equipment Corporation; **Richard E. Bellman**, University of Southern California; **Elwyn R. Berlekamp**, University of California, Berkeley; **Seymour M. Bogdonoff**, Princeton University; **William B. Bridges**, Hughes Research Laboratories; **Norman A. Copeland**, E. I. duPont de Nemours & Company, Inc.

Stephen H. Crandall, Massachusetts Institute of Technology; **Elio D'Appolonia**, E. D'Appolonia Consulting Engineers, Inc.; **Robert C. Dean, Jr.**, Creare Innovations, Inc.; **Henry J. Degenkolb**, H. J. Degenkolb and Associates; **Charles A. Desoer**, University of California, Berkeley; **A. E. Dukler**, University of Houston; **Howard D. Eberhart**, University of California, Berkeley; **Merril Eisenbud**, New York University Medical Center; **Leopold B. Felsen**, Polytechnic Institute of New York; **M. F. Gautreaux**, Ethyl Corporation; **Ronald L. Geer**, Shell Oil Company; **Edward L. Glaser**, System Development Corporation; **Robert N. Hall**, General Electric Research and Development Center; **Grant L. Hansen**, General Dynamics-Convair Division; **Stephen E. Harris**, Stanford University; **William J. Harris, Jr.**, Association of American Railroads; **Julius J. Harwood**, Ford Motor Company; **Robert W. Hellwarth**, University of Southern California; **Philip G. Hodge, Jr.**, University of Minnesota; **C. Lester Hogan**, Fairchild Camera and Instrument Corporation.

D. Brainerd Holmes, Raytheon Company; **George R. Irwin**, College Park, Maryland; **John D. Isaacs, III**, University of California, San Diego; **Burgess H. Jennings**, Northwestern University; **Paul C. Jennings**, California Institute of Technology; **Eneas D. Kane**, Standard Oil Company of California; **Arthur R. Kantrowitz**, AVCO Everett Research Laboratory, Inc.; **William M. Kays**, Stanford University; **Clyde E. Kesler**, University of Illinois, Urbana-Champaign; **Thomas R. Kuesel**, Parsons, Brinckerhoff, Quade & Douglas, Inc.; **Christian J. Lambertsen**, University of Pennsylvania; **John Laufer**, University of Southern California; **Frederick F. Ling**, Rensselaer Polytechnic Institute; **Alan G. Loofbourrow**, Chrysler Corporation; **Frank W. Luerssen**, Inland Steel Company; **Louis C. Lundstrom**, General Motors Corporation; **Artur Mager**, Aerospace Corporation; **Warren L. McCabe**, North Carolina State University, Raleigh; **Perry L. McCarty**, Stanford University; **Ross E. McKinney**, University of Kansas; **G. Alexander Mills**, Energy Research and Development Administration.

Paul W. Morgan, E. I. duPont de Nemours & Company, Inc.; **Kenneth H. Olsen**, Digital Equipment Corporation; **Walter S. Owen**, Massachusetts Institute of Technology; **Stanford S. Penner**, University of California, San Diego; **Joseph Penzien**, University of California, Berkeley; **Alan J. Perlis**, Yale University; **William N. Poundstone**, Consolidation Coal Company; **C. Dwight Prater**, Mobil Research and Development Corporation; **Ronald F. Probstein**, Massachusetts Institute of Technology; **Norman C. Rasmussen**, Massachusetts Institute of Technology; **Stephen O. Rice**, University of California, San Diego; **Richard W. Roberts**, General Electric Company, **Joseph E. Rowe**, Case Western Reserve University; **Jean E. Sammet**, IBM Corporation; **Thorndike Saville, Jr.**, Coastal Engineering Research Center; **Otto H. Schade, Sr.**, West Caldwell, New Jersey; **Sidney E. Scisson**, Fenix & Scisson; **Meté A. Sozen**, University of Illinois, Urbana; **Arthur M. Squires**, Virginia Polytechnic Institute and State University; **E. C. Starr**, Bonneville Power Administration.

