covered such major costs as those for ship and aircraft operations and data reduction.)

Although ESSA's administrator, Robert M. White, has described BOMEX as an outstanding example of interagency cooperation, he evidently is not eager to strain his luck in the future. White was a member of the Commission on Marine Science, Engineering, and Resources which recently recommended establishment of a National Oceanic and Atmospheric Agency. "NOAA" would be made up principally of ESSA, the Coast Guard, and the Bureau of Commercial Fisheries; and it would coordinate, as the President might direct, interagency programs in civilian meteorology and oceanography. Among other reasons it gave for establishing the new agency, the commission said NOAA would offer the "major advantage" of providing consolidated planning and operating capabilities for the large-scale field experiments expected to follow BOMEX.

—LUTHER J. CARTER

Arms and the Scientists: A Long Dialogue Continues

The national debate on Sentinel is the first example I know of a military system being a matter of public debate not confined to a small group of experts or advocates of a special cause.—Professor Jack P. Ruina of M.I.T., a former top Pentagon weapons adviser, at recent Senate ABM hearings

Earlier in the cold war the technical and strategic pros and cons of a new military system could not have been aired with the fullness which has lately marked the discussion of ABM capabilities and potential countermeasures against such a system.

David E. Lilienthal, first chairman of the Atomic Energy Commission, made this point in a recent CBS public affairs program when he contrasted the ABM debate with conditions prevailing two decades ago when the decision to develop the hydrogen bomb was made. Lilienthal, who opposed development of the H-bomb, commented on the decision and its effect on the arms race. "Well it's easy," said Lilienthal, "to look back and say you were right, but now we're going through another cycle. . . .

"Now we're having a public debate about another issue of this kind, and it's casting a lot of light on public policy. The H-bomb should have been discussed that way."

Certainly there is a new freedom in discussion of weaponry in comparison with the early postwar period, when the military secrecy lid was kept clamped down with wartime tightness. But it is unclear to what extent more open discussion has actually affected key strategic decisions or the process by which they are made.

Debate on the ABM, in fact, seems to be following a pattern set during a succession of crucial debates on weapons and arms control, in which a group of university scientists, who established themselves as weapons experts during World War II, have sought to influence the dialectic of the arms race.

Over the years there has been a certain continuity in arguments and in personalities. Hans Bethe, Nobel-prize-winning theoretical physicist, played a key role in the work of American scientists mobilized during World War II and was a dominant figure among those who argued that it was possible to develop a detection system adequate to police a nuclear test ban. And it was Bethe, collaborating with physicist Richard L. Garwin, who produced an article, published in the March 1968 issue of *Scientific American*, which provided a prime public source of information for opponents of the ABM. Bethe and Garwin discussed in detail offensive tactics and aids to penetration of the putative "thin" ABM shield, and thus markedly raised the level of sophistication of subsequent debate.

More open discussion of both technology and strategy is not the only change which occurred during the debates over the hydrogen bomb and the continental air defense system and during the long gestation of the test-ban treaty. The Pentagon and the White House developed greater "in-house" capabilities in dealing with weapons evaluation and strategic policy. Most notable were the creation, after the Sputnik I scare, of the Advanced Projects Research Agency (ARPA) and the Directorate of Defense Research and Engineering (DDRE). Of increasing importance during the period were such semi-detached advisory organizations as the RAND Corporation and the Institute for Defense Analyses. The "think tanks" at first concerned themselves with technical problems but soon evolved a capacity to advise on strategic questions. The emergence of the "defense intellectuals," offering analyses of policy questions, inevitably gave government policy-makers a source of advice which could be set against the advice of university scientists. The academic scientists were mostly natural scientists whose claim to authority lay originally in their expertise in developing weapons and their understanding of weapons effects. The scientific strategists were mainly mathematicians and, especially, economists, who evolved an even more dismal science by thinking about the unthinkable in a professional way.

