fact that causes rumbles of concern among congressional hawks. This edge is offset, according to the Administration, by the qualitative superiority in U.S. weaponry, including computer technology. The U.S. lead in the development of MIRV (multiple independently targeted reentry vehicles) warheads is regarded as particularly significant. The Russians have larger, but less accurate, warheads and are not expected to have a good supply of MIRV's for another 5 to 8 years.

The matter of inspection—which, because of the Soviets' abhorrence of on-site inspection, provided obstacles to the consummation of the 1963 treaty barring atmospheric testing—has been solved because both countries now have spy satellites adequate for the job.

Two other agreements were signed at the summit: one to reduce mutual harrassment by Soviet and American navies, the other a joint commission to talk about trade. A joint trade agreement was anticipated at the summit, but apparently it will take longer to straighten out such issues as long-term credits for wheat transactions, settlement of the U.S.S.R.'s World War II Lend-Lease debt, and Russia's desire to get on a "most favored nation" trade basis.

From what President Nixon told Congress on his return, the two countries are indeed heading toward a practical and businesslike, if not affectionate, relationship. The effect of the summit agreements, if they are followed, will be to involve many layers of the scientific community in stable, long-term, cooperative projects. Presumably such a welter of ties, joint committees, and mutually dependent projects will spring up that neither country will let third-party aggravations, such as in Vietnam and the Middle East, jeopardize an increasingly productive relationship.

Everything is at the budding stage now—by the end of the summer, after initial meetings have taken place, the significance of the autographing marathon in Moscow will be clearer.

—CONSTANCE HOLDEN

Smart Bombs: Air Warfare Undergoes a Reluctant Revolution

As military authorities tell it, Richard Nixon's Operation Linebacker —the code name for the renewed bombing of North Vietnam—is turning out to be considerably more devastating than Lyndon Johnson's Rolling Thunder of 1965–68. One major reason for the air war's deadly new efficacy is said to be the introduction of laser- and television-guided "smart bombs" in the campaign against the North. According to Columbia University physicist Richard Garwin, a former science adviser to the Department of Defense, these new guided weapons have brought about a "revolution in bombing accuracy"—one that permits the destruction of bridges, petroleum tanks, and other targets with surgical neatness, while greatly reducing "collateral" or inadvertent damage to civilian populations.

It happens, however, that the revolution in bombing and its presumed benefits for the hapless residents of Hanoi and Haiphong have been waiting on the arsenal shelves a lot longer than most people thought. Last week, Alexander Flax, a former assistant secretary of the Air Force, revealed that the laser-guided bombs were made available to the Air Force as long ago as 1967, but that high military officials evidently were not sufficiently impressed with these exotic new weapons to use them at the time.

"We had the bombs in 1967, but we couldn't find any customers," Flax said in a brief interview in Washington. Asked if laser-guided bombs might have helped reduce losses o pilots and aircraft as well as civilian casualties during the height of the bombing campaign in 1967, he replied that they probably would have.

Flax, who is now president of the Institute for Defense Analyses, dropped his revelation during a 2-day seminar on "science and public policy" sponsored by the Council for the Advancement of Science Writing and the Alfred P. Sloan Foundation. His remarks caught no apparent notice by the press, probably because competing news conferences in Washington that day drew away most of the reporters who had attended earlier.

He said it was difficult to pin down precisely who resisted the use of the laser weapons in 1967 or why, although he indicated that some Pentagon officials and field commanders may have felt that the complex new bombs were inconvenient for bomber crews to use. He did say, "We had a production capacity of 100 [laser-guidance units] per month in 1967, and we couldn't find any takers."

The bombs aroused "wild enthusiasm" after the bombing halt of March 1968. As the focus of the air war shifted to the network of supply trails meandering down through Laos and Cambodia, Flax said, pilots found during late 1969 and early 1970 that the new "smart bombs" were superbly adept at hitting trucks and other small targets.

In principle, the laser guidance system is simple, and it makes for one of the cheapest guided weapons in the American arsenal. Devised in 1966 as a "kit" that could be affixed to conventional bombs weighing anywhere from 500 to 3000 pounds, each unit costs about $3500 to install on one bomb. This involves mounting a laser-light sensor on the bomb's nose and some movable steering vanes on its body. The vanes adjust the bomb's ballistic path as it falls toward the target.

An attacking aircraft—not necessarily the one that drops the bomb—aims a laser beam at the intended target and the bomb simply homes in on the reflected light. The guiding plane may twist and turn in any evasive action necessary, so long as it keeps its laser beam pointed at the target.

Air Force spokesmen at the Pentagon indicate that the laser-guided bombs now being used are mostly in the 2000- to 3000-pound range and are routinely directed at "priority, heavily defended, point targets" in both North and South Vietnam. One of the weapon's more widely publicized accomplishments is the reported destruction of the Thanh Hoa bridge in North Vietnam, which stood intact under repeated bombing raids from 1965–68. *Aviation Week* reports that a single, 3000-pound, laser-

