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THE LAUCKS FOUNDATION

from time to time calls attention to published material that might contribute toward clarification or understanding of issues affecting world peace. The accompanying reprints constitute Reprint Mailing No. 80.

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February 24, 1986

The following is an excerpt from Senate Resolution No. 227, submitted on September 23, 1985 by Sen. Claiborne Pell for himself and Sen. Richard Lugar, urging a joint United States-Soviet effort to achieve worldwide disease immunization by 1990:
(Congressional Record, September 24, 1985)

Resolved, That—

(1) the United States and the Soviet Union should immediately undertake a formal commitment to initiate, using their own resources and those of other donors and appropriate multilateral agencies, a joint effort to bring the benefits of immunization to all children of the world by the year 1990;

(2) this joint world immunization effort should be undertaken in a spirit of common dedication to a transcending humanitarian purpose, and with the practical hope that such constructive collaboration may also serve as a model for further superpower cooperation.

(Reprinted from PSR Reports, Fall 1985, pp.2-4. Physicians for Social Responsibility, 639 Massachusetts Ave., Cambridge, MA. 02139

The Last Mistake

– William Ury

There is a story of a man who left seventeen camels to his three sons. He left half the camels to his first son, a third to his second, and a ninth to the third.

Despairing of their ability to negotiate a solution – because seventeen could not be divided by two or three or nine – the sons finally consulted a wise old man. After pondering the question, the old man announced, "I don't know if I can help you, but at least take my camel." That way the sons had eighteen camels. The first son took his half – that made nine. The second took his third – six – and the third son took his ninth – two. Nine and six and two made seventeen. They had one camel left over. They gave it back to the old man.

Like the seventeen camels to be divided, the nuclear dilemma at first seems intractable. If President Reagan and General Secretary Gorbachev are to find the beginning of a way out at the Geneva summit, they need, like the wise old man, to step back from the problem, look at it from a fresh angle, and find an "eighteenth camel."

Applied to the nuclear dilemma, an "eighteenth camel" would need to meet four tests. It would have to:

1) reduce the risk of nuclear war.
2) be practical and easy to implement.
3) be politically acceptable not only among liberals and conservatives in the US but also between Washington and Moscow.
4) get the ball rolling. It does not need to be a comprehensive solution, but it does need to be an entering wedge.

Does such an approach exist? I believe so. One possible candidate is that the United States and the Soviet Union work intensively together in their common interest in preventing an accidental war.

A New Crisis Control System

To reduce the likelihood of unintended nuclear conflict, the superpowers should establish two crisis control centers in Washington and Moscow, linked by the most modern telecommunication technology. In times of crisis, the centers would function together like the emergency room of a hospital, providing the principals with a place and resources to deal with the problem effectively and expeditiously. During calmer times, the centers would play a preventive role, monitoring potential problems and ensuring that early warning signs are addressed.

The centers would form the core of a comprehensive crisis control system, which would also include:

- intensive training in crisis management for top leaders;
- regular summits between US and Soviet foreign and defense ministers;
- a host of agreed-upon emergency safety procedures;
- an international mediation service to keep Third World conflicts from escalating into superpower confrontations.

Taking this path would mean creating a new operational dialogue with the Soviets. In the current Geneva talks, the two delegations meet twice a week to discuss limiting arms at some future date. In the new dialogue, American and Soviet diplomats and military officers would work around the clock to prevent war now. They would discuss how to stop nuclear weapons from falling into the hands of terrorists, how to avert tragedies like the downing of Korean Air Lines flight 007 or the shooting of Major Nicholson, and how to prevent the inadvertent triggering of a war from, for example, a nuclear detonation whose source is not known. In effect, the goal of this new dialogue would be to create a system under which US and Soviet officers would share a joint mission: the prevention of the last mistake.

Now, does this approach meet the four requirements for an "eighteenth camel"?

Will It Reduce the Risk of War?