Academic scientists also institutionalized their government advisory activities in groups such as the President's Science Advisory Committee (PSAC) and the National Academy of Sciences' Committee on Science and Public Policy, but it is fair to say that members of these groups have felt themselves to be, as the saying goes, on tap rather than on top.

In the debate on the ABM, the dissenters who received most public notice have been men like the former Presidential science advisers James R. Killian, George B. Kistiakowsky, Jerome B. Wiesner, and Donald F. Hornig (*Science*, 21 March), all of them products of the wartime incubator of statesmen of American science. All of them, also, can be placed in what Robert Gilpin, in his book *American Scientists and Nuclear Weapons Policy*, calls the "school of finite containment." This group excludes the unilateral disarmers. As Killian said in the recent ABM hearings before the Senate Foreign Relations subcommittee, it is "essential to preserve the deterrent." But the finite

containment group. takes the view that the arms race could be arrested by properly inspected arms control agreements.

An opposing "infinite containment school" holds views associated particularly with Edward Teller and with such other academic scientists as Willard F. Libby and the late E. O. Lawrence. In effect, they argue that the arms race has an irresistible momentum and that the only choice for the United States is to stay ahead.

The attitude of the finite containment school, which is probably the majority party among academic scientists in the United States, was well expressed by one of its more outspoken exponents, Jerome B. Wiesner, at a symposium on the ABM (the proceedings were recently published as an occasional paper by the Center for the Study of Democratic Institutions). His remarks were prompted largely by allusions to the threat implied in Soviet work on ABM defenses and a reported buildup of Soviet missiles with very powerful warheads.

> Now, General [Leon] Johnson's statement about the problem we have with regard to the Russians does not seem to me to take sufficiently into account the maneuverability we have in controlling the arms race, or even our responsibility for contributing to it. When I first began to play with these toys, working at the M.I.T. radiation laboratory, I believed everything I was told. I spent the nineteen-fifties working very hard on air defense, on missiles, on a variety of things, because I was told by my superiors that the Russians were ahead of us, that they were working against the day when they would get enough power to carry out a surprise attack and wipe us out. This, it was said, was their only purpose in life. Then we graduated from that to the "missile gap," which, in fact, I helped invent. But soon it became clear that many of us had just misinterpreted the signals. Eventually, when we got enough information, we saw two things: first, the Russians had opted out of the bomber race quite early in the game; they never built a bomber force capable of wiping out our force or doing the other things we said they had wanted to do and could do. And, second, for a long time, they were prepared to settle for a missile force considerably smaller than ours.
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> Then, a few years ago, the Russians decided to build more missiles, and they are now drawing equal. I hope they are only drawing equal. I hope they don't intend to double what we have, because if they do we obviously will respond. I don't know why the Russians began to build more missiles. Maybe it stems from their embarrassment over the Cuban missile crisis. Maybe it stems from their embarrassment at having Mr. McNamara stand up in the Congress every time he had to explain why he was not buying more missiles and point out that the United States already has four times as many as the Russians. Whatever their motivations, the Russians began adding to their missiles.
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> This point is important, and one that General Johnson seemed not to appreciate adequately when he said we might wake up one day and discover that the Soviets had made a defensive system that rendered our offensive system inoperative. I have been trying to say that nothing like this is in the cards with these massive, expensive, hard-to-build, hard-to-deploy, hard-to-train-people-to-operate systems. This is real protection. Our information is good enough and the time-lags are such that long before a ballistic missile defense system could be deployed to protect enough of the Soviet Union to make any difference we could sail past them, just as we did in the case of offensive missiles. In any event, now that we have led the Soviet Union in this new weaponry for years, I think it might be an interesting experiment to see whether we couldn't cool this whole business off by slowly cutting down on the numbers we all live by.

In the postwar era, however, the arguments for arms limitations from dissenting scientists have consistently lost out, and official policy has, in effect, been one of infinite containment. As the Washington journalist I. F. Stone has said, "The arms race is based on an optimistic view of technology and a pessimistic view of man."

