of aluminum, and one to remove sulfur from coal. There are proposals to increase the efficiency of irrigation in the Southwest, and to develop the continental shelf, and restore the fish population. Another proposal would even provide helicopters with which to log forest areas.

► *Cities and suburbs.* Proposals for aiding the development of industrialized housing—already part of an ambitious program in the Department of Housing and Urban Development—and plans for neighborhood preservation are in this category, although similar proposals have been gathering dust around in government files since the early 1960's. Another plan would integrate public utility use.

Magruder also sought changes in government policy which might encourage R & D, particularly in industry. A prominent proposal, largely accredited to the Industrial Research Institute (a national organization of research managers of private industries), was for a 25 percent tax exemption on industry baseline costs of R & D. How the tax would work, in detail, is not known, but the aim would be to make it cheaper for a company to invest in research. The need to maximize profits has forced many major U.S. corporations to cut back their basic research laboratories by about 30 percent in the last few months (*Science*, 17 December 1971). Other proposals have included the creation of a new office of technology reporting to the President, for the management of the technology initiatives in the agencies in whose jurisdictions they would normally fall.

There was wide support for the basic concept of the Magruder study among the industry and university administrators and scientists whom *Science* consulted. The notion of linking the ills of the nation's scientists to the related maladies afflicting the U.S. world trade position and domestic situation has apparently struck a very responsive note among many scientists.

However, in terms of science policy, many see the President's space shuttle announcement of 6 January as a complete about-face from this progressive approach that has been touted. The space shuttle, which will cost $6.5 billion, and create 50,000 jobs (half in southern California), has no particular relevance to domestic needs. It represents, many believe, exactly the short-term, artificial, forced feeding of R & D which has characterized U.S. technology over the last decade and left one segment of the economy—the aerospace business—in a shambles. The shuttle green light as a sop to the California vote in the presidential elections in November.

Other sources point out that many of the proposals Magruder has been sifting through are old. They were already considered by the government at one time or another, and many were rejected, perhaps for good reasons. According to this line of thought, for even a man of Magruder's energies to devise in 4 months a low-cost plan for solving some of the nation's key environmental, urban, and economic problems, is simply asking for the impossible.

—DEBORAH SHAPLEY

Arms Control and Disarmament: SALT, CCD, CTB, MBFR, Etc.

Since the beginning of the nuclear era, arms control diplomacy has concentrated successively on single, well-defined, limited objectives. The partial test ban treaty in 1963 and the nuclear nonproliferation treaty (NPT), which went into effect in 1970, have been the most important products of the process. Now, although the strategic arms limitation talks (SALT) between the Soviet Union and the United States command primary attention, the arms control dialogue has done some proliferating of its own, as have the acronyms and abbreviations of arms controlese.

Efforts to achieve a comprehensive test ban (CTB) are continuing, and prospects of finally bringing underground testing under the ban seem to have brightened recently. (Developments that have reduced chronic impediments to a CTB are discussed in an article on page 283.)

The arena for test ban talks has been the Conference of the Committee on Disarmament (CCD), lineal descendant of an 18-nation group that was formed under U.N. auspices in 1962 and has met intermittently in Geneva to work on arms control and disarmament problems ever since. There are 25 nations now in CCD, including the nuclear powers minus China and France.

It was CCD which negotiated the recently concluded Seabed Arms Control Treaty, which prohibits the installation of nuclear weapons on the seabed outside a 12-mile limit. The seabed treaty, like the Outer Space Treaty (1967) banning orbiting nuclear weapons in outer space, appears to foreclose the deployment of some exotic new weapons systems, but, in the case of the seabed treaty, probably no nuclear power was seriously inconvenienced, since nuclear weapons installed on the seabed are viewed as being relatively easy to locate and attack.

The CCD, however, is also the source of a proposal that is likely to become the first genuine disarmament measure—as contrasted to arms control measure—since the pre-World War II era. The CCD has sent the United Nations a draft biological warfare (BW) treaty, which prohibits the development, production, or stockpiling of biological weapons, including toxins. Research on defensive measures is permitted in the draft treaty and is in fact encouraged, in part at least because some such research is virtually indistinguishable from valuable nonmilitary biomedical research. A BW treaty, unlike the seabed treaty, would deal with weapons that are real, but risky to a potential user.

A ban on chemical warfare (CW) is also on the CCD agenda, but is regarded as even more difficult to achieve than a BW treaty. Chemical weapons have been used in this century with much effect. They are relatively cheap "weapons of mass destruction," which

could make small nations hesitate to renounce them. Most important, probably, verification of a CW treaty would be even more difficult than of a BW treaty. For example, a lot of plants produce organophosphates, the chemical family tree on which the most potent nerve gas grows.