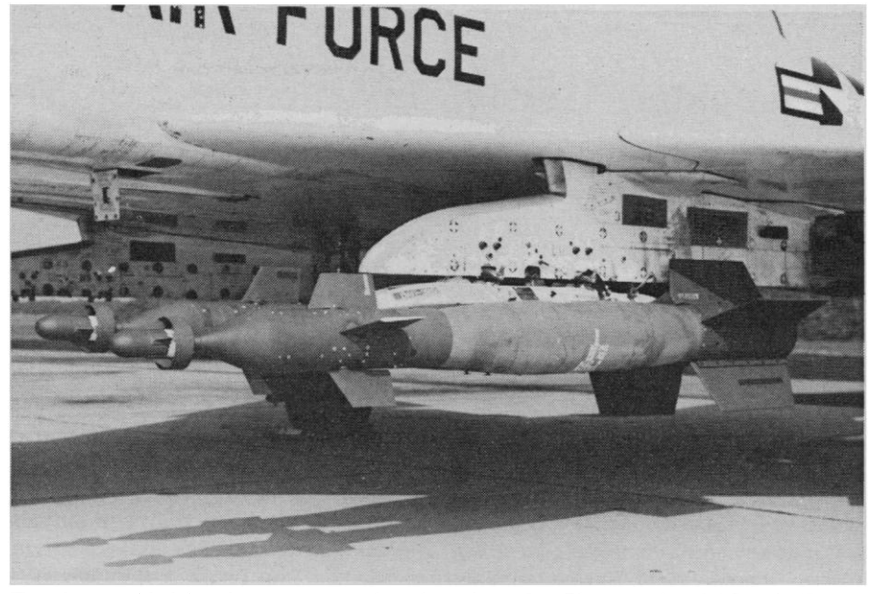
guided bomb knocked out the bridge last month.

With the Thanh Hoa bridge evidently in mind, Garwin, who is now a member of the President's Science Advisory Committee, told the seminar that the new bombs deserve a measure of credit for reducing the extraneous damage to populated areas which has always been inevitable in bombing raids. Though there is little hard evidence of this, Garwin said it was only reasonable to assume that "if one bomb does a job on a bridge, you don't have thousands hitting in the neighborhood."

References to the laser-guided bombs were made in the context of a broad discussion of how the Pentagon goes about deciding to build new weapons systems. Flax's point was that the military mind is inclined to feel more comfortable with tried and true systems—in this case, the conventional "dumb" bombs handed down from World War II—and that this inclination has a way of showing up on occasion in the planning of new weapons. Its effect is to produce demands for new systems, Flax said, that involve less imagination and more money than can reasonably be justified. Garwin and Flax agreed that a vigorous public debate over the military's requirements for astronomically expensive new hardware might counterbalance this tendency, but neither seemed confident that debate would come to pass.

Though reluctant to finger specific programs, Flax went so far as to suggest that the Air Force's case for building a $2 billion fleet of flying radar stations, called the Airborne Warning and Control System (AWACS), rests on rather thin ground. AWACS incorporates some technological improvements over the strategic command centers inside jet transports which the Air Force has been flying around for years, "and they're comfortable with that concept," Flax said. But he added that the Air Force's purposes might be served just as well, and at far lower cost, by making use of newly developed helicopter-lifted radar units already available to the Defense Department. Nevertheless, the Air Force is asking Congress for $470 million to proceed with AWACS in fiscal 1973.

Richard Garwin, in keeping with his image as a resident critic of the defense establishment, went a good deal farther than Flax in his jabs at the quality of Pentagon planning. For all the perennial talk about slicing the defense budget, Garwin said, Congress, the budget bureau, and the academic community lack sufficient expertise to successfully challenge the Defense Department's conception of what it needs in the way of new tactical and strategic weapons. Garwin then added:



Two laser-guided bombs are mounted under wing of a Phantom jet. [U.S. Air Force]

"Managers of the Defense Department regard as their primary mission the support of the Defense Department. But nobody on top really knows what our defensive forces can do. They'd rather spend money for new forces than evaluate old ones, let alone proposed forces.

"And there's no punishment or incentive to do the job right. A guy can go before Congress and make the most bizarre statements, and if he gets caught up, well, he says that's the way the cookie crumbles. As a result, there's a tendency to accede to internal pressures—to service or departmental loyalty—and this applies right on up to the secretary, who tends to think of himself as one of the boys."

Garwin, for one, believes the Defense Department could maintain a "first class" military force at $50 billion a year, some $35 billion less than it is asking. The Army, he said, could justifiably dispense with its costly tank development program and concentrate instead on antitank technology. The Air Force could do without AWACS, it doesn't need the AX counterinsurgency aircraft now on the drawing boards, and, heretical as it might seem, Garwin thinks the Air Force doesn't really need all the conventional fighters and bombers it has. Instead, he said, it ought to be pushing the development of remotely piloted, drone bombers and fighters. "Do we really need all those aircraft delivering POW's to the North Vietnamese?" he asked.

Finally, Garwin counts himself among the small but growing number of figures in science advisory circles who think the Navy's immensely expensive Undersea Long-range Missile System (ULMS) is premature at best. ULMS consists of both a sea-going intercontinental missile and a huge new submarine to carry it. The new sub fleet would begin replacing the present Polaris-Poseidon system in the late 1970's at an eventual cost, according to reliable estimates, of between $40 billion and $50 billion. This year the Navy is asking $937 million for ULMS development, at least partly at the behest of Admiral Hyman Rickover.

"Gradual development of a new missile makes some sense," Garwin said. "But I certainly don't think we need an ULMS boat for the foreseeable future. Who knows what the strategic requirements of the 1980's will be?"

That, of course, is precisely the problem. The Defense Department thinks it knows, and, as Flax and Garwin agreed, there are few persons outside the department with the interest or the competence to come forward with convincing arguments to the contrary. "Getting the requirements debate into the open," Garwin concluded, "is not a problem of opening up classified information. There's a lack of interest in the universities, in industry, and in the foundations."—ROBERT GILLETTE