

ginal existence that the \$70 million a year budget permits. Another researcher thinks that "dissemination," which will swallow about 40 percent of the free funds in fiscal 1976, shouldn't be NIE's business at all. Others argue that dissemination is a central *raison d'être* of NIE, and the institute has no business taking the taxpayers' money if it is going to rumble along generating "cognopsychological" knowledge that never, in the foreseeable future at least, finds its way into classrooms.

NIE administrators, however, are sounding considerably more optimistic than they were a few months ago. The legislation allows 20 percent of the personnel to be exempted from civil service requirements, which has permitted the institute to recruit a number of well-trained and talented individuals who would never have been attracted to OE. The basic research grants program, brought to a halt in fiscal 1975 for lack of money, is to be reestablished next year, supported by funds made available by termination of old OE contracts. This time, research grants will be targeted to subject areas designated by NIE, such as how children learn to read—an area in which

breakthroughs are said to be imminent.

NIE has been something of a madhouse throughout most of its existence, a victim of anti-Nixon sentiment, congressional skepticism, political maladroitness, the tardy appointment of its policy council, confusion over its basic purposes, the albatrosses inherited from other agencies, and inability, because of unexpectedly low appropriations, to formulate a long-term research program of its own.

There does, however, appear to be widespread feeling that the basic concept of a federal R & D establishment for education is a sound one—after all, as Brademas has repeatedly pointed out, only 0.3 percent of federal education funds have gone into R & D, compared with 1 percent in agriculture, 4.6 percent in health, and 10 percent in defense spending. Inasmuch as education in America is a \$100 billion a year enterprise, it seems as though a few more people ought to be given the wherewithal to sit around and think about how to improve things.

Senator Magnuson indicated a softening in his attitude toward NIE last November when he said he perceived "the beginnings of a recognition and

appreciation by NIE of the concerns of Congress." NIE's broad mandate theoretically gives the agency flexibility but also robs it of excuses not to stray into policy matters of interest to politicians, such as the effect of open enrollments, and collective bargaining for teachers. Brademas says he is open to suggestions for modifying the legislation so as to tighten the agency's focus and get people from more disciplines involved in "first class thinking" on the core problems. Advisory council member William Baker of Bell Laboratories agrees it might be well to write more "specificity" into the legislation. This might help NIE and Congress develop a common language, he observes—since both sides continue to suffer from failure to understand exactly what each other is talking about.

Those who envisioned NIE as a small, pristine research outfit free from political concerns will have to cancel their dreams. But NIE may be the country's best hope for giving educational research the multidisciplinary underpinnings as well as high quality brainpower that it needs to become a respectable and productive undertaking.

—CONSTANCE HOLDEN

Cruise Missiles: Air Force, Navy Weapon Poses New Arms Issues

Arms race critics and Pentagon planners have become so accustomed in the last two decades to locking horns over large-scale, costly weapons systems that a weapon of an entirely different character—small in size, relatively cheap, and barely out of the research stage—may seem hardly worthy of their attention. However, a handful of outside experts and members of Congress are viewing with increasing alarm a weapon known as the strategic cruise missile—a nuclear-armed device about the size and shape of a small telephone pole—which could dramatically alter the force structure and capability of the United States.

Critics and advocates say that the effect of the cruise missile on the

bomber force may be analogous to the effect that the MIRV (multiple independently targeted reentry vehicle) is having on the ballistic missile force. The strategic cruise missile offers, in short, a way to multiply quickly and cheaply the number of nuclear warheads that bombers and submarines can deliver to targets in the Soviet Union. The United States already has a number of short-range nuclear tipped rockets and older cruise missiles aboard its bombers, and these are targeted on the Soviet Union. But on the whole these weapons are larger and less accurate and, therefore, are of less concern to critics than the new cruise missile.

The new cruise missile can be launched from airplanes, ships, or sub-

merged submarines. Some people say that the air-launched version of the new missile has the potential to save the Air Force up to \$7 billion by substituting for hundreds of its manned bombers and accompanying tanker planes. The sea-launched version, designed to be carried by all U.S. submarines, is viewed by some arms controllers as undesirable, because the missiles would give the U.S. fleet of attack submarines a nuclear capability that it does not now have and, some argue, that it does not need.