Morris A. Steinberg, Lockheed Aircraft Corporation; **Stanley D. Stookey**, Corning Glass Works; **L. E. Swabb, Jr.**, Exxon Research and Engineering Company; **Judson S. Swearingen**, Rotoflow Corporation; **John G. Trump**, Massachusetts Institute of Technology; **Vito A. Vanoni**, California Institute of Technology; **Herbert D. Vogel**, Herbert D. Vogel Associates; **C. Howard Vollum**, Tektronix, Inc.; **Arthur R. von Hippel**, Massachusetts Institute of Technology; **James R. Wait**, National Oceanic and Atmospheric Administration; **Paul B. Weisz**, Mobil Research and Development Corporation; **Robert H. Wertheim**, U.S. Department of the Navy; **Robert H. Widmer**, General Dynamics Corporation; **Edward Woll**, General Electric Company; **Richard L. Woodward**, Camp Dresser and McKee Inc.; **Dean E. Wooldridge**, Santa Barbara, California; **John F. Yardley**, National Aeronautics and Space Administration.

The new foreign associates are as follows:

Pierre M. Ailleret, France; **Edward G. Bowen**, Wales; **John H. Chesters**, England; **Leo Esaki**, Japan; **Andre Giraud**, France; **Wolf Haefele**, Federal Republic of Germany; **Goro Inouye**, Japan; **Gunnar Jancke**, Sweden; **Jan Kaczmarek**, Poland; **Koji Kobayashi**, Japan; **Warner T. Koiter**, The Netherlands; **Georgy V. Kurdyumov**, U.S.S.R.; **Sir Michael J. Lighthill**, England; **Johannes Moe**, Norway; **Carlos Ospina**, Colombia; **Jacques Peters**, Belgium; **Emilio Rosenblueth**, Mexico; **Hans Rumpf**, Federal Republic of Germany; **Hubert Rüsch**, Austria; **Maurice V. Wilkes**, England.

fected communities should be boiled. The boiling point of carbon tetrachloride is sufficiently below that of water that the contaminant can be removed in this manner. According to Manwaring, they first calculated that the concentration of the chemical released into the air would be some 100 times below that deemed to be an occupational hazard by The National Institute of Occupational Safety and Health. This calculation is not an issue.

The estimate that has stirred up the trouble is that of the rate of flow of the slug down the Ohio. The officials used the flow rates measured on the days the samples were taken. However, the rivers, which had been frozen over earlier in the winter, had begun to thaw, there had been some rain, and the river flow increased appreciably right after the samples had been taken. Manwaring says that the mistake was caught within 6 hours, but by then it had been released. The notification that people should boil their water had come too late to do any good; and Congressman Luken still wants to know why.

The explanation given by the EPA is that the samples, which had been collected on the weekend (11 and 12 February) were transported to the agency's laboratory in Cincinnati. On Monday, 14 February, the instruments were first calibrated to ensure accurate results, but an instrument breakdown on Tuesday delayed the start of the analyses until Wednesday. The data were ready on the 18th and were relayed by telephone to the EPA officials at the Parkersburg courthouse where the working conditions were less than ideal. Apparently a public telephone in the courthouse hall served as the scientists' only link to their laboratories and EPA headquarters in Washington. Involved in the court proceedings and cut off from easy access to the information they needed, the scientists used the wrong data to calculate the river flow rate.

Luken is not completely satisfied with that explanation. As a member of the Oversight and Investigations Subcommittee of the House Commerce Committee, which has jurisdiction over laws relating to the safety of drinking water, the congressman has been holding hearings in Cincinnati on the issue. He wants to determine whether the current laws are adequate but are not being enforced properly or whether they need to be strengthened.

However, the current laws did permit the temporary closing of the West Charleston plant of the FMC Corporation in March. The source of the 70 tons of carbon tetrachloride is not known, but on 24 February, FMC reported a spill of 5300 pounds of the chemical to the state of West Virginia, which in turn notified the EPA. On this occasion the public found out in time to take precautions. Utilities either closed their intake pipes and depended on their reservoirs, or if this was not possible, people were directed to boil their water. Then, in early March, FMC reported a small spill that did not require that the public take any precautionary measures.

After the spill of 24 February, the EPA sent a team of inspectors to "go over the plant with a fine-tooth comb." Manwaring says that the team found corroded pipes and tanks that were suspect as possible sources of leaks. While investigating this spill, the EPA also learned that FMC Corporation had reported 20 spills of carbon tetrachloride to the state of West Virginia over the past few years. The agency was not notified of these spills, and it is not clear whether the current laws require such notification.

