

Patriot's Scud Busting Record Is Challenged

MIT weapons analyst Theodore Postol sees an ominous lesson: Cheap decoys may befuddle costly defenses

FIRST IT WAS NORMAN SCHWARZKOPF WHO took a hit to his public image when he got embroiled in a postwar flap with the president over the timing of the ceasefire in Iraq. Now it's the Patriot missile—the mechanized champion of the war—that's had its reputation injured after becoming entangled in a debate over the future of the Strategic Defense Initiative (SDI). Sometimes, it seems, war heroes have a hard time staying heroic, especially when they get caught up in politics.

The recent flap began when advocates of SDI started touting the Patriot's record as a

weapons manufacturer to add a "decoy package" to future missiles, enabling them to distract the kind of homing device used on the Patriot. Whether an improved version of the Patriot could overcome decoys is an unanswered question, and one that should be investigated, Postol says.

Postol, an expert on missiles and arms control, bases his view on an analysis of data put together by the Israeli newspaper *Ma'ariv*, chiefly a record of Patriot hits and misses in Israel, along with associated damage reports. (Neither the U.S. nor the Israeli government has released an official analysis of its own.) Although the *Ma'ariv* data may not be definitive, they are the best available, and, according to another missile expert at Tel Aviv University, Reuven Pedatzur, they are reasonably accurate.

Citing the *Ma'ariv* figures, Postol told the House Armed Services Committee on 16 April that there were three major problems with the Patriot's performance in Israel. One was that the Patriot's homing device seems to have been confused by pieces that broke away from the Scuds as they came in and so failed to target consistently on the warheads. This could be particularly bothersome for future antimissile

programs—including SDI—because it indicates that defenses could effectively be spoofed by the use of decoys. Second, the successful hits sprayed lethal Scud fragments over a wide area, possibly wider than would have been affected by an unopposed warhead. Third, because Patriots operate at a relatively low altitude, they sometimes followed targets to the ground, adding their own debris and possibly their explosives to the damage done by Scuds.

If correct, Postol's analysis may have significance not just for war historians but for future decisions on the Patriot program and on successor technologies, such as a more sophisticated system called the Arrow, now being developed jointly by Israel and the U.S. Army. The goal of the Arrow project is to create an antimissile weapon capable of striking missiles at a greater altitude than the Patriot (up to 40 kilometers rather than

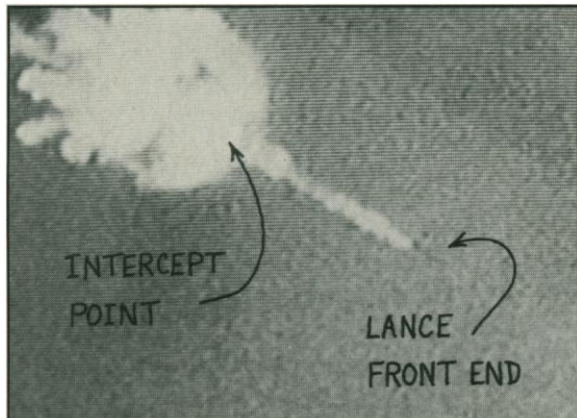
around 5) and reaching a longer range (100 kilometers rather than 10 to 20). The total expenditures on the Arrow since research began in 1988 are \$158 million, 80% paid by the United States. According to Pedatzur, it could cost \$2 billion to \$3 billion to manufacture the Arrow for deployment in Israel, if such a program were approved. To be effective, the Arrow would have to overcome the decoy problem.

Official claims, according to Postol, indicate that 158 Patriots were fired during the war, and that they successfully stopped 45 of 47 Scud attacks. Forty of the Scuds were aimed at Israel, mainly at Tel Aviv. Before the Patriots were used, Postol says 13 Scuds fell unopposed near Tel Aviv; they wounded 115 people and damaged 2698 apartments. After the Patriots went into action, another 11 Scud attacks occurred in this area, killing one person, injuring 168, and damaging 7778 apartments. So while the number of attacks dropped 15%, injuries grew nearly 50% and the reports of damaged apartments tripled.

While other defense analysts have not gone as far as Postol in questioning the Patriot's record, many agree that the weapon's effectiveness as an antimissile system may have been hyped. Independent military analyst Pierre Sprey, for example, says the record is still cloudy. "Given that the taxpayer has already spent nearly \$15 billion on Patriot," said Sprey, "I think it would not be unreasonable for Congress to demand a shot-by-shot accounting of Patriot versus Scud encounters...."

After mulling over Postol's criticism for a few days, the Patriot's manufacturer—the Raytheon Company of Lexington, Massachusetts—fired off a verbal rocket of its own last week. On 25 April, Robert A. Skelly, Raytheon's vice president for public and financial relations, sent a statement to reporters over fax machines, charging that testimony by Postol and others was "inaccurate" and based on "unsubstantiated" data.

But Raytheon's statement also seems to give some support to Postol's analysis. It confirms that the two problems he identified—the speed and scattered nature of the targets presented by the Scuds—were significant. Skelly said the Patriot's job was made "very difficult" in the Gulf because it was being used for a job it was not designed to do. The Pentagon conceived the Patriot in the late 1960s as an anti-aircraft weapon. Then, in the 1980s, Raytheon improved the electronics and the warhead to enable the missile to destroy faster targets—such as short-range ballistic missiles. As Skelly says, this revised "PAC-2" Patriot was meant to stop the type of Soviet missiles allowed by the Intermediate Nuclear Forces Treaty—that is, missiles "with ranges less than 500 kilometers." But in the



Missing the point? An early demonstration film shows the Patriot intercepting a Lance missile but apparently failing to knock out its warhead.

Scud killer in Israel as proof that antimissile systems in general have become highly effective. The SDI chiefs are trying to persuade Congress to boost the project's budget from \$2.9 billion to \$5.2 billion this year. But the Patriot was never part of the SDI program, and the targets it is designed to hit—originally airplanes and, more recently, missiles armed with conventional explosives—are physically much less challenging than the nuclear warheads that an SDI system would have to stop. So when SDI's leaders became effusive in their praise of the Patriot, Theodore Postol, a defense analyst at the Massachusetts Institute of Technology, decided to take a closer look at what the Patriot accomplished.

Postol reached a couple of jarring conclusions: First, that Israel might have been better off if it had never fired any Patriots at all, and second, that it would be relatively easy for a

Persian Gulf, the Patriot went against a more formidable adversary, Saddam Hussein's homemade "Al-husayn," a modified version of the Soviet SS-1 or Scud. Its range is longer (more than 600 kilometers) and its reentry speed is greater (around Mach 8).

The crudeness of the Scud, Skelly confirmed, worked to its advantage. The U.S. forces were aware that the increased speed of the Al-husayn would challenge the Patriot's capabilities, and so they relied heavily on satellites and other high-powered radar systems to spot and track Scuds at launch and early in their trajectory. What the experts didn't anticipate, though, was that the Iraqi missiles were so ill-made that they would fall apart in flight. As Skelly put it, "Due to poor

workmanship, Iraqi Scuds fired at Saudi Arabia and Israel began to break apart during the downward reentry portion of their trajectories, at altitudes of 15 to 20 kilometers." This meant that the Patriot radars picked up many targets, a situation that often causes electronic homing devices to take an average aim at the center of a pattern—not at the crucial part, which in this case would be the leading edge of the missile. To cope with this problem, Skelly said, Raytheon made "rapid software changes" during the war. He claims that as a result, "about half of Scud engagements by Patriots resulted in confirmed destruction of the Scud warhead, as assessed by Israeli Defense Forces." Skelly believes the record was even better in Saudi Arabia, where

"just under 90%" of the engagements ended with destruction of the Scud warhead.