A prototype of the new cruise missile will not fly for about another year; its components are still being refined and tested. However, military officials are optimistic that the missile will perform as planned, since most of the technology it will use is already in existence. The cruise missile, now in the development stage, will be a miniature, pilotless airplane less than 20 feet long and a little more than 20 inches in diameter. Powered by an air-breathing turbofan jet engine and equipped with wings that spread out after launch (see

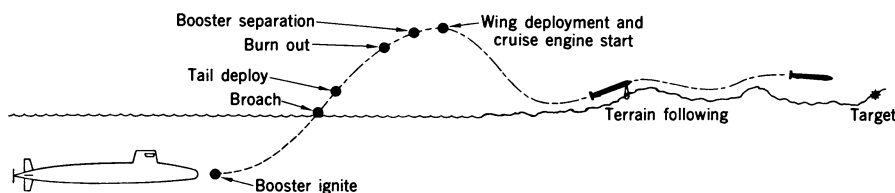


Illustration by Eleanor Warner

Both submarine-launched cruise missile (shown above in sketch) and air-launched version would have estimated maximum 1500-mile range.

illustrations), the missile will be able to guide itself to a target some 1500 nautical miles away and hit it with an accuracy of about 200 feet. Cruise missiles may be classified into two types, depending on the kind of warhead they are designed to carry: the nuclear-armed missile, which has been dubbed the "strategic" cruise missile, and that carrying conventional explosives, known as the "tactical" cruise missile. In a coordinated program that has cost \$118 million to date, the Navy and the Air Force are each developing strategic and tactical cruise missiles. The eventual cost per missile is estimated at \$500,000, relatively modest by Pentagon standards.

An important feature of the strategic cruise missile is that it will be able to fly at altitudes lower than the 555-foot high Washington Monument—and under the present Soviet radar and any the Soviets are likely to deploy. Even the new B-1 bomber probably could not do this. The cruise missiles are designed to travel at subsonic speed, and have radar and infrared signatures so small as to blend in with the background. Everyone seems to agree that this will make them virtually undetectable and equally difficult to shoot down. Hence, some Pentagon officials have nicknamed the strategic cruise missile "the ultimate deterrent."

The Pentagon justifies cruise missiles by arguing that the Soviet Union already has them aboard its planes, ships, and submarines. The Soviet Union's Versiens can range from 10 to 450 miles and, although certain types could be nuclear armed, most are believed to carry conventional explosives. For years U.S. military strategists have considered the Soviet cruise missiles as an unimportant part of their conventional warfare arsenal.

Some arms controllers oppose any development of long-range cruise missiles by the United States, arguing that if this country produces a new, superior generation of cruise missiles, the

Soviet Union will feel obliged to do likewise.

The idea of a nonballistic long-range missile is not new. The Germans had one, the V-1 buzz bomb, in World War II. Some of the U.S.'s first post-war missiles were crude and expensive cruise missiles of a sort. To fire the Regulus, for example, a submarine had to surface, the crew had to come out on deck to erect the missile, and then had to go below again to launch it.

During the late 1950's, research was progressing on inertial guidance for ballistic missiles, and military fashion followed this latter course; efforts to develop cruise missiles as part of the U.S. deterrent ended in the early 1960's.

The present incarnation of the cruise missile arose out of some work done by the Advanced Research Projects Agency (ARPA) in the late 1960's on a "jet belt"—an air-breathing jet engine which a soldier could strap on his back and fly around wearing. As a result of ARPA's interest, Williams Research Co. developed a miniature air-breathing turbofan jet engine. The Air Force, which has lead responsibility for the cruise missile engine development, has selected a modified version of this Williams engine for the missile. One reason for the certainty with which Pentagon strategists talk about the cruise missile's future capabilities is that