In addition to these periodic spills, EPA officials say that FMC Corporation has a history of regular discharges of carbon tetrachloride into the Kanawha River. When the corporation applied in 1971 for a permit to discharge pollutants into the river, the management told the EPA that the West Charleston plant was releasing about 70 pounds of the chemical per day; in October of 1975, the corporation notified the agency that the plant was discharging an average of more than 200 pounds per day; and in late January of this year, the corporation reported to the EPA that the discharge had increased to about 4000 pounds per day.

Plant Closed Down

The EPA thus decided in early March to take FMC Corporation to court and ask for a temporary restraining order to prevent further release of carbon tetrachloride into the river. In requesting the order, the agency alleged that the corporation's "record of past discharges, and the deteriorated condition of its plant, indicate that large quantities of carbon tetrachloride have escaped, and are likely to continue escaping, to the Kanawha River." The order was granted, and the plant, which employs some 1200 persons, had to close down. The agency also requested a permanent injunction that would require FMC to install treatment equipment to minimize all discharges of carbon tetrachloride from the plant. In mid-March, the agency and the corporation reached an agreement out of court, and the plant was allowed to reopen.

The consent decree which allowed the reopening requires that FMC initiate a spill prevention program. It includes, among other things, a dike system to contain the effluents until the carbon tetrachloride evaporates. The corporation, in a series of advertisements running in newspapers in several cities along the Ohio River, points out that work on the dike and spill-containment systems was begun in October of 1976. The decree also requires that the corporation install by January of 1978 a system to remove carbon tetrachloride from the effluents before they leave the plant.

Some people, including Luken, have expressed dissatisfaction with this decree. Luken thinks that it contains some critical loopholes. One of them is that the corporation can be relieved of liability for the effects of a spill if "it demonstrates that circumstances beyond its control, including employee negligence, which could not be prevented or foreseen, caused such discharge." Luken is especially concerned about the provision exempting employee negligence. Another possible loophole is that FMC can deny access to the plant to EPA inspectors "if there are circumstances that would endanger the health or lives of such representatives." The corporation defines what circumstances are hazardous.

In any event, the carbon tetrachloride contamination of the rivers appears to have cleared up. Joseph Cotruvo, director of the Criteria and Standards Division in the Office of Water Supply at EPA, says that since the EPA and the industries have been conducting the 45-day survey, the concentrations of the chemical in the rivers have been very low, returning to background levels of a few parts per billion. The other results of the surveys, which have been extended somewhat, are not yet available. Moreover, the legal aspects of the situation have not been completely resolved. Federal grand juries in Philadelphia and West Virginia are investigating the goings-on and, depending on the outcome of the investigations, further civil or criminal litigation involving FMC and the EPA is possible.

A still-unanswered question is whether the public health was endangered in the first place. Not surprisingly, FMC Corporation thinks that it was not and EPA thinks that it was. In high enough doses carbon tetrachloride will cause liver and kidney damage. But FMC contends that the quantities of the chemical appearing in drinking water did not present a threat to human health. One of the corporation's consultants on the matter,

pharmacologist Gabriel Plaa of the University of Montreal, points out that carbon tetrachloride was used for many years as a deworming agent in humans. The standard adult dose was 3 ml per day. A person would have to drink several thousand gallons of water containing 100 ppb of the chemical in order to ingest that much.

Plaa also calculated that a person would have to drink thousands of gallons of the water in order to ingest the minimum dose that causes damage in the most sensitive species. However, in an affidavit filed during the litigation with FMC, EPA toxicologist Robert Tardiff claimed that the effects of carbon tetrachloride accumulate with repeated ex-

Briefing

Califano Loses Fordham As Assistant Secretary

Christopher C. Fordham III, designated to be assistant secretary for health in the Department of Health, Education, and Welfare (HEW), quit in a huff after only a month in "office" and flew home to Chapel Hill, where he will resume his job as dean of the University of North Carolina Medical School. Technically speaking, Fordham had not yet become assistant secretary at the time of his abrupt leave-taking—in fact, the White House was going to make his nomination to the post official on the day he quit—but had been in the job as a "consultant" long enough to conclude that there is not much to it. Fordham withdrew on 20 April after a dispute with HEW Secretary Joseph A. Califano, Jr., in which the two men argued over the role the assistant secretary would play.

Califano offered Fordham the job of assistant secretary in March, after at least two other prominent doctors turned it down, in part because the position, which had been growing in stature during the Republican administrations, was being deflated by Califano himself (*Science*, 8 April). In one of his first moves as Secretary, for instance, Califano split health care financing away from the assistant secretary's office, thereby removing the office's influence over one of the most important current issues facing HEW.

Nevertheless, in job interviews with Califano, Fordham succumbed to the Secretary's blandishments about the importance of being assistant secretary. Obviously they did not work. It is widely believed in the Washington health community that Califano wants to run health affairs with a firm hand out of his own office. Fordham reportedly concurred that this is the case. So, he decided to get out early and in a handwritten note to Califano said simply, "With regret and for deep personal reasons I must withdraw." He will, however, continue to have some association with HEW as a member of the Secretary's advisory committee on national health insurance, an area in which Fordham has a particular interest and one in which he hoped to have some authority had he become assistant secretary.

It is not clear now whether Califano will begin once again a search for an assistant secretary or whether he will turn to James Dickson, the deputy assistant secretary, to fill the job.—B.J.C.

Meanwhile, at NCI the Search for Director Narrows

Pathologist Arnold Brown of the Mayo Clinic, radiobiologist Arthur C. Upton of the State University of New York at Stony Brook, and immunologist Baruj Benacerraf of Harvard are the three contenders for the job of director of the National Cancer Institute (NCI), a presidential appointment that has been vacant since Frank J. Rauscher, Jr., resigned last fall. (Brown previously was nominated for the NCI post by Benno C. Schmidt, chairman of the President's cancer panel, who had urged former President Ford to make the appointment before he left office.)

The new three-name list has been submitted, unranked, to Health, Education, and Welfare (HEW) Secretary Joseph A. Califano, Jr., by a search committee that he appointed with instructions to produce a short list of candidates who could be persuaded to take the job if offered. (Califano, having spent a lot of time talking with people who have turned him down for other jobs, did not want to go through that again.)

The search committee, which functioned out of the National Institutes of Health and only met twice, was headed by Ivan L. Bennett, provost and dean of New York University Medical Center. Califano may forward one name, or all three, to the White House. So far, no one has been interviewed, and it's anybody's guess whether the selection will be made in a week or a month or . . . .—B.J.C.

Scientists in Space—At Least Eventually

Some 222 scientists—81 from the United States and the rest from 14 other countries—have been selected to compete to have their experiments carried on one of the early orbital flights of the space shuttle. One or two of the scientists could accompany the experiments into space.

NASA and the European Space Agency (ESA) chose the group from among 2000 applicants to participate in the mid-1980 mission which has been dubbed Spacelab 1 because it will feature a reusable space laboratory which ESA will supply.

The shuttle consists of an aircraft-like orbiter designed to be flown back to earth after the mission and reused several times, an expendable tank which carries fuel for the orbiter, and two solid-propellant booster rockets which will be recovered and reused. NASA is scheduled to begin orbital test flights of the shuttle in 1979, and the first spacelab mission is expected to be the sixth trip into orbit.

ESA's spacelab, which will cost an estimated $500 million consists of a pressurized laboratory where one to four scientists will work, and a pallet area for mounting instruments which need to be exposed to space. Originally, plans called for one American and one European scientist to be chosen from the group of experimenters to make the 7-day flight as "payload specialists." Now, however, NASA says that no final decision has been made on whether the payload specialists will be drawn from among the experimenters or from the NASA contingent.

In any event the payload specialists will not be required to meet the demanding physical and training standards demanded of astronauts and which still apply to the orbiter crews. Normal good health and the ability to carry out the experiments aboard the spacelab are the main qualifications.—J.W.

posures; he says that such repeated exposures are more potent in terms of producing bodily damage than a single larger but sublethal dose of the agent. Tardiff asserted that other chemicals, including polychlorinated biphenyls (PCB's), barbiturates, and alcohol potentiate the toxic effects of carbon tetrachloride, and that persons who already have liver or kidney damage are more susceptible to the chemical than the normal population. According to Tardiff, water containing 150 ppb of carbon tetrachloride, a concentration within the range found in the slug, would cause further damage in about one-fourth of those with liver or kidney disease and might also harm those exposed to the other chemicals.

