Taking Care of the Things We Own in Common

Long ago, Aristotle observed that "that which is common to the greatest number has the least care bestowed upon it."

Americans, more than most people, have failed to take good care of the things that belong to all of us together: air, water, land, cities, regions, neighborhoods. Yet unless we start taking care of these things that belong to nobody in particular and everybody in general, we are going to find ourselves faced not only with a narrower range of individual choices than before, but with individual choices that are less worth making.

These common choices must be made through political processes and institutions that are both democratic and effective, that are large enough to encompass the problems and small enough to reflect and respond to the needs and desires of the citizens concerned. Most of these common choices involve problems that simply cannot be contained within any single local jurisdiction. Local governments are too feeble and too fragmented to cope with an increasing range of problems such as transportation, air and water quality, and, above all, the problems of growth —of the patterns and pace of development, of the way in which housing, jobs, schools, recreation, and similar activities are distributed within a given area. Citizens within each separate jurisdiction are deeply and directly affected by decisions made within other jurisdictions; yet they have no say in those decisions. Each jurisdiction pushes and pulls against the other. And the citizens of each watch helplessly as their region assumes shapes and directions that are determined by forces they do not understand and cannot influence.

If the citizens of this country are going to have the chance to make intelligent, effective decisions about the patterns and problems of growth, and if they are to exercise any real control over those patterns that so deeply affect and influence their lives, then we are going to have to develop, as rapidly as possible, effective democratic governmental institutions on the state and regional level to direct and regulate growth. As long as we fail to do so, then communities like Petaluma and others across the country that are engaged in what appear to be thoughtful efforts to manage their growth will find themselves increasingly thwarted.

Earlier I mentioned Aristotle. I think we would do well to rediscover two old Aristotelian ideas. The first is the idea of politics as the process by which the citizens of a common area come together to make decisions about the problems and prospects they share in common. The second is the idea of nature as an unfinished creation which man, by his intellect and imagination, can bring to various kinds of completion within the broad boundaries of the laws and limits inherent in nature itself.

If we really understand these ideas, if we accept them and act upon them, then we will I think not only extend our range of individual choices, but discover that our choices are increasingly worth making.

References

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NEWS AND COMMENT

India: Into the Nuclear Club on Canada's Shoulders

There floated through my mind a line from the Bhagavad-Gita in which Krishna is trying to persuade the Prince that he should do his duty: "I am become death, the shatterer of worlds." I think we all had this feeling more or less.—ROBERT OPPENHEIMER at Alamagordo.

Krishna's words came full circle on the morning of 18 May with India's first nuclear explosion, a shallow underground test of a plutonium device in the great northern desert of Rajasthan. The yield was announced as 10 to 15 kilotons, or slightly less than that of the plutonium bomb that destroyed Nagasaki in 1945.

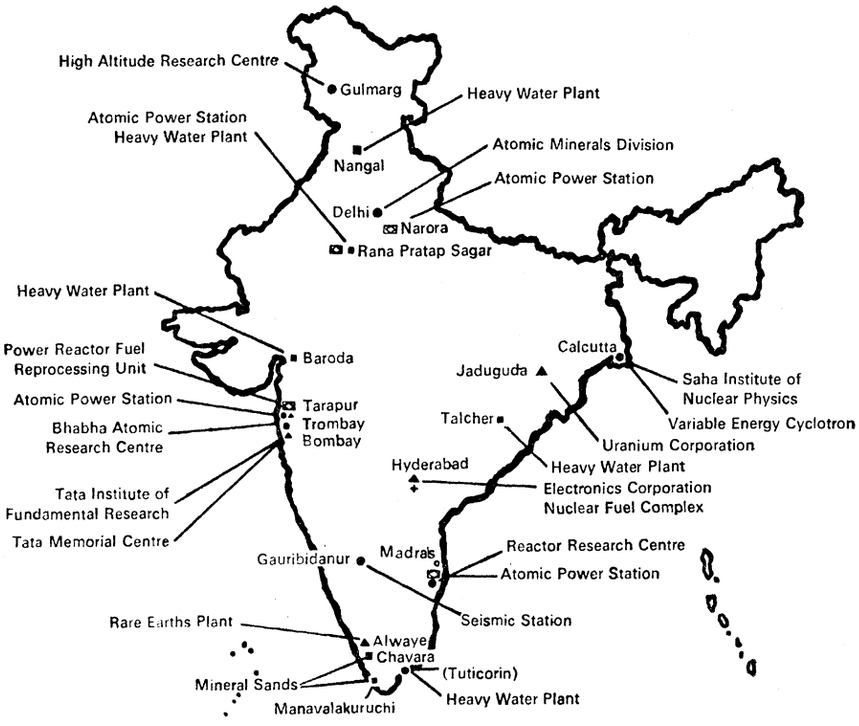
If an Indian Oppenheimer felt misgivings about his achievement that morning, they were not in evidence in New Delhi. Prime Minister Indira Gandhi praised her nuclear scientists for doing a "good clean job," and she told reporters the test was "nothing to get excited about." Defense Minister Jagjivan Ram, whose hints 2 years ago that India might be working on a nuclear explosive were greeted mainly by yawns, disavowed any interest in nuclear weapons. India was not to be regarded as the sixth shatterer of worlds, but rather as the first, he said, to develop nuclear explosives purely for such peaceful applications as excavation and mining.

Arms control analysts in Washington uniformly discounted these protestations with, as one of them expressed it, "broad winks and leers." Adrian S. Fisher, dean of the Georgetown University law school and a former chief negotiator at the Geneva disarmament talks, noted that "no fundamental difference exists between the innards of a weapon and a 'peaceful' explosive."

With one singular exception, international reactions to the Indian test seemed guarded, with diplomats and arms analysts expressing dismay but not surprise. India, after all, had long been regarded as one of the two nations most likely to follow China into the ranks of nuclear powers (Israel being the other). A vigorous protest from Pakistan was predictable, but the most vehement expressions of thinly veiled outrage came—of all places—from Canada.

It was not without a cause, and a certain touch of irony. Canada, unlike India, has signed and ratified the 1968 Non-Proliferation Treaty and thus has renounced interest in building nuclear explosives for any purpose. But India, it soon became evident, had climbed into the nuclear clubhouse on the shoulders of Canadian technology and Canadian foreign aid.

Two days after the Indian blast foreign affairs officials in Ottawa issued one of their own, accusing India of violating the terms under which Canada had provided technical aid in the



India's nuclear research and power facilities are depicted in this 1973 map, reproduced from an Indian government report.

nuclear energy area—an accusation Indian officials denied. On 22 May, Ottawa announced the summary suspension of aid to the Indian atomic energy program (sharply curtailed 2 years before over the same issue). The remaining aid programs to India, said Mitchell W. Sharp, the Secretary of State for External Affairs, were being "reviewed" to determine whether "our priorities are the same as the Indians'."

There is no question but that India assembled its plutonium device without outside help. An abundance of talent is available at the huge Bhabha Atomic Research Center at Trombay, a few miles north of Bombay. According to an Indian government report published last year, the Trombay laboratories, uranium and plutonium processing plants, and electronics manufacturing facilities employ 10,400 persons, 2400 of whom are scientists. The well-regarded Tata Institute of Fundamental Research, established in 1945 in nearby Bombay, could also have contributed to the explosive design.

What India could not have done without Canadian help, it now appears, was to make plutonium. Canadian officials believe the plutonium used in the Rajasthan explosion almost certainly came from a small, 40-megawatt research reactor called "Cirus" that Canada helped the Indian government build and pay for in the late 1950's.

Donald G. Hurst, the president of the Canadian government's Atomic Energy Control Board, told *Science* in a telephone conversation that, "We have no hard knowledge that Cirus was the source. But until we learn otherwise, that is the assumption we are going on."

If this assumption proves correct, Hurst said, the Canadian government would consider India to be in violation of a 1956 bilateral agreement stating that "the reactor and any products resulting from its use will be employed for peaceful purposes only."

Cirus is by far the largest of four operating research reactors in India, all of them located at the sprawling installation at Trombay. Cirus is moderated by heavy water, and its fuel is natural (or unenriched) uranium. These features give the reactor two major attractions: India can, and does, produce its own fuel without having to buy enriched uranium abroad or to build its own hugely expensive enrichment plants; and natural uranium reactors are prolific manufacturers of plutonium, turning out almost 50 percent more than conventional, light-water reactors of comparable power.

According to a spokesman for Atomic Energy of Canada, Ltd. (AECL), the government's nuclear development corporation, Canada agreed to build the Cirus reactor in 1956. The AECL picked up more than half the $15.5 million tab, trained about 30 Indian technicians at the Chalk River Nuclear Laboratories in Ontario, and supplied the reactor's first load of fuel.

The U.S. Atomic Energy Commission (AEC) also contributed initially to the Cirus project by selling India 42,000 pounds of heavy water in 1956 for the express purpose of running the reactor. The AEC leased an additional 30,000 pounds of heavy water to India for a second research reactor, a small "zero-energy" facility at Trombay, but an AEC spokesman said this had been returned. He added that India has produced its own heavy water on a large scale since the mid-1960's.

Altruistic as Canada's aid may have been, it also provided a foot in the door for subsequent sales of a distinctly Canadian variety of nuclear power reactor called CANDU, an upbeat acronym for Canadian Deuterium-Uranium. In the mid-1960's India agreed to buy a pair of CANDU reactors from the AECL; Canada helpfully lent India $82 million at a favorable 6 percent interest rate to assist in the purchase. The twin 200-megawatt units were built in Rajasthan state; one has been running since August 1972. Like Cirus, they use natural uranium and heavy water.

Also in the mid '60's, the U.S. AEC sanctioned the sale to India of twin 190-megawatt boiling-water reactors, to be supplied by General Electric and fueled with enriched uranium imported from the United States. These were built at Tarapur, near Bombay.

Allowing for normal shutdowns for maintenance, the four power reactors are capable of producing about 175 kilograms of plutonium a year, enough for 36 explosives with a yield of 20,000 kilotons apiece. Canadian, U.S., and United Nations officials interviewed by *Science* say they are convinced, however, that the plutonium from these plants has not been and cannot be "diverted" to make explosives. The main reason for their confidence is that this plutonium—unlike that from Cirus and the other Indian research reactors—is under the supervision of the International Atomic Energy Agency (the U.N. nuclear security agency) by mutual agreement between India and the United States and Canada. A spokesman for the IAEA in New York said the agency's accounting and inspection procedures were believed to be "working well."

That similar measures do not apply to the Cirus reactor is evidently a con-

sequence of its age and loose wording in the 1956 agreement. Canadian officials explain that the agreement came into force before the establishment of international safeguards and before the idea that nuclear explosives might have peaceful applications became widely popular.

In the late 1950's, when Canada supplied the fuel for Cirus, India was required under terms of the agreement to keep a close accounting of the resulting plutonium. But that requirement is said to have lapsed in the mid-1960's when India began making its own fuel and extracting what it considered to be its own plutonium. The "peaceful uses" injunction still pertained to the reactor and its products, but, by 1966, as Indian scientists began talking about building a "peaceful bomb" in emulation of the U.S. Plowshare program, it dawned on Canadian officials that the 1956 agreement contained a loophole.

In a futile effort to plug the loophole, Canada's representative to the Geneva disarmament talks, General E. L. M. Burns, put his government on record in the summer of 1966 as defining "peaceful uses" explicitly to exclude explosions of all kinds. Indian representatives are said to have rejected this interpretation. And Prime Minister Pierre Trudeau apparently fared no better when he wrote to Mrs. Gandhi in 1971 to remind her of Canada's definition. Indian officials say the decision to build an explosive device was made that July.

A year later, in July 1972, the United Nations Association of the United States, a private policy-study and fund-raising group, released a report on nuclear safeguards that singled out a Canadian research reactor in India (without mentioning its name) and a French reactor in Israel as being the only two "unsafeguarded" reactors known to be operating in nonnuclear countries that had not signed the Non-Proliferation Treaty. The report estimated India's plutonium stockpile at 95 kilograms and Israel's at 40 kilograms, enough for 19 and 8 bombs, respectively, of Nagasaki-size.

The political repercussions of the Rajasthan explosion are still largely a matter of speculation, with the tone ranging from grim to mildly positive.

In arms control circles, the Indian test is widely viewed as a serious but not lethal blow to completion of the Non-Proliferation Treaty. India's action, and the generally mild international reaction, are seen as stiffening the resistance of already resolute holdouts—notably Pakistan, Israel, South Africa, and Brazil. To some analysts, a more immediate concern is that India may have strengthened the hand of right-wing elements in Japan opposed to ratification of the treaty.

On the positive side, India's newly acquired power (and perhaps prestige among poorer nations) may improve its chances of negotiating a détente with China. And the test puts new pressure on the United States and the Soviet Union to come up with a conciliatory countermove at the June summit, perhaps in the form of a broader test ban agreement (*Science*, 17 May).

Even if India's disavowal of military intent is discounted entirely, the military significance of the Rajasthan test is no larger than India's supply of unsafeguarded plutonium. Its stockpile is small now—probably not larger than 100 kilograms, and some of this is committed to fuel two fast-neutron test reactors—but there is a great deal of growth potential just over the horizon. In April 1972 the Indian atomic energy agency began designing a new 100-megawatt production reactor modeled on Cirus. And near Madras, at Kalpakkam, India is building two 200-megawatt power reactors that one Canadian official describes as "almost carbon-copies" of the CANDU units in Rajasthan state.

To build the Kalpakkam reactors India is using technology purchased from Canada as part of the Rajasthan deal. But because no foreign help is being used in the design and construction of the power plant, the plutonium it produces will not be subject to international control. Under normal operating conditions the three new reactors will make a total of about 118 kilograms of plutonium each year.

In providing India with the nuclear technology that has made all this possible, Hurst explains that "We were trying to help a country that desperately needs energy. They could hardly be expected to stop with one reactor."

From the Canadian point of view, it has begun to look like a case of technological charity gone sour.

—ROBERT GILLETTE

Windmills: The Resurrection of an Ancient Energy Technology

The windmill seems fair set to make a comeback from the trash heap of technical history. Once a derisible symbol of archaic technology, the environmental reawakening and the sudden wane of the cheap energy era have left the windmill looking more like the feasible alternative power source that its enthusiasts claim it to be.

A recent sign of the windmill's potential as an unfueled provider of electricity was to be tilted at by the oil industry. "But what do you do when the wind dies down?" one company's television ad asked its audience last year. To advocates of the windmill, the question misstates the problem. The basic technology, they believe, is already there. The remaining task is primarily economic: to make the capital costs of windmill energy competitive with what the oil industry and other rivals have to offer. With that achieved, for an energy device that runs on air and doesn't pollute, it should be plain sailing.

Interest in windmills is picking up fast. Two years ago only a dozen or so people in the United States were studying the devices; now there are a few hundred, working at universities, in large companies such as Boeing or Grumman, and in smaller firms such as R. Buckminster Fuller's Windworks. A few weeks ago the National Science Foundation (NSF) asked the research community for proposals on how best to use and construct windmills. The agency plans to spend $7 million on windmill research in the next fiscal year (this fiscal year's budget is $1.5