Fear of a Soviet weapons "breakthrough" which would nullify the U.S. deterrent has actuated almost every crucial decision on weapons development. Officials ultimately responsible for national security always tended to make the decision which corresponds with the conventional military wisdom. Any other course, incidentally, leaves the domestic political flanks wide open, as was illustrated by the missile-gap issue raised by the Democrats in 1960 and toyed with by the Republicans last year.

Strategic-weapons decisions are made in an environment which military and diplomatic doctrines and assumptions necessarily influence very heavily. Such things as increasing Soviet activity in the Mediterranean, trouble in the Middle East, the Soviet occupation of Czechoslovakia, and of course the expected debut of China as a nuclear power with an intercontinental ballistic missile capability doubtless weigh heavily in the scales.

And last week Secretary of Defense

United States Ratifies Non-Proliferation Treaty

Senate ratification has given the Nuclear Non-proliferation Treaty new momentum, but it remains uncertain if and when the treaty will go into effect. The treaty has not been ratified by either the Soviet Union or West Germany, and observers say that mutual suspicions will probably have to be allayed before either country takes action. Other potential nuclear powers which have not signed it are India, Israel, and Japan. France and Red China have refused to participate in the treaty negotiations altogether. To date the treaty has been ratified by only ten nations, but a number of other countries are now expected to follow the U.S. lead. The treaty will go into effect after it has been ratified by the United States, Great Britain, the Soviet Union, and 40 other countries. The non-proliferation treaty was ratified on 13 March by the Senate by an overwhelming vote of 83 to 15. President Nixon is expected to sign the treaty soon, but formalities have not yet been arranged.

The international treaty, which was first proposed almost 5 years ago and signed last year by 87 countries, including the United States, received U.S. approval after an 8-month delay by the Senate. The delay is attributed to the invasion of Czechoslovakia by the Soviet Union and the fact that Congress stalled action because of election-year uncertainties.

Basically, the treaty prohibits nonnuclear states which sign the treaty from acquiring or developing atomic weapons, and prohibits nuclear powers from assisting them in the development of a nuclear weapons capability. The treaty also requires the nonnuclear countries to agree to inspections by the International Atomic Energy Agency. The treaty permits nuclear powers to provide nuclear explosives for peaceful purposes to nonnuclear powers on a nondiscriminatory basis. It also includes a pledge that nuclear powers enter into negotiations to end the nuclear arms race.—M.M.

Melvin Laird played a classic trump card when, in ABM hearings before the Senate Armed Services and Foreign Relations Committees, he invoked the threat of a Soviet nuclear first strike which could nullify U.S. capability to retaliate. In recent years a relative equilibrium has prevailed between the U.S. and the Soviet Union, based on a principle of "assured mutual destruction." The reassuring theory was that either nation could respond with a devastating "second strike" to a nuclear first strike. Laird argued that the Soviet Union's increase in its number of big missiles, the growth of its submarine fleet, and work on the so-called fractional orbital bombardment system, which threatens U.S. bomber capacity, could soon undermine U.S. second-strike ability unless Nixon's "Safeguard" ABM system is adopted.

Laird also produced a list of prestigious independent scientists and science administrators who, he said, support the Safeguard system. In addition to Teller he named Detlev W. Bronk, former president of the National Academy of Sciences; Gordon J. F. MacDonald, vice chancellor of the University of California, Santa Barbara; William G. McMillan of the University of California, Los Angeles; Frederic Seitz, president of the National Academy; and Eugene B. Wigner and John A. Wheeler of Princeton University.

Neither side of the ABM controversy has dwelt much on the development of the so-called MIRV's (Multiple Independently Targetable Reentry Vehicles) being developed by both the U.S. and the Soviets. MIRV warheads, as the name implies, divide into a number of separately guided nuclear weapons and penetration aids designed to confuse and saturate missile defenses. The decision to develop the MIRV may, in fact, deserve the "irreversible decision" label which Senator John Sherman Cooper (R–Ky.) has affixed to the ABM deployment and may signal progress from the era of overkill to the era of superkill.