A more traditional sort of disarmament seems possible if discussions on a Mutual and Balanced Force Reduction (MBFR) in Europe bear fruit. An MBFR depends on negotiations between the North Atlantic Treaty Alliance (NATO) nations and their Warsaw Pact counterparts. Last spring, the Russians for the first time declared themselves receptive to the idea. The NATO ministers this fall named an "explorer" to pursue the idea, but the Soviets appear to have cooled off on the MBFR, at least for the time being.

The idea of a major disarmament conference has been in the air for some years and recently has been evolving rapidly, although apparently not getting much closer to materializing. The concept seems to have begun with General de Gaulle and his proposal that the nuclear "Big Five" (Britain, China, France, the Soviet Union, and the United States) meet and agree on a disarmament package to which other nations would be required to acquiesce. Last spring, the Russians rather unexpectedly began espousing the French plan. Then the Chinese blasted the Soviets for proposing to exclude the small nations and advanced their own idea for a worldwide disarmament conference. The Soviets thereupon veered sharply and, at the U.N. General Assembly last fall, put forward their own proposal of a worldwide conference. When the Chinese delegation arrived at the United Nations, however, the conference became the subject of a sharp exchange between the Chinese and the Russians, and there the matter now seems to stand.

The rise of China as a nuclear power and China's entry into the United Nations has obviously added new dimensions to arms control and disarmament issues, which heretofore have been dominated by the two nuclear superpowers. But in arms control matters, a development of comparable importance has been the approach of the Soviets toward "parity" in nuclear power with the United States.

The conventional view is that the Cuban missile crisis convinced the Russians of the disadvantages of being number two militarily, and since then they have been trying harder. Not only have the Soviets increased the number of their land-based intercontinental missiles so that it exceeds the American arsenal by an estimated 1500 to 1050, but the Soviets now have a fleet of nuclear armed submarines nearly as large as that of the United States. In addition, the Soviets have built up their naval strength and long-range air transport capability and they have become an authentic global power, as their operations in the Middle East and most recently in the India-Pakistan hostilities testify.

American defense officials have warned in recent years that the Soviets have been spending heavily, not only on nuclear weapons systems and conventional military forces, but also on military research and development and that the United States may soon find itself on the wrong side of a "research gap." This argument is often bolstered with references to new hardware that the Russians have been observed testing —for example, the so-called fractional orbital bombardment system (FOBS), which is said to be capable of launching a missile from orbit that could approach the United States low and through the "backdoor"—perhaps from the direction of the South Pole—and therefore could not be detected early. There have recently been reports of Soviet tests of a satellite killer presumably designed to destroy intelligence satellites.

Research Gap Rebutted

The research gap arguments have been rebutted by critics, notably by scientists with weapons development experience who are members of the Federation of American Scientists (FAS). One theme of FAS spokesmen is that the research gap is being created as earlier "bomber gaps" and "missile gaps" were created—by adopting projections of what the Russians can do with maximum effort. The critics also charge that selective comparisons are being made in both weapons procurement and research and development areas, and that budget analyses are made on dollar-ruble comparisons that are unrealistically unfavorable to the dollar's buying power.

Comparisons of strategic weaponry generally are tricky to make, since Soviet and American nuclear arsenals are still not symmetrical and agreement on denominators has been one of the problems for SALT negotiators.

United States worries reportedly center on the Soviet's monster, land-based SS-9 missile, which now is said to be equipped with 25-megaton warheads, far bigger than any U.S. warhead. The Russians are thought to have about 300 SS-9's, and a primary American objective has been to negotiate a ceiling on these missiles.

The Soviets, for their part, are bent on getting an agreement on limiting the number of American ABM's, and they seem particularly anxious to keep building nuclear-armed submarines.

A deadlock in SALT negotiations was reported broken last spring, and it has been assumed that the talks were focused on reaching agreement on means of protecting the capacity of each side to retaliate effectively if the other should launch a nuclear "first strike." In the interim, however, the Russians were reported to have been digging holes for new, larger silos, presumably for new offensive weapons. The Americans have been pressing ahead on ABM systems designed to protect Minutemen land-based missiles, and are also equipping missiles with multiple warheads (MIRV's), moves which some say are aimed at nullifying the Soviet lead in land-based missiles.

Statements by the Nixon Administration last spring and fall created an expectation that SALT would produce an agreement on both offensive and defensive weapons within a reasonable time. It is being assumed that final bargaining positions will not be adopted until after President Nixon's planned trip to China in late February, in part because of Soviet sensitivity over Chinese-U.S. relations. Most observers expect, however, that an agreement will be formally announced or perhaps final negotiations conducted when Nixon makes his scheduled visit to Moscow in May.

While other arms control and disarmament negotiations are in progress in Geneva and, potentially, in Brussels or Warsaw, failure to reach a significant agreement at SALT this year would have serious consequences. Not only would strong expectations be disappointed, but it is likely that the Soviets would go ahead with their SS-9's and the Americans with their ABM's—and many observers think that these actions could no longer be regarded as arms control "bargaining chips," but as stakes in a new arms competition that could go out of control.—JOHN WALSH