This interpretation does not gibe with Postol's information or with the informal opinion of Pedatzur, who says the word in Israel is that the Patriot's success rate in striking warheads, as opposed to the bodies of the missiles, was "very, very low." But Postol himself warns that everyone involved in this debate has an ax to grind, including the Israelis, who are eager to move on to production of the Arrow. This is shaping up into a major debate on the effectiveness of high-tech weaponry that would benefit from an open and impartial review—one which, at this writing, no one is planning.

■ ELIOT MARSHALL

Conventional Math Tests Get Low Marks

Last week, a group of educators, policy makers, and politicians got together at the National Academy of Sciences to rid themselves of their math anxiety. The focus of their concern: Current standardized tests do not adequately assess the ability of U.S. students to solve real world problems.

Though students and teachers have been grumbling about the efficacy of math tests for years, the problem has become acute as curricula are being revamped to put more emphasis on concepts. That makes most standardized tests anachronisms: They still basically assess a student's ability to manipulate numbers. Said Shirley Hill, a mathematician at the University of Missouri at Kansas City, in her keynote address, "What we test is usually what we teach." But, she added, that is not the case today.

There's little disagreement in the education community about the need for new tests and new ways to measure a student's mathematical abilities, but so far reform has been slow. So last week's gathering, grandiosely called the National Summit on Mathematics Assessment, was an attempt to nudge things along. In a sense, it was a show of force from the nation's top education officials—including Education Secretary Lamar Alexander and President Bush, the self-described "education president."

The summit members drafted a statement resolving to focus on developing new assessment instruments for early math education, including a call to eliminate multiple-choice tests for students below the fourth grade. And the statement calls for a variety of tools to be used in assessing mathematical achievement, including portfolios of student work and group work, and the incorporation of problem-solving tools such as calculators and computers into the new assessment mechanisms. Finally, it reasserted the notion that questions on standardized tests should probe reasoning (see example in box).

Summit organizers couldn't have chosen a more propitious time for their meeting. The summit followed on the heels of

President Bush's announcement of "America 2000," an ambitious, if ill-funded, plan to "reinvent the American school." Bush, who addressed the summit, reiterated his intention to make American students, "first in the world in math and science by the year 2000." But, he added, "the federal government can only play a limited role. Dollars alone won't get the job done." Among the tools that will facilitate the process, said Bush, is an American Achievement test in the five core subjects—English, mathematics, science, history, and geography—and he challenged summit participants to have a math test for fourth graders ready by 1993. The tests, Bush said, should not "weed kids out" of the drive to be "world-class," but should "promote better math skills for all."

However, whether "all" would be best served by a blanket national exam or by more local assessment was a matter of heated debate. In a session following the president's speech, Colorado Governor Roy Romer questioned whether a national test would be sensitive to differing needs of students in different regions. He proposed instead that four or five regional "assessment instruments" be administered to a "logical grouping of states in the nation."

With debates like this one over basic implementation strategies, this summit agreement will be hard to consummate. Moreover, as education consultant Joan Barron of the Connecticut Department of Education noted, the actual task of developing multifaceted, real world assessment tools may be easier said than done. In her own state, where new forms of assessment are being tried, she said educators found "it was difficult to 'mathematize' the world." "It is difficult to come up with questions that employ multiple strategies." So, the group that convened to discuss math may have gotten a lesson in epistemology. The answer to the question "How will we know that they know what they ought to?" may have to await the next summit.

■ MICHELLE HOFFMAN

A Real World Math Question

Instructions: Use this sheet to solve this problem. Write a complete justification of each solution.

For an upcoming sports vacation, the Smith family has budgeted \$250 for some new sports clothing for their children, Mike and Karen. Mike would happily spend the entire \$250 on a new pair of sports shoes. Karen wants two new designer sports outfits that cost \$85 each. However, Mike must have at least one pair of sports shoes and two athletic shirts. Karen must have at least one new sports outfit, a pair of sandals, and two sweatbands. The sports clothing must be purchased from mail order catalogs.

Use at least three different mail order catalogs to develop two different purchasing plans that you think would satisfy both Mike and Karen. Write a justification for each plan and include shipping charges and tax.

Source: Mathematical Sciences Education Board