Experts are coming to agree that the greatest nuclear danger stems not from a coolly calculated surprise attack – both governments realize that would be suicide – but rather from the runaway escalation of a crisis. A war breaks out in the Middle East. A terrorist group gets hold of nuclear weapons. A third country detonates a nuclear bomb in an American city to provoke a war between the superpowers and hence rid the earth of the "two great Satans." Whatever the precise trigger, the crisis leads Washington and Moscow under intense time pressure into a fatal series of miscalculations, miscommunications, and organizational snafus. Expecting an imminent attack and seeing no way out, one side presses the button.

For forty years, the US and the USSR have been preparing to prevent another World War II. But another World War I, a global war no one wanted, may be the greater danger. This is precisely the problem a crisis control system would address.

Is It Practical?

Many fear we cannot work together with the Soviets on a shared problem like preventing accidents. The truth is we already do. Consider the communication that goes on every day between the US and Soviet navies. The naval vessels and tracker planes of both nations follow each other, sometimes dangerously closely, all over the world. In the late 1960s and early 1970s this practice had turned into a game of chicken on the high seas. The intimidating behavior included the aiming of ship guns and missiles at an offending vessel. Since 1972, however, with the signing of the Incidents at Sea Agreement, such encounters are much rarer.

Captains in both navies now have rule books that tell them how to communicate with each other and how to avoid accidents. At least once a year, high-ranking American and Soviet officers meet to review the process. This low-profile professional communication goes on regardless of the state of political relations. Now the exception, this kind of operational dialogue should become the rule.

Is It Politically Acceptable?

In June 1984, the Senate, led by Sam Nunn of Georgia and John Warner of Virginia, voted to urge the President to put the crisis centers proposal on the negotiating agenda with the Soviets. The vote was 82-0; the proponents included everyone from Edward Kennedy to Jesse Helms.

In July, one month later, American and Soviet negotiators reached an agreement to improve the Hotline. In November, the Aspen Institute International Group, which included former European heads of state, called for creating a network of crisis control centers.

In April 1985, Ambassador Dobrynin, in a joint statement with former presidents Carter and Ford, agreed that the US and USSR "should address with the utmost priority the question of establishing mechanisms aimed at crisis prevention and crisis management."

In May, President Reagan called for regular talks between Soviet and American military leaders and for a military-to-military Hotline to prevent potential tragedies. In August, the Administration made the centers (in a limited form) an official policy goal.

A week later, General Secretary Gorbachev said the idea "demands attention."

Crisis control is thus not only common →

sense, but also common ground.

Will It Get the Ball Rolling?

Crisis control is by no means a complete answer. It is just a start—to buy us the time needed for longer term approaches like arms reductions and improving US-Soviet relations. The question is: can it serve as an entering wedge?

In the Geneva negotiations, the United States and the Soviet Union are trying to talk about the trickiest issues of all: nuclear arms and space weapons. These are critical issues but, with such a low level of confidence in each other, neither side is likely to take the political risks necessary to negotiate flexibly enough to reach agreement. To build the needed confidence, they ought first to look for easier agreements, such as ways to prevent accidental war.

Twenty-two years ago, the superpowers found themselves at a similar impasse. They were just emerging from the Cold War. They had been talking about disarmament in Geneva for fifteen years with no progress. Both sides were looking for a way to break the stalemate.

They found it in June 1963. They agreed to install a Hotline for direct communication between the White House and the Kremlin in times of crisis. As the first concrete bilateral measure to prevent war, the Hotline agreement changed the climate from endless deadlock to potential cooperation. Within months came the signing of the Limited Test Ban Treaty, and the slow process of arms control began.

Today, crisis control centers and other measures to prevent accidental war offer Ronald Reagan and Mikhail Gorbachev a similar opportunity to break the deadlock and reduce the risk of war.

Reframing the Issue

Crisis control meets the four requirements for an "eighteenth camel." It also performs one other useful role: it reframes the nuclear issue.

The problem of deliberate nuclear war, which currently draws most of the attention, both public and governmental, puts us in a face-to-face confrontation with the Soviets. Since the issue is seen as "Will they kill us? Will we kill them?" it immediately brings to the surface the deep distrust each side feels for the other. Progress becomes painfully slow.