The Nixon decision on the ABM seems to have been made very much as previous Presidential decisions on strategic weapons policy have been. According to the sketchy accounts available, Nixon relied mainly on his closest national security affairs advisers rather than on formal consultations with experts in the Executive branch or outside government, or even with influential members of Congress.

Henry A. Kissinger, the chief White House adviser on national security, and his aides reportedly played pivotal roles in assembling contesting arguments and providing an orderly context for the decision-making.

Shortly before the President's decision on the ABM was announced, it was reported in the press that a PSAC panel had submitted a report which expressed fairly strong reservations about the effectiveness of a Sentinel ABM system. Bethe, a member of the PSAC panel, was quoted as saying that a majority of panel members shared his views on the potential effects of penetration aids. The panel's conclusions on the practicability of an ABM "hard-point" defense like that advocated by Nixon, however, were apparently not included.

Presidential science adviser Lee A. DuBridge concurred publicly with the Nixon decision in a letter which concluded,

> The Safeguard system which you now propose eliminates the serious defects of the old Sentinel plan, focuses on the reasonable, feasible and necessary defense of our deterrent force, provides time for more thorough testing of an operating system and phases future deployment to progress of arms control negotiations and the changing information on the nature and imminence of potential threats to our security.
>
> I shall endeavor to make clear to my scientific colleagues that the Safeguard plan represents a sound and reasonable approach to our strategic defense problem.

The activities of DuBridge's predecessors Hornig, Wiesner, Kistiakowsky, and Killian in opposing ABM deployment raises a generational question of the kind that is fashionable these days. Most prominent opponents of ABM deployment have been alumni of the wartime mobilization of scientists. The generation of natural scientists which matured after World War II have been—with some exceptions, such as Herbert F. York and Ruina—a silent generation by comparison. Some in this middle generation made early careers in defense research and moved into positions of responsibility and power, like Harold Brown, former Secretary of the Air Force, and John S. Foster, director of defense research and engineering. But many seem simply to have got on with their careers and have been neither radicalized, like many of their younger colleagues, nor committed to a long-term effort to affect strategic policy, like their seniors. There is the theory that the older generation matured in a prewar age of innocence, experienced the Fall in the summer of 1945, and have sought to regain that prelapsarian state of grace, while their successors were pragmatists who simply were better able to accept a world they hadn't made.

Younger scientists concerned about public policy seem, in fact, to have achieved an impact on policy when they joined, and in several cases led, the protests against emplacement of ABM "farms" near major cities. No causal relationship between the protests in Boston, Chicago, Detroit, Honolulu, Los Angeles, San Francisco, and Seattle and abandonment of the ABM area defense can be demonstrated. But reaction in Congress was galvanic, and the circumstantial evidence for effectiveness of the protests is strong.

The threat of a nuclear accident seemed very immediate to many people, and they acted accordingly. The dissent of the older academic scientists influences policy in a less dramatic way. It is probably true that two opposing views on arms policy have crystallized in Congress—notably in the Senate Foreign Relations and Armed Services committees—as never before. But as the ABM debate moves into a discussion of the complexities of nuclear strategy, some classic forces will assert themselves.

There are real uncertainties about the effectiveness of ABM technology on the one hand and suspicions about Soviet and Chinese actions and reactions on the other. Precedent says that official policy gives the benefit of the doubt to the hardware, not to humans.

—JOHN WALSH

RECENT DEATHS

Joseph A. Falzone, Jr., 44; senior research scientist with the Masonic Medical Research Laboratory in Utica, N.Y.; 18 February.

John Farmer, 36; associate professor of psychology at Queens College; 17 March.

Robert L. Hass, 46; assistant professor of health science at the University of Illinois; 7 March.

Ralph R. Huestis, 77; professor emeritus of biology at the University of Oregon; 25 February.

Ian Weinberg, 31; associate professor of sociology at the University of Toronto; 12 March.