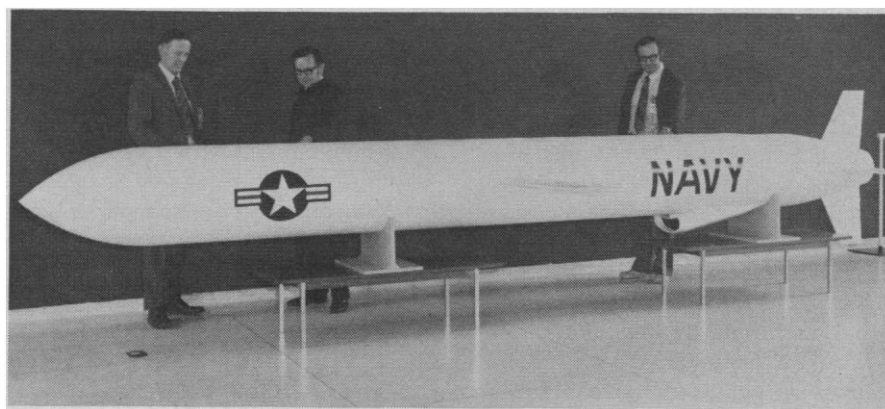
most of its components have already been developed and tested, such as the Williams engine.

Also well along in the development is the missile's terrain-following guidance system, called TERCOM by its manufacturers (E-Systems Inc.); TERCOM enables the missile to hug the ground and follow a programmed path. The system takes up approximately a cubic foot in the nose of the missile. A radar altimeter looks down at the ground and compares height readings with a digital contour map. Resulting directions are fed to an inertial guidance system which steers the missile.

TERCOM has performed well in tests. Last fall a Navy plane (with a pilot) left Patuxent, Maryland, and, guided only by a TERCOM system aboard, "found" its target (the Burlington, Vermont, airport), as well as numerous landmarks along the programmed winding route.

The cruise missile's accuracy compares favorably with both ICBM's and the Air Force's existing cruise missiles. Last April, Navy witnesses before New Hampshire's Senator Thomas McIntyre's research subcommittee of the Senate Armed Services Committee said that it can achieve an accuracy of 0.1 nautical mile, or 600 feet; but the accuracy of the missile could be closer to 200 feet. Television homing equipment can make the missile even more accurate. Kosta Tsipis (see p. 393), who is a senior researcher for the Stockholm International Peace Research Institute (SIPRI), and now working at MIT, said, "If you can acquire the target, it's dead."

Such fine accuracies clearly raise the possibility that cruise missiles could be used as a first-strike weapon against Soviet missile silos and military bases.



Mockup of Navy cruise missile.

With improvements in the missile's range—to 2000 or 3000 miles, which planners say is feasible, some large proportion of key Soviet targets could be struck. However, Air Force and Navy witnesses before Congress have adamantly insisted that the cruise missile is intended not for use as a first-strike weapon but as a retaliatory weapon.

The Navy contemplates putting the sea-launched cruise missile (SLCM) "on every submarine," according to Rear Admiral G. E. Synhorst. This would mean placing both the strategic SLCM's and the tactical SLCM's aboard the present force of several hundred attack submarines, which now carry only tactical weapons and whose mission is to locate Soviet submarines and to guard American shipping. There are also indications that the Navy is thinking of placing nuclear-armed SLCM's aboard its fleet of Polaris and Poseidon submarines as well.

Last April, in testimony before McIntyre's subcommittee, Synhorst explained how the Navy thinks the SLCM's would be useful and why they are a stabilizing deterrent.

The Soviets will always have to consider that even if they could get everything else, if they could target our SSBN's, if they had an ABM system, if they can target our Minuteman, we would still have every submarine torpedo tube we have at sea that can employ this missile. That should be stabilizing.

Toward this end, the Navy is considering production of perhaps 1000 SLCM's or, as project manager Captain Walter M. Locke told McIntyre's subcommittee, some number less than 2000.

Nobody objects to the shorter-range tactical cruise missiles which the Navy also plans to put aboard submarines as an antiship weapon. (The Soviet cruise missiles are ostensibly deployed to attack our ships and aircraft carriers.)

But the emplacement of U.S. strategic SLCM's on U.S. attack submarines would force them to stay within 1500 miles of targets in the Soviet Union, presumably hovering off the coasts of Scandinavia, the Middle East, Pakistan, or India.