In contrast, the issue of accidental war puts us and the Soviets on the same side of the table facing our common problem, accidental war. Neither side wants an accidental war. Working together on this issue depends not so much on trust as on each side's narrow self-interest. Accidental war can thus serve as a common enemy, somewhat as Hitler did for both nations in the Second World War. Progress in reducing the risk of war becomes easier.

What Physicians Can Do

Physicians and psychiatrists have a critical contribution to make since the danger of accidental war stems in good measure from the human factor: people making mistakes under stress. This is an area ripe for psychological study and recommendations.

By the very nature of their profession, moreover, physicians are crisis controllers. They constantly cope with life-threatening emergencies and try to find ways to prevent them from occurring in the first place. A global crisis control system involves putting into practice the same commonsense measures of training and prepared safety procedures that the medical profession takes into the realm of individual health.

With so little known about crisis and crisis control in the nuclear arena, physicians are uniquely situated to offer suggestions as we begin to fashion a system to prevent accidental war.

At this time of poor US-Soviet relations, it is public support that has helped bring about the current progress towards a crisis control system. It will take a further show of support, more letters and resolutions, to make the system a reality. But the goal is within reach.

A Parting Image

Last April, in San Francisco, a man went out for a sail. His boat capsized under the Golden Gate Bridge. The man set off some flares but the passing freighters didn't see them. One cannot survive for very long in the freezing Pacific; his chances didn't look good.

However, he had an emergency radio beacon. He sent a message for help. The signal was picked up by a Soviet satellite passing overhead. The Soviet satellite relayed the message to Scott Air Force Base in southern Illinois. Someone there read the message and called the Coast Guard in San Francisco, which sent a helicopter to rescue the stranded man.

If the United States and the Soviet Union can cooperate like that to save a single human life from a boating accident, then surely we can find it within our powers to cooperate to save all human life from the ultimate accident.

I believe we can. I believe we can find that "eighteenth camel." And I believe that working together on crisis control is one such "eighteenth camel" that could get us moving towards a safer world.

William L. Ury is Associate Director of the Avoiding Nuclear War Project at the Kennedy School of Government at Harvard. He is co-author of Getting to Yes. *His most recent book is* Beyond the Hotline: How Crisis Control Can Prevent Nuclear War *(Houghton Mifflin 1985). This article is adapted from a speech he gave last April at a PSR conference on the psychological aspects of the arms race held in Washington DC.*

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STAR WARS ONCE WAS!

Administrative spokesmen are fond of defending the Star Wars program by asking rhetorically: "Why are the Soviets worried if it is so certain that it won't work?" History and a semantic analysis of the words "work" and "it" provide an easy answer.

In the first place, it is obvious that if "work" means the U.S. can reasonably rely upon the system carrying out its purpose, then it cannot "work." No system, based on any physical principles, can be reasonably expected to fulfill its function if that function cannot be tested repeatedly and realistically, and if it is to eliminate hundreds of missiles and thousands of warheads fired against it with unknown tactics.

But "work" is the least of the obstacles; the real problem is "it." Star Wars proponents are fond of assuming that "it" is some system when, in fact, "it" is a "strategy"—the strategy of defending the United States against nuclear war. Such a strategy requires many systems at any one time and, even more serious, requires a series of systems over decades as each system is neutralized by new generations of Soviet scientists.

For example, let us assume the miracle that a U.S. system would shoot down all Soviet ICBMs and their warheads and, in addition, do it with complete reliability known to us in advance. Let us assume the further miracles that this system would do the same with Soviet nuclear-armed cruise missiles and Soviet nuclear-armed bombers. "Now," Star Wars proponents would say, "we're getting somewhere."

The Miracles Move Us Backward

In fact, we would simply have moved backward to the late 1940s when we had the atomic bomb and, because they did not, we had a perfect defense. What happened then?

Did we, as Bertrand Russell once suggested, launch a preemptive nuclear attack to prevent the contest from developing to its present deadly overkill? We did not. And certainly we would not do so now.

So what happened then would happen again. The Russians just waited—waited until they could assimilate the new technology. In a few years, they had the atomic bomb. Similarly, in a few years, appraised of the technology we were using for our Star Wars defense, they would find ways of neutralizing it.

For a few years, in our miraculous scenario, we would indeed have a defense. But even in this scenario we would have purchased defense for a few years at the cost of an accelerated arms race for many more years with weapons that are likely to be ever more hair-trigger and dangerous.

This analysis explains why the Russians can be worried even though "it" won't work. "It" won't work precisely because the Soviets will hold up their end of a struggle to prevent the strategy "it" represents from working. And so, while we and they know quite well that no lasting total defense can work, it does require them to run a new round of arms race. They are right to oppose it—and indeed they are saying nothing more than was brought to their attention about defensive systems by American scientists in the period 1963-1972 when the present ABM Treaty was debated and accepted.

The Star Wars program is, really, a national hoax. As the then-Undersecretary of Defense, Richard DeLauer, put it with courageous candor, "With unconstrained proliferation of Soviet missiles, no defensive system will work." And there is simply no reason to believe that the Soviet Union would confront our defensive efforts with anything other than unconstrained proliferation of offensive weapons. Surely we would not!

It is embarrassing to see so many of the Washington fish explaining how grand it is to swim in this new direction when, one day before the President spoke, they were exclaiming how grand it was to swim in another offense-dominant direction—so long as they could have a bit more offensive firepower in the MX.

There is not going to be an end to technological history timed precisely to the day when we get our Star Wars defense. Never has the fallacy of the last move been made in such a grand fashion as it has been made by President Reagan. And rarely in this splendid democracy have so many failed to denounce what, in their hearts, they know is wrong.—JJS *(Jeremy J. Stone, Director FAS)*

The following is an excerpt from "The President's Choice: Star Wars or Arms Control" by McGeorge Bundy, George F. Kennan, Robert S. McNamara and Gerard Smith, from Foreign Affairs, Winter 1984/85, p. 269:

The inescapable reality is that there is literally no hope that Star Wars can make nuclear weapons obsolete. Perhaps the first and most important political task for those who wish to save the country from the expensive and dangerous pursuit of a mirage is to make this basic proposition clear. As long as the American people believe that Star Wars offers real hope of reaching the President's asserted goal, it will have a level of political support unrelated to reality. The American people, properly and sensibly, would like nothing better than to make nuclear weapons "impotent and obsolete," but the last thing they want or need is to pay an astronomic bill for a vastly intensified nuclear competition sold to them under a false label. Yet that is what Star Wars will bring us, as a closer look will show.

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Experts Cast Doubts on X-ray Laser

The jewel of the "Star Wars" missile defense program fails to glitter

At the Lawrence Livermore National Laboratory, east of San Francisco, nearly a hundred scientists are hard at work on what they hope will be the most potent and cost-effective weapon in the Strategic Defense Initiative (SDI) arsenal. This weapon, when lofted to a distant point in space, will be capable of firing laser beams to destroy tens, if not hundreds, of Soviet ballistic missiles all at once, its proponents claim. If successful, it would go a long way toward fulfilling the dream of a missile shield envisioned by President Reagan in his historic 1983 "Star Wars" speech.

Edward Teller, who touted the weapon to the President well before his speech, describes it as the "most novel and potentially the most fruitful" missile defense technology under investigation. Similarly, Lowell Wood, a physicist at Livermore and protégé of Teller's who helps direct the research effort, regards it as "the most robust means of strategic defense that has yet surfaced." Last March, Richard Wagner, an assistant to the secretary of defense for nuclear energy, told the House Appropriations Committee that the weapon "is, in fact, very much at the center of our thinking."

The object of this enthusiasm is an x-ray laser, the nearest to fruition of all the so-called third-generation of nuclear weapons. The shared goal of these weapons is to harness the energy of a nuclear detonation and focus it on a specific target instead of dispersing it in all directions. An x-ray laser, for example, is created when x-ray and gamma radiation from a nuclear detonation is directed onto rods of lasing material, causing some atoms to lose their electrons. The electrons that remain are then briefly "excited," or moved to an orbit of higher energy. As the electrons return to a normal state, additional x-rays are generated, and a "cascade" of coherent light radiation is thus created and emitted in the direction the rods are pointing.

Lasing occurs only momentarily, as the entire weapon is obliterated by the effect of the shock wave within a millionth of a second or so. Theoretically, the beams can heat the skins of enemy missiles as hot as the sun, causing violent, extremely rapid evaporation. This in turn generates a rebounding shock wave that can cause the missile to buckle and break up. The only problem is that the beam is incapable of easily penetrating the earth's atmosphere, so both the bomb's detonation and the missiles' destruction must occur at an altitude greater than 100 kilometers.

Recognizing the potential usefulness of such a weapon, the Department of Energy has given the program a high priority. Next year, it will spend roughly $100 million on x-ray laser research, more than triple the amount spent in 1982. The Defense Department is also enthusiastic. Next year it will increase its support from roughly $7 million to $20 million, and the following year it will spend $35 million. The possible value of such weapons has also not been lost on the White House, where the need to conduct underground x-ray laser tests is seen as an enduring obstacle to agreement with the Soviet Union on a comprehensive test ban.

Curtis Hines

"Every time we look at it, it seems very difficult to ensure the survivability of space-based assets."

Elsewhere in the defense community, however, there is growing skepticism about the x-ray laser. In the wake of several disappointing tests, as well as a detailed study of potential countermeasures, many weapons analysts and engineers have concluded that the weapon will be incapable of attacking Soviet missiles in the boost phase, while they are easily tracked and still carrying warheads and decoys. The deployment of a defensive system with this capability is considered by many to be crucial to the success of the overall Strategic Defense Initiative (SDI) goal.

Paul Robinson, the principal associate director for national security programs at Los Alamos National Laboratory, believes that the x-ray laser is flawed because it might inadvertently wreak havoc on other SDI components in space. Similarly, Curtis Hines, a department manager for systems analysis at Sandia National Laboratory, believes that its range and power will be inadequate for boost-phase missile defense. And Edward Gerry, a former directed-energy manager for the Defense Advanced Research Projects Agency and a key member of the influential Fletcher panel on SDI (*Science*, 25 November 1983, p. 901), is skeptical about the practicality of any defensive nuclear weapon that may have to be detonated within seconds after a Soviet nuclear attack has begun.

Some of this skepticism extends, moreover, to other defensive weapons that might be used against Soviet missiles during the boost phase. "Yes, I think boost phase [defense] may be out of the question," says Hines, "which is unfortunate. There is a lot to be gained by it." The difficulty, according to Hines and others, is that the x-ray laser, like any defensive weapon intended for boost-phase attack, must either be based in space or swiftly launched upon warning of an attack, and neither choice seems practical.

So far, these pessimistic judgments by weapons designers have escaped wide public notice, partly because of the intense secrecy that enshrouds the x-ray laser program. Perfunctory documents explaining the program to Congress this year received an extremely high classification, and the Federal Bureau of Investigation was called in to investigate the source of a brief news account of the program last June. But stirrings of unrest are nonetheless evident in Congress, where this spring an attempt was made to end the research effort on the grounds that the government has no business preparing for the deployment of nuclear bombs in space. "The Administration talks about all this as a non-nuclear defense, a program to rid the world of nuclear weapons," says an aide to Representative Thomas Foglietta (D–Pa.), who sponsored the attempt. "The question is what are they selling?"

Foglietta's amendment would have blocked all "development, demonstration, test or evaluation of . . . weapons powered by nuclear explosions in space," and as a result it created considerable anxiety in the office of William Hoover, then the assistant secretary of energy for defense programs. But Hoover was able to hammer out an agreement about the importance of x-ray laser research with his counterparts at the Defense Department, and release it on the day before the amendment was considered on the House floor. Foglietta then agreed to alter the provision so that it merely barred "advanced development" that is inconsistent with existing arms treaties, effectively allowing the research to proceed without constraint.

Since the program formally got under way in 1980, there have been only a handful of underground tests, the most recent of which is said to have cost roughly $30 million. At least three are known to have been either unsuccessful or indeterminate because monitoring equipment malfunctioned. The most recent test, held on the second anniversary of Reagan's 23 March speech, was reported in the *New York Times* to have demonstrated a dramatic increase in laser beam brightness. Subsequently, however, lab researchers discovered that key monitoring equipment had been improperly calibrated, rendering this judgment uncertain. In addition, a new defect in beam collimation cropped up, apparently caused by an acoustic disturbance of the lasing medium. A vigorous search for alternative lasing rod materials is under way, and plans have been set to reduce the laser's considerable mechanical complexity, as well as to boost its relatively low efficiency and power, according to several scientists familiar with the program.

Despite these rumored difficulties, Lowell Wood, for one, remains unfailingly upbeat. "Obviously, we aren't satisfied with where things stand, or we would have pushed the weapon out the door and we wouldn't be doing a lot of work that we are manifestly doing," he says. "Where we stand between inception and production I can't tell you . . . [but] I am much more optimistic now about the utility of x-ray lasers in strategic defense than when we started." In particular, he adds, there has been "very substantial improvement, relative to where we started" in laser beam fractionation and brilliance.

George Miller, the deputy associate director for nuclear design at Livermore, is more cautious, however. The scientific goal of bomb-pumped x-ray lasing has indeed been achieved, he says. "But what we have not proven is whether you can make a militarily useful x-ray laser. It's a research program where a lot of physics and engineering issues are still being examined. . . . There's a lot of work to do, not the least of which is actually designing the system, not just the laser itself."

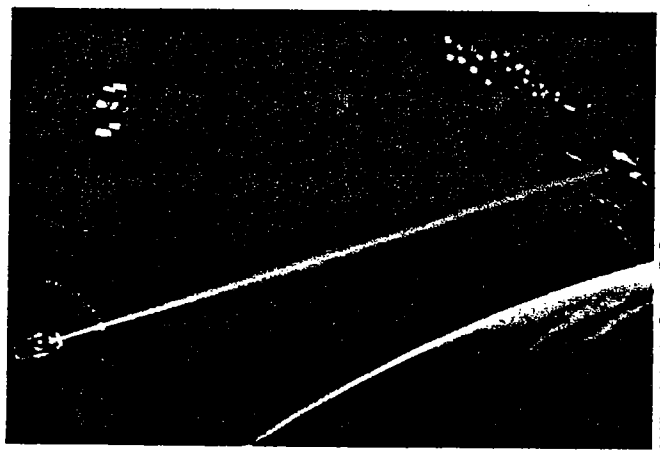
Indeed, it is precisely this challenge that worries the experts most. Under one approach, the United States would use the x-ray laser to attack Soviet boosters from permanent battle stations in space. Steven Rockwood, the director of SDI research at Los Alamos, spells out the immmediate political drawbacks. "What would you think if this satellite is passing over Washington 5 times a day and you know it's carrying a nuclear weapon? Will you trust me that it's only a defensive weapon, and not something that can be dropped on your head without any notice or warning? I don't think the Soviets in their paranoid attitude will ever believe what we tell them."

Curtis Hines of Sandia explains the principal military drawback. "Every time we look at it, it seems very difficult to ensure the survivability of space-based assets," he says. One important threat is the x-ray laser itself. Although the Soviets are thought to be behind the United States in x-ray laser development, there is a widespread presumption that if the United States builds one, they will too. The Soviets could then use their lasers to attack those based in space, even while they remain protected by the earth's atmosphere.* Such an attack "could present a serious threat to space-based assets and seriously disrupt our plans for defense," says Cory Coll, the director of SDI systems analysis at Livermore. Miller and Robinson both agree.

The alternative is to deploy the x-ray laser atop numerous land and sea-based missiles, ready for instantaneous launch on warning of a Soviet attack. In one sense, the laser is ideally suited for this mission, being substantially lighter and more powerful than virtually any other type of defensive weapon. "I don't know of anything that has that combination of lightweight power supply and speed of light kill," says Gerald Yonas, SDI's chief scientist. "What else is there?"

But here, too, there are serious drawbacks. Due to the laser's inability to penetrate the atmosphere, the missile carrying the x-ray laser must outrace that carrying nuclear warheads and fire when both are in space. This requires at a minimum an elaborate, virtually perfect warning system. Even then, ordinary procedures for presidential consultation would have to be short-circuited, a circumstance that may prove politically unpalatable. "Personally, I have trouble with any system that requires hair-trigger launch of a nuclear weapon," says Edward Gerry. Rockwood agrees. "I have not seen a scenario that uses nuclear directed-energy weapons that is politically acceptable and gets into the early part of a war," he says.

If the political obstacles can somehow be overcome, the Soviets could sharpen the technical difficulties by developing and deploying rockets substantially faster than those they have at present. This would require that the lasers be stationed at sites close to Soviet territory, in order to gain time and obtain the most direct line of sight. "Turkey, Japan, Western Europe, Norway, maybe even China: All of these are places that have a legitimate interest in being defended from Soviet attack," Wood says. But other experts, including Donald Kerr, who recently retired as Los Alamos director, are incred-



LLNL painting by George P. Dooley

Pictured is an artist's conception of a nuclear-pumped x-ray laser (lower left) and chemical rocket platform (upper left) attacking enemy missiles during the boost phase of their flight. At least one missile, however, has survived its boost phase and is shown releasing its warheads and numerous decoys, chaff, and other materials aimed at confusing sensors.

*Because beam intensity diminishes with increasing distance from the power source, a laser still within the atmosphere has an inherent advantage over one based in space. The former will be able to penetrate or "bleach" through the atmosphere long before it can be attacked by the latter.

ulous that these countries would ever agree to such a step.

Wood counters that in any event the demand for quick launch might eventually be eased because x-ray lasers will be powerful enough to reach far into the upper atmosphere—to an altitude of roughly 60 to 80 kilometers—through a process known as bleaching. Bleaching occurs when the beam exhausts the absorption capabilities of molecules in its path, and a column of air becomes momentarily transparent. But some experts say that this can be accomplished only if the brightness of present x-ray laser beams is increased by more than ten orders of magnitude—an extremely daunting scientific challenge.

One approach might be to increase the yield of the bomb that pumps the laser. Already, according to various officials, yields of at least 100 kilotons are required; thus, the bomb in each superlaser might be well over a megaton. Even at the lower yield, according to Robinson and Ashton Carter, a physicist at Harvard who wrote a 1984 study of SDI for the congressional Office of Technology Assessment, the detonation in space of x-ray lasers might spill enough radiation to disrupt the operation of some key U.S. satellites. Those within a direct line of sight or a distance of 100 kilometers or so might perish immediately from x-ray and gamma radiation; others might fail when floating clouds of radioactive plasma "charge up various parts of their circuits, accelerating the current and overheating solid-state elements," as Robinson describes it, much like a powerful sunstorm. Particularly vulnerable are satellites in equatorial orbits at low altitudes, the optimum spot for the infrared sensors on which a boost-phase defense may depend. The only effective safeguard might be to limit the satellites' power while the plasma is nearby, rendering them virtually useless in combat.

This might be academic, of course. Hines believes that the development of such a superlaser is not likely "in the foreseeable future," and Coll is also pessimistic. "In the end, the pop-up x-ray laser is simply not feasible against a fast-burn booster," he says. "Fast-burn boosters rule out pop-up anything." This judgment is also expressed in a little-noticed letter to the House Appropriations Committee from the Defense Department last year. "Should switching to faster burning boosters prove to be a feasible and effective countermeasure," the Pentagon acknowledged, "it would cast doubts upon some proposed concepts for boost-phase intercept. In particular, standard chemical rockets, x-ray lasers, and particle beams might not be viable options for boost-phase intercept against faster burning boosters."

What, then, is the x-ray laser likely to be good for? One argument, frequently raised by Teller and Wood, is that the threat of its deployment may induce the Soviets to produce hundