7. 34 Federal Register 13552 (22 Aug. 1969).
8. See, for example, *New York Times* (29 July 1969), p. 1.
9. *Medical Malpractice: The Patient Versus the Physician, A Study by the Subcommittee on Executive Reorganization of the Senate Committee on Government Operations, 91st Congress, 1st Session* (Government Printing Office, Washington, D.C., 1969), pp. 467–468.
10. 42 U.S.C. [U.S. Code] § 241(h) (Supp. I, 1965); 10 U.S.C. § 2354 (1964).
11. S. Rep. 367, 89th Congress, 1st Session (1965).
12. 41 C.F.R. [Code of Federal Regulations] §§ 1–15.205–16, .309–15.
13. 41 C.F.R. § 1.205–16.
14. 41 C.F.R. §§ 1–15.201–5, .303–5.
15. 41 C.F.R. §§ 1–15.202, .203; 42 C.F.R. §§ 52.31, .32.
16. 42 C.F.R. § 52.41 (grants); 41 C.F.R. §§ 1–15.307–3, –4.
17. The Atomic Energy Commission has developed a standard-form policy for nuclear accidents (10 C.F.R. § 140.91). Precedents developed in the field of atomic energy will be useful in carrying out the recommendations made herein, especially since some clinical experimentation may require protection against disaster. The protection of research institutions against the consequences of public disasters should be integrated with protection of research subjects against the consequences of private ones.
18. D. L. Stickel, *Law & Contemporary Problems* **32**, 597 (1967).
19. See R. S. Merrill, in *The Rate and Direction of Inventive Activity: Economic and Social Factors* (National Bureau of Economic Research, Special Conference Series No. 13) (Princeton Univ. Press, Princeton, N.J., 1962), pp. 420–26.
20. This article was written in conjunction with work performed pursuant to contract No. HSM 110-69-214 with the Public Health Service, Department of Health, Education, and Welfare.

South Africa (I)

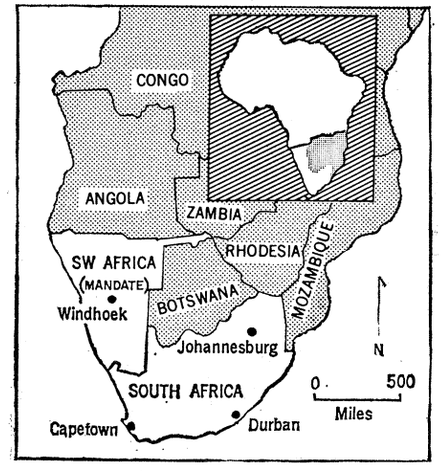
Booming Nation's Research and Industry Benefit from Close Ties with the United States

South Africa occupies a unique position in the world today. It is unique in that it bases its entire constitution, legislative system, and practically every other phase of life on differential treatment of different sections of its population. Rightly or wrongly, these different groups of people are spoken of as "races." Every single aspect of our life has come to be dominated by the thought: to what group or race does that *man belong? . . . The idea of race has gained a tenacious grip on the minds of South Africans and, especially, our political leaders. It has become a national neurosis of obsessional variety.*—From a lecture, "The Meaning of Race," by Phillip V. Tobias, head of the Department of Anatomy, University of the Witwatersrand (1961).

South African Prime Minister B. J. Vorster returned in June from a visit to Europe, and told his countrymen, "We are not as isolated as our enemies try to make out." It was appropriate that this should be among his first remarks because, for two intertwined reasons, concern about isolation ranks high among those who are categorized as white in this economically booming and most prosperous of African nations. First, South Africa is at least some 5000 miles from the nations with which the whites have important affinities—cultural, economic, familial, and of other sorts. Aviation and telecommunications are reducing the effects of that distance. But, with an almost unanimously hostile Black Africa between them and Europe, and with the Portuguese battling to hold on to nearby Mozambique and Angola, South Africa's nearly 3.6 million whites—living among some 15 million persons classified as "nonwhite"—feel very far away from the rest of the white world. Which makes it all the more painful as well as infuriating for them to know that, within that white world, revulsion toward South Africa's *apartheid* policies has led, often successfully, to attempts at boycotts and octracism. For example, of grievous hurt to many whites in this sports-loving country, Britain—South Africa's leading trading partner—recently invoked opposition to *apartheid* as grounds for refusing to receive a South African cricket tour. Several years ago, the same reason led to South Africa's ouster from the World Health Organization (WHO). Many nations have invoked arms embargoes against South Africa, in accord with a U.N. resolution, and attempts at boycotts of South African goods regularly take place around the world.

Against this background, and despite the WHO ouster, which seems to have had little effect on South African medicine, public health, or access to foreign expertise and information, it is worth noting that one of the least affected areas for white South Africans is that embracing science, technology, and medicine. These are fields in which South Africa has built considerable strength—outstandingly so in some areas—and which, with few exceptions, continue to benefit from close and fruitful relations with leading research centers in Western Europe and especially the United States. These relations are mainly on an individual basis, but U.S. government research organizations are also involved, most notably the National Aeronautics and Space Administration, the National Institutes of Health, and the Atomic Energy Commission. But even when the relationship is formally on a man-to-man basis, it is very often that U.S. government funds support the American share of activity.

There are exceptions to the theme of cordiality. South African scientists now and then tell of hostile encounters in the United States and elsewhere. One told of recently being challenged at a professional meeting, and another, who frequently visits the United States,



formulated the matter as follows: "If they attack you in a plenary session, you've had it. No one is going to stand up for South Africa over there." There are other instances of attempts to extend ostracism to the generally unruffled field of scholarly relations. For example, Jerome Bruner, the Harvard psychologist, recently declined an invitation to lecture in South Africa because, as it was reported in the South African press, he "could not appease his conscience by working in South Africa with its present racial policies." However, at about the same time, the press in this isolation-fearing country gave prominence to the acceptance of an invitation to a conference in South Africa by Samuel Huntington, chairman of the Harvard government department. In other lands, local pride is probably the main reason for press notice being given to the comings and goings of foreign scholars. In South Africa, where the Prime Minister raises the issue of isolation immediately upon returning from abroad, the presence of such visitors goes into a nervously observed ostracism index.

In any case, the brotherhood of scholars, particularly scientists, is strong, and, during a 3-week visit to South Africa in June, I was repeatedly struck by evidence of the close working relations that exist between scholars there and abroad and, furthermore, by the carefully devised organizational mechanisms that exist for bringing South Africa's scientific and technical talents into the service of the government and the economy. Few, if any, oases for the indulgence of curiosity exist in South African science and technology. Rather, there are many strong centers, enriched by close foreign contacts, working on what the government and industry have designated as major problems. This was the main impression that emerged from interviews with scores of South Africans who are concerned at various levels with research, technology, medicine, education, and industry. In position, they ranged from science adviser to the prime minister to laboratory technicians, and they included basic scientists, government officials, university researchers, teachers, and administrators, student leaders, industrial executives, physicians and medical organization leaders, and newspapermen. Their places of employment in this racially compartmentalized country covered the color spectrum, including five of the major institutions among the ten full-fledged white universities and five of the six institutions that exist for nonwhite students. My visit was shepherded by the quasi-governmental Council for Scientific and Industrial Research (CSIR), which is the most powerful and diversified research organization in the country. Operating on a budget of about $28 million a year, it is the principal research arm of government for all research outside of atomic energy, agriculture, and medicine, which was recently separated from CSIR and put under an independent council. About half of CSIR's income comes from contract work for industry, and CSIR is also the principal source of funds for research in universities—a setup that further assures a strong applied and developmental influence in South African research. My CSIR guides made many suggestions about what and whom they deemed worth seeing, but there was time and opportunity to follow the suggestions of others as well as my own leads. It is impossible to assess how representative a picture I was able to assemble, but on the basis of what I did find, the following came through most strongly.

Paramount Impressions

1) The South African government recognizes the relationship between economic strength and expertise in research and is investing shrewdly and heavily in technical activities. Statistical services are now receiving a long overdue improvement, but it is estimated that from all sources—with government by far the largest—South Africa is spending about $70 million a year on research and development. According to the prime minister's science adviser, Herman O. Mönnig, this is about 0.5 to 0.6 percent of the gross national product, very low by U.S. and European standards, but perhaps of some significance is the fact that there is relatively little slack in South African research; most of it is clearly aimed at well-identified problems. About 18 percent is said to be for "basic research," but many doubt that the definition would stand up to conventional standards. The published figure for "research in connection with defense" is $1.8 million for 1967. But this is a tightly curtained area, and the prime minister's science adviser stated that he knew nothing about it. Others remarked that they neither knew nor wanted to know anything about it. Overall, the financial situation for research has brightened considerably in recent years. But not too long ago it was so bad that a grass-roots movement, titled the National Association of Scientists, grew up on the issue of research salaries, and apparently successfully put considerable pressure on the government. The Association claims 1200 paid-up members out of what it calculates to be approximately 6000 working researchers in South Africa. One of its principal themes is that the government has failed to formulate an effective science policy for working on the country's economic and industrial problems. Though I did not come across very much fundamental research, the Association's leaders say that perhaps there is still too much of it.

2) In line with the emphasis on applied and developmental research, the South African government is adamantly unreceptive to "prestige" projects or, with few exceptions, those with a distant or uncertain payoff. Unlike Israel, with which many South Africans draw analogies (a white, Europeanized minority, surrounded by a hostile, dark-skinned, poorly educated majority), South Africa boasts no equivalent of that edifice to basic science, the Weizmann Institute. Unlike Australia, Canada, and the Netherlands, it has not ventured into the prestigious, but costly and nonutilitarian, field of radio astronomy, despite some barehanded efforts by several scientists at Rhodes University who have set up a tiny station for tuning in on Jupiter. "When we approached CSIR for money for a radio telescope," one of them explained, "they replied, 'It's too expensive; it's not for South Africa.'" A physicist who came back with a degree from Oxford said he was advised, "'Do something useful.'" So, it is not surprising that South Africa boasts some extremely sophisticated examples of homemade advanced technology closely related to national needs. For example, the combination of enormous coal reserves, virtually no domestic oil, and fear of boycott inspired the construction of a coal-to-oil conversion plant, reportedly the world's largest. Sasol, as it is known, was built at a cost of about $150 million, and currently supplies about 10 percent of the country's gasoline; it is capable, I was told, of supplying 40 percent. Inadequate water supplies in the South-West African city of Windhoek inspired the construction of what is described as the world's first operational plant for recycling waste water. Currently, 30 percent of

Scientia, the 370-acre Pretoria campus of the South African council for Scientific and Industrial Research. More than 20 buildings here, with a capital investment of more than $30 million, house laboratories and institutes covering a variety of subjects, including chemisty, physical research, road research, mechanical engineering, building research, and nutrition. Additional CSIR laboratories and research units are located in other parts of South Africa.

the city's supply is produced from sewage. Half of South Africa's research and development funds go into agricultural and veterinary research, and there is no doubt a connection between this order of priority and the country's self-sufficiency in all important foodstuffs. Distribution is a problem and malnutrition is said to be widespread among the rural African population, especially as a consequence of dislocations and social fragmentation resulting from forced moves under the *apartheid* laws. But again, with an eye toward the threat of boycott, South Africa—or at least its whites—have enlisted agricultural technology for strategic purposes.

3) The government recognizes the economic utility of the universities, both those that are English-speaking and those that, as is the case with the ruling Nationalist Party, are Afrikaans in language as well as political and racial sentiment. (The white population is roughly 60 percent Afrikaans, deriving from Dutch and French Huguenot immigration starting 300 years ago, and about 40 percent English. Both languages are officially recognized. Afrikaans, being a Dutch derivative spoken nowhere else, is piously cultivated, and in the Afrikaner universities, it is as much the language of instruction and daily conversation as is French in French universities.) The fact that several English-speaking universities are centers of opposition to *apartheid* has, by unanimous account, had no effect whatever on general educational support, which is distributed through a dispassionate formula linked to enrollments, programs, and facilities. Money for research in the natural and physical sciences is awarded on a basis of peer reviews, and is likewise said to be unaffected by politics. Intimidations enter into the social sciences, particularly when they seek to venture close to matters concerning *apartheid*. But in general, those who are frustrated in this regard have left South Africa, leaving behind those who are content to pursue interesting but politically innocuous inquiries. As one Afrikaner professor remarked, "Within fairly narrow bounds, South Africans are more or less reconciled to *apartheid*, that is except for those who have been eliminated by the Special Branch." As for those centers of opposition, the English-speaking universities, it appears that the government, operating behind a battery of legislation that permits it to squash any individual or organization "legally" and without question, feels that an occasional sit-in, petition, or march is a harmless price to pay for well-trained engineers and scientists. The English-speaking University of the Witwatersrand (meaning Ridge of White Water), in Johannesburg, prides itself as a hotbed of opposition to the government. It is also South Africa's largest academic recipient of government research funds, a status that is in no way affected, for example, by the recent prosecution of a law faculty member for publishing several law journal articles on capital punishment in South Africa. Based on an extensive survey of the South African legal profession, the articles showed, among other things, that no white has ever been sentenced to death for raping a nonwhite; that between 1963 and 1966, 26 Africans were sentenced to death for murdering whites, while only one white received a death sentence for murdering an African. It was also pointed out that South Africa accounts for some 45 percent of the world's (whether "free world" or not, was not clear) court-ordered executions. The author, charged with casting doubt on the impartiality of the judiciary, was acquitted on the grounds that he did so but without intent to commit contempt of court.