Richard Garwin, an IBM physicist who has studied military questions for the now-defunct President's Science Advisory Committee, views any such coastal approach by the attack submarines bearing long-range strategic weapons as politically foolhardy. The countries whose coastlines are involved

will view the weapons as an unfriendly "message," Garwin believes, not unlike the Soviet's deployment of strategic weapons in Cuba in 1961. Tsipis says that the SLCM's may induce attack submarines to move closer in to shore, and this will "exacerbate the tension. At present, they try to keep those submarines out of other peoples' shores."

Air-Launched Cruise Missiles

The Air Force justifies the air-launched cruise missile (ALCM) as an addition to the present bomber force, which, when expanded to include the B-1, will consist of about 450 bombers and 450 tanker planes. Some 20 or 30 ALCM's could be carried aboard each plane. This proposed addition of thousands of cruise missiles has caused some strategists to compare the ALCM to the MIRV warheads which have vastly increased the strike capacity of the ICBM force. Giving the bomber force this much more firepower may or may not enhance the performance of its present mission, which is to fly over Soviet territory and attack military targets. But the main change wrought by the addition of the ALCM is that, with it, the bombers do not have to penetrate Soviet airspace in order to attack, with a high likelihood of success, military targets.

The ALCM force could number eventually as many as 2000 or 3000 individual missiles, according to published statements of military officials. Because the missile might make it unnecessary for bombers to fly into Soviet territory, the ALCM program has been interpreted by some as a threat to the Air Force's cherished program to build a fleet of new B-1 bombers at a current projected cost of \$18.5 billion. However, if the Air Force were to carry thousands of ALCM's on a smaller force of conventional bombers and cargo planes one expert calculates that the cost would be \$7 billion less, or \$11.5 billion.

Some Congressmen wonder whether the Air Force should be planning a "standoff" attack strategy using the ALCM. However, the Air Force, which is pursuing the ALCM program only at the insistence of Congress, maintains that it considers a standoff attack only one of several options. ARPA shares this view, as its head, Stephen Lukasik, testified last year:

Based on our analysis to date we do not view the ALCM as a replacement for a penetrating bomber force. Rather the ALCM, carried on a platform . . . like

the B-1 . . . can complement the bomber force and give us the option either to stand off with cruise missiles or to penetrate Soviet air defenses. Thus it is an option which could add a new dimension to our strategic deterrent.

Garwin, for one, advocates going all the way, entirely substituting the ALCM standoff force for the new B-1 bomber. For a Harvard University seminar group last fall he wrote:

The major influence of the ALCM would not simply be as another weapon for the existing bombers or for the B-1. It would rather be to avoid the necessity to develop the B-1 to have a survivable versatile new strategic bomber. The ALCM could be carried 100 to a 747 aircraft, 50 to a C-135 or a C-141, to provide as large a striking force as is desired, without the necessity of designing airplanes to penetrate Soviet air defenses at high cost and with rather uncertain results. . . .

In my opinion, this is the proper application of strategic cruise missile technology, and the ALCM in cargo aircraft, rather than the B-1, should be the successor to the current strategic bomber force.

There is, however, general agreement among outsiders and some Pentagon officials that the Air Force, as a bureaucracy which trains and supports thousands of pilots, will vigorously resist the suggestion that it substitute unglamorous cargo planes and cheap ALCM's for the traditional Air Force activity of preparing manned bombers to send against the enemy.

Despite its lack of popularity with the Air Force, the ALCM could ultimately prove useful as a hedge against future contingencies. For one thing, the recent Vladivostok accords put a ceiling on the number of air-launched missiles each side can deliver to the other. There remains a dispute of interpretation over whether the ALCM is included under this ceiling. According to recent news reports the Soviet side interprets the accord as including the ALCM but the U.S. side contends that it applies only to ballistic missiles. The question is expected to be taken up in Geneva, where details of the accord are now being refined.

If the long-range strategic cruise missiles, air-launched or sea-launched, escape the Vladivostok accord's ceiling, they could engender an arms race with the Soviet Union just as the ICBM did more than a decade ago. And although these cruise missiles have the potential to make our airborne attack forces more efficient and less costly, their impact in other respects could be less than beneficial.—DEBORAH SHAPLEY