There is also the possibility that repeated exposure to small doses of carbon tetrachloride may cause cancer. The chemical causes liver cancer in rats, hamsters, and mice when administered to the animals by a variety of routes. There is little evidence that it does the same in humans, but many investigators prefer to err on the side of caution in this regard and minimize human exposures as much as possible. For example, Samuel Epstein of the University of Illinois Medical School said in another affidavit filed in support of EPA's case against FMC that there is no known method for setting safe levels of exposure to chemical carcinogens and that contamination of drinking water with carbon tetrachloride poses a serious health hazard. According to Epstein, in some animal studies, even the lowest doses caused cancers. In contrast, Plaa points out that most of the animal studies were performed with doses high enough to cause liver damage. Thus, the cancers might have resulted from repeated insults to the tissue rather than as a direct effect of the agent.

The issues regarding the human carcinogenecity of chemicals are as difficult to resolve as they are common in modern life. The carbon tetrachloride contamination of the Ohio River has been cleared up but it is a safe bet that a similar situation will arise again somewhere.—JEAN L. MARX

Science in Europe/Low Marks for High Technology

Neither West Germany nor Britain has succeeded in encouraging the vigorous growth of new companies based on technological innovation, according to a report just published in London and Bonn. As a consequence, both countries are likely to find themselves paying royalties to American companies for the use of technology which might just as easily have been developed and commercialized in Europe.

The report, produced for the Anglo-German Foundation for the Study of Industrial Society by Arthur D. Little Limited, shows in exhaustive detail what casual observation has long suggested: that Europe has yet to devise a social and industrial framework within which new technology-based companies can thrive. Britain has perhaps 200 such companies formed since 1950 (the starting point for the study) and West Germany, despite a much better economic performance and a considerably greater gross national product, even fewer. In each country the total sales of the new technology-based companies is around £200 million a year. Yet the United States has many thousands of such companies, with sales of billions of dollars a year, the report says.

With "honourable exceptions," such as Racal Electronics in the United Kingdom and Nixdorf Computer AG in West Germany, the performance of new technology-based firms has been unimpressive, demonstrating no particular success whether measured in terms of numbers, size, growth, or contribution to GNP and employment. As a result, the report warns, Britain and West Germany are neglecting an important channel for the exploitation of technological innovation, are failing to establish the new industries which will supply jobs and exports in the future, and are leaving themselves open to American technological domination.

The interest in the report lies in its comparison of Britain and West Germany. It shows that the failure to achieve the right climate for the exploitation of technology by small firms is not just another index of economic failure—as people in Britain might have suspected—but can also occur in an apparently vigorous and successful economy like that of West Germany. "A favourable economic climate is not alone sufficient to generate these firms," the report concludes.

Some of the inhibiting factors are common to both countries, including the generally hostile attitude toward entrepreneurship held by academic and government scientists in Britain and West Germany. Neither country has traditionally directed its research and development budget toward small firms, preferring to get the work done in government laboratories, the places least likely to produce "spin-off" companies, according to the report. In addition, the fragmented market in Europe means that a newly formed company, even if successful, finds it much harder to grow rapidly than its opposite number in the United States.

In Britain, the penal rates of personal taxation, rising to a maximum of 83 percent on earned income, mean that there are too few rich men willing to invest a few thousand pounds in a venture carrying a high risk. Personal taxation in West Germany is much lower, rising only to 53 percent, but the tax position for companies is very much less attractive than it is in Britain, making it difficult for new companies to get a start. Thus, while Britain makes it almost impossible to become rich out of income, West Germany allows people to become rich only to discourage them from using their money creatively to set up new companies.

The attempt to get around the problem by establishing risk capital organizations has been only partly successful. Britain pioneered this approach by setting up the National Research Development Corporation in 1948, but NRDC has invested only £5.0 million of its total expenditure so far of £44 million since 1949 in new technology-based companies. And, since setting up the NRDC, the British Government "has done very little else to encourage innovation," the report complains. Public discussion of the issue has been more active in West Germany, with the result that a number of new organizations and programs have been set up; too many, perhaps, the report suggests, since it is doubtful they "can achieve their full impact while their efforts remain so fragmented."