4) While government and industry recognize that research is an important component of economic growth, they also recognize that South Africa is too small to attain a position on many frontiers of economically valuable science and technology. Therefore, connections with foreign science and technology are vigorously encouraged, generously subsidized when necessary, and diligently exploited for the benefit of the South African economy.

Consider, for example, the relationship involving the U.S. National Aeronautics and Space Administration and the development of skill in electronics in South Africa, which, like many other small but prosperous countries, finds itself burdened with foreign-owned manufacturing subsidiaries whose presence discourages the development of industrial research talents. NASA is helping South Africa overcome this problem.

In 1961, NASA opened near Johannesburg one of the Radio Space Research Stations that make up its international tracking network. Included were facilities for near-space tracking, as well as a Deep Space Instrumentation Facility, the latter for research conducted by the Jet Propulsion Laboratory (JPL), which is operated by the California Institute of Technology under contract to NASA. When questions arose as to whether black Americans would be permitted to work there, the U.S. State Department issued assurances that the United States would not be party to any arrangement involving racial discrimination. The issue, however, was actually moot from the start, since NASA took the step of contracting operation of the $2.5-million-a-year station directly to CSIR and taking CSIR staff members to the United States for training. (Most other NASA stations abroad are manned by a mixture of Americans and local nationals.) As a consequence of this arrangement, no Americans, with the exception of one JPL employe and occasional visitors, are assigned to the station. The remaining 250 or so persons employed there are all South Africans, and employment is in accord with the *apartheid* regulations. These specify, among other things, that nonwhites in white areas may not hold employment above the menial level, give orders to whites, receive pay equivalent to white pay for equivalent work, dine with whites in public, or share public transportation with whites. In NASA's view, CSIR is simply another contractor making an important contribution to the space program. But from CSIR's perspective, the station is a valuable entrée to advanced technology. This point was made in an interview with John Goddard, an electrical engineer who became deputy director of the station in 1963, after having served as comanding officer of the South African Air Force school of electronics. Goddard explained that one of the proudest achievements of the station is a 4-year training course, partially financed with NASA funds, in which South African secondary school graduates obtain a diploma based on work equally divided between the station and a nearby technical college. During the 6 months or so of each year that the students work at the station, Goddard said, NASA funds are used to provide them with salaries of $1680, which is roughly three times the sum that the South African government and other sources normally provide as grants or loans for university students. Upon graduation, the students are required to work at the station for 2 years. Goddard said that 30 or 40 students have completed the course since it was established in 1964. "We eventually lose them to industry or other organizations," he said, "but we know we're doing the country good and we don't mind." On the subject of race relations, Goddard said, "NASA puts no pressure on us."

The director of the station, Doug Hogg, summarized its contribution to South Africa in the March 1970 issue of *Scientiae*, journal of the CSIR: "To South Africa and the CSIR," he wrote, "participation in space research has brought . . . national prestige and membership [in] the international Committee on Space Research, but probably more important has been the opportunity to acquire the skills necessary to operate and maintain the ground stations, and the chance to expose engineers and technicians to the latest equipment and electronic techniques."

New Gold-Digging Machine

To turn to another example of South Africa's fruitful relations with foreign science and technology, we can consider the geophysical, metallurgical, and social problems associated with gold, for which South Africa is the source of 80 percent of the "free world" supply. Last year, according to the South African Chamber of Mines, which encompasses virtually all of the country's minerals industry, South Africa produced over $1.2 billion worth of gold, a sum equivalent to approximately half of the country's import bill for manufactured goods. The economics of gold, however, is freakishly affected by the fact that for 25 years, world prices have been closely tied to the rigidly held U.S. government purchase price of $35 per ounce. At the same time, the most easily mined veins have been exploited, and mining has now been extended to record depths of 12,000 feet and beyond. With the price inflexible, and costs rising both from the increased difficulty of getting at the ore and general inflation, the key to profitability is lower production cost, especially since there are well-identified fields of ore that, with present mining methods, would be unprofitable at $35 per ounce. Government, academic, and industry researchers are heavily engaged with the quest for lower costs, and are making good use of their international ties in working at the problem. What is generally considered to be the most promising line of attack centers around a newly devised cutting machine that can slice close to the gold; its attraction is that it reduces the need for blasting, thus diminishing the amount of rubble that must be brought to the surface and processed to separate the gold. The successful trial of a prototype in actual mining conditions recently was followed by a rise in gold share prices. Heading the development of the machine is N. G. W. Cook, a young South African who is director of the Mining Research Laboratory of the Chamber of Mines. Cook is also an adjunct professor in the School of Mineral and Metallurgical Engineering at the University of Minnesota, where he has spent a good deal of time in recent years.

At the University of the Witwatersrand, newly appointed as the youngest professor in the university's history is a 27-year-old mathematician, A. H. Starfield, who, with funds provided by the Chamber of Mines, moved for 4 years between Johannesburg and the University of Minnesota while working on a Ph.D. thesis on the problem of heat flow in gold mines. At the CSIR, Z. T. Bionawski, head of the Rock Mechanics Division, reports cordial relations with colleagues at M.I.T., the University of California at Berkeley, and the University of Minnesota, as well as what he described as a formal arrangement for exchanging publications with the U.S. Bureau of Mines. Publications from the U.S. Army Corps of Engineers, he said, are regularly forwarded to him through a military attaché at the U.S. Embassy.

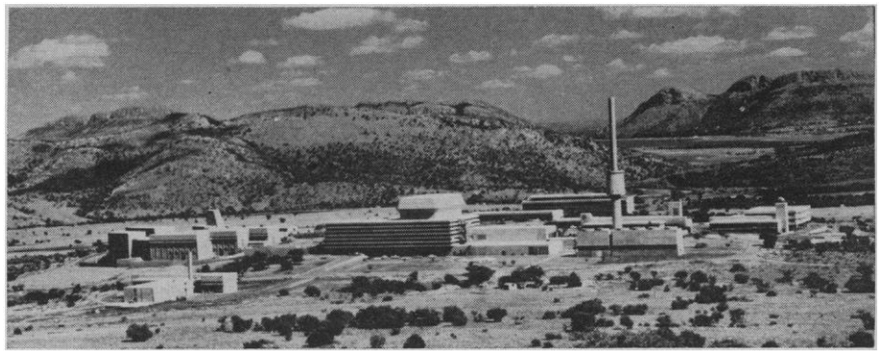
The management of the labor force at the mines presents a variety of problems that are the concern of several organizations that work in the social sciences. Among these is the CSIR Institute for Personnel Research, which, under contract to the Chamber of Mines, has helped develop a series of tests known as the General Adaptability Battery for "classifying" the annual turnover of 222,000 Africans who work in the mines. The Institute, which is a contributor to the Human Adaptability program of the International Biological Program, has had several staff members spend considerable time at the Educational Testing Service, Princeton, New Jersey, and maintains close ties with that organization.

Close relations with American or-

ganizations, including M.I.T. and the U.S. Department of Agriculture, were described by J. P. de Wit, director of the CSIR Food Research Institute, which, among other things, performs research on the nutritional requirements of the mine labor force. With minimum remuneration in the mines $15 a month, plus food, lodging, medical care, and transportation, I was told by de Wit, "a slight reduction in the cost of food can make a great difference."

With an affluent white population raised to European medical standards, and foreign medical expertise thousands of miles away, medical research—principally of a clinical nature in line with South Africa's chosen emphasis on applied research—has reached a high standard. The celebrated transplant work of Christiaan Barnard is, of course, a departure from South Africa's general order of priorities in using its technical resources. Barnard was on vacation in Spain when I visited South Africa; I had little success in seeking information from persons familiar with his work. In response to my inquiry as to whether another human transplant was in the offing, I was told, "We hope not." Someone else remarked, "That depends on whether Chris goes on holiday after he comes back from holiday." Another person said, "The first thing Chris did after he planted that first heart was run to the telephone and call up the paper and shout, 'Hey, I just transplanted a human heart.' They didn't know what the hell he was talking about." There was general agreement at the University of Capetown, Barnard's home base, that he could be credited for focusing international attention on South Africa's medical proficiency and also that he was responsible, as a colleague put it, "for the first good news to come out of South Africa in years." But there was also concern over great approbation being given a technical spectacular of dubious value. "It's not the style of South African science," the head of a research department said gravely.

South Africa's medical skills were professionally recognized long before Barnard achieved prominence, and, not suprisingly, South Africa has long been included among the foreign recipients of NIH research grants, though as is now the case with almost all U.S.-supported research abroad, the sums are in decline. NIH reports five grants in South Africa, totaling $105,832 for fiscal 1969. These are at the universities of Capetown and Rhodes, and the Durban Medical School, an institution which is something of an oddity on the South African educational scene, since it is a school for nonwhites—the only nonwhite medical school in the country—but is part of the University of Natal, which is a white university. Over the violent opposition of the medical faculty, the government is moving toward detaching the school from the university and putting it under the administration of a nearby university that is exclusively for the country's Indians. Much high-level medical and racial politicking has been generated by this attempt; the Indians are delighted, as are the Afrikaner whites who run the Indian university. On the other hand, the English-speaking whites, who comprise most of the medical faculty, are appalled, while the nonwhite non-Indians are deeply concerned with what happens to medical education for their categories if the Indian university takes charge. (In South Africa, everyone is labeled with one or another color, and regardless of the anthropological nonsense inherent in the designations, profound social, economic, and political consequences automatically flow from the designations. But basically, the system gives 80 percent of the country to the approximately 20 percent who are categorized as white. Persons of Asian origin are listed as "colored," but Japanese have been accorded the status of "honorary white," a decision which is said to be related to a strong surge of business dealings between Japan and South Africa.)



Pelindaba, 20 miles west of Pretoria, National Nuclear Research Center of the South African Atomic Energy Board.

As is the case with clinical researchers in many nations, the increasingly publicized question of "informed" or "advised" consent from human experimental subjects is a matter of concern among South African researchers, particularly those performing drug trials that come under the scrutiny of the U.S. Food and Drug Administration and NIH. The problem is compounded by the fact that, though South African hospitals offer a plentitude of "clinical material" in the persons of black patients seeking help, few of these patients are considered to be attuned to the nuances that underlie "consent." One long-term South African NIH grantee said, "Of course, we have to be as ethical as possible. But how am I to tell a wild and woolly African that he is to be a guinea pig? I could get him to put his thumbprint on a piece of paper, but it would be meaningless." The researcher added, "We have a *theoretical* committee watching us, and believe me, NIH and FDA know that. But the only safety is in being as ethical and as careful as possible, and I assure you that is the way we operate."

Another researcher, in this case a political liberal openly identified with opposition to *apartheid*, remarked, "Informed consent? You can't possibly understand the problem here. How do you explain these things to a Bantu? I've gotten informed consent for the price of bus fare to the hospital. That was the difference between getting it and not getting it."

The Atomic Energy Board, which is responsible for South Africa's atomic energy program, provides another example of the country's close scientific and technical links to the United States. According to the Board's published reports, scores of its scientists and engineers have been trained in the United States, particularly at the U.S. Atomic Energy Commission's Oak Ridge National Laboratory, since South Africa's lone reactor is an Oak Ridge design, purchased through Allis-Chalmers. Considering South Africa's strategic sensitivities, the question of nuclear weapons intentions naturally arises. The available evidence suggests that these have not gone far, if any distance at all. South Africa is a party to the nuclear nonproliferation treaty, and is an active

member of the International Atomic Energy Agency, which is responsible for monitoring the whereabouts of fissionable materials held by its members. South Africa's nuclear activities are publicly stated to be open to inspection, and no dispute concerning this has come to light. (A student who once worked at Pelindaba, the National Nuclear Research Center of South Africa, near Johannesburg, told me, "This American bloke would show up at odd times and check out the fuel.") But more important, in view of South Africa's undisputed military and economic superiority on the African continent, and its policy of emphasizing short-term utility in research and engineering, it seems unlikely that it would wade into the costly business of building nuclear weapons. It does not need them, now or for the foreseeable future, but it desperately needs for pressing current problems the large numbers of scientists, engineers, and technicians who would be required for such a venture. From what I saw and was told during a visit to Pelindaba, the most noteworthy feature was the architecture of the place—strikingly handsome sculpted concrete, in contrast to the surplus-Army-hut style that prevails at many such establishments around the world. The budget, I was told, is around $8 million a year, which does not buy much nuclear technology. Plans are under way to build South Africa's first nuclear power station, but with all that coal available, there is no sign of haste.

Nuclear Apartheid

Apartheid intrudes into everything in South Africa, but it does so in a most curious fashion in the field of nuclear research. Of the 900 or so employes at Pelindaba, all are white, including—a rarity from experience elsewhere in South Africa—the lady who served the lunch that I had with J. P. B. Hugo, the deputy director general. Hugo explained, "We had quite a problem when we were planning to build this place. There are lots of radioactive materials here and we have to have decontamination facilities in case of an accident. Of course, we'd have to have white and nonwhite facilities, since no sharing is allowed. We added it up, and decided that the cost would be too high, so we've kept it all white. We've mechanized the cleaning operations and things like that and it's worked out very well."

Hugo said that the nuclear center does little basic research. He explained that its task was to help develop a nuclear power industry, and that focus on this objective was assisted by a board on which industry and business were heavily represented. "We wouldn't get involved in any transuranium work or anything like that," he said, "even if it meant losing people whose interest lies in that direction. We don't like to lose them, but our job is clearly laid out for us."

Traffic in scientific and technical matters between South Africa and the United States is understandably mainly from the world's Goliath of research to South African researchers seeking to keep up with activities beyond their means or scope. But occasionally, American organizations find benefit in exploiting South Africa's natural features, as is the case with the NASA tracking station, or they find value in particular talents that have developed in South Africa. An example in that first category is the high-energy neutrino detector experiment, financed by the U.S. Atomic Energy Commission, and located 3290 meters underground in a mine near Boksburg. F. Reines, originally of the Case Institute of Technology, but now of the University of California, Irvine, is principal investigator, but the experiment, which resulted in the detection of the first natural neutrino, is in the day-to-day care of the University of the Witwatersrand. I was told that the experiment has cost about $1 million so far. Again, South Africa's natural features are what make it an attractive site for astronomy organizations. While I was there, I encountered a representative of the West German Max Planck society who was examining sites for an optical observatory. And CSIR officials told me that the Smithsonian Institution plans to revive an observatory that it has maintained there on a caretaker basis. The French space organization maintains a tracking station, though unlike the American station, it is mainly staffed by Frenchmen.

A curious aspect of the U.S. lunar program provides another example of foreign interest in South Africa's natural features and South African exploitation of that interest for its own economic purposes. South Africa has been found to contain the oldest dated rocks on earth, and, in conjunction with analysis of lunar samples, American investigators have been collaborating with the economic geology research unit of the University of the Witwatersrand in the collection and analysis of these rocks. One of the objects is to determine whether they contain material of biological origin. D. A. Pretorious, head of the unit, explained to me that his research unit, originally founded and funded by the Chamber of Mines, but now integrated with the university, finds interest in the rock analysis project because of an apparent relationship between the presence of fossil organisms and gold. "The studies with NASA," he explained, "may turn out to be very useful for exploration."

Plaudits from America

The quality of South African research not infrequently draws laudatory notice from American organizations. Take, for example, the case of Professor G. B. Lauf of the University of the Witwatersrand. A recognized authority on gyroscopic instruments, he has had a long association with the Colorado School of Mining Engineering. It was through John Reed, chairman of the school's Department of Mines, Lauf told me, that he came to be considered for, and received, last year a Senior Foreign Scientist Fellowship from the National Science Foundation. While at Colorado, Lauf said, "Someone phoned around to check on whether anyone might be interested in my work on direction-finding instruments. They called the U.S. Army artillery base at Fort Sill, Oklahoma, and the Army said, 'You couldn't have come at a better time.' I was called in and lectured for 3 days, and they asked me back twice. And now I'm going there again to give a 3-week course for about 20 people. They're not financing any research for me. They just want to be brought up to date on what I know."

Since foreign antagonism to *apartheid* is a central fact in South Africa's foreign relations, it is not surprising that many whites whom I met there chose to bring up the subject and attempt to explain what they considered to be its complexities and problems. Often this was done with the object of making me understand that *apartheid* was actually not what I might have understood it to be. One such episode stands out. The wife of a prominent physician volunteered the information that she and her husband had entertained a visiting black American scientist at home. "We were expecting him at home, but I didn't know he was black. Well, the

houseboy came to me and said a black man was at the door. I told him to take his name and that we would see him some other time, since I was busy getting ready for the evening. He came back with the man's name, and I realized at once that it was our guest. Naturally, I was surprised that he was black, but we had a marvelous evening. After it was over, the houseboy said to me, 'Why can that man eat with you and the master [a common form of address that South African domestic and hotel employes use to whites] and I can't?' I told him, 'When your brain is as good as that man's, you can eat with me and the master.' "

"So, you see," she concluded in telling this story, "things here are not the way you probably thought they were."—D. S. GREENBERG

Dissent and Reaction: Vigilante Activity at NBS Labs in Boulder

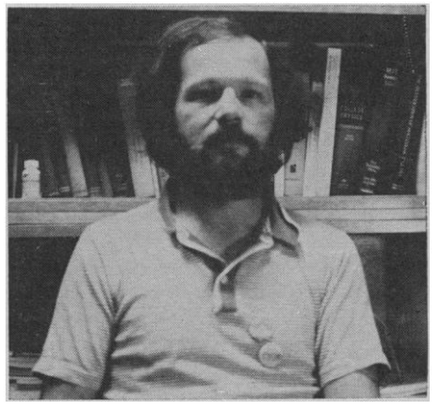
The polarization that afflicts American society has struck even the placid Boulder (Colorado) Laboratories of the National Bureau of Standards. Over the past 6 months Warren Bingham, a 30-year-old peace activist employed as an engineering technician at the laboratories, has been subjected to what he regards as a "pattern of discrimination" and of "day-to-day repression" in retaliation for his political activities on behalf of various peace groups. Bingham charges that laboratory officials have pressured him to stop participating in local peace demonstrations, have threatened to fire him, and have condoned, if not encouraged, a "vigilante group" of blue-collar workers that has harassed him in a series of bizarre incidents ranging from threats on his life to the filling of his car with some 5 bushels of sheep dung.

"Things got so bad at one point that I didn't even dare to leave my office," Bingham told *Science*. "You hear people say that the United States government is good at producing radicals. Well, that's certainly the case. This year has radicalized me more than the preceding 15 years put together."

Bingham is a Quaker, a pacifist, a conscientious objector, and a believer in what he calls "anarchistic socialism." "My concerns are moralistic," he says. "I'm not a Weatherman out bombing things on the weekends. I believe in non-violence." Bingham took undergraduate courses at M.I.T. but dropped out of school to support himself. He has since taken courses at Harvard and held a variety of jobs. Last September he joined the NBS Boulder operation after compiling an impressive work record as a technician at the Harvard College Observatory. He is now in the midst of a probationary period served by new government employees.

A well-rounded evaluation of Bingham's plight is somewhat difficult to obtain. Bascom W. Birmingham, head of the Boulder laboratories, tried to persuade *Science* there was no merit in Bingham's complaints but then refused to allow his views to be published. "If you print this, I'll deny being quoted," he said. The official NBS position—as expressed in an interview at the Bureau's Gaithersburg, Maryland, headquarters by Allen Farrar, legal adviser, and Robert Walleigh, associate director for administration—is that there has been no "official" harassment of Bingham and that the laboratory, in fact, has taken steps to curb the vigilantes. Farrar said that Bingham is being fired in early September but he said this is not because of Bingham's political activities but rather because he has compiled an "unsatisfactory" work record. Bingham believes otherwise, however, and he contends that the firing is just the last chapter in a "pattern of ideological discrimination" against him.

Bingham's troubles seem to have started back in January when he participated in week-long demonstrations sponsored by the Boulder Workshop in Non-Violence, a largely Quaker group that Bingham had helped to found. The group picketed and passed out leaflets at a high school, a public utility, a court house, a draft board office, a church, and the Rocky Flats plutonium plant of Dow Chemical Co. The leaflets charged that "many of the institutions of our society work together to destroy life." The school was accused of turning out "docile citizens," the utility of polluting the environment, the draft board of enforcing "slavery," and the church of compromising on war.



Warren Bingham

Bingham says that when he returned from picketing at the high school during his lunch hour he was told by an administrative official that he was not to engage in such demonstrations any more because Birmingham, the laboratory head, was "very upset." (Birmingham's office had received a complaint from the high school principal.) Bingham also says that on at least three separate occasions during the week he was told by various senior personnel at the laboratory that he had better drop out of the demonstrations or else he might be fired. "They said Birmingham was a conservative man and he was not going to put up with this affront," Bingham says. "They said I'd better conform or there'd be trouble." But Bingham refused to heed the advice, which he says was usually tendered in a "fatherly" way. There was sharp disagreement over whether Bingham was playing politics on government time (by taking extraordinarily long lunch hours) or on his own time, but this was resolved when Bingham agreed, under protest, to take an hour's annual leave for every noon hour he picketed.

A short while after the week of demonstrations ended, Bingham says, he was further harassed by being called to a meeting with a personnel official at which he was told there was "some question about my security clearance." Bingham says he was told that "an FBI report" had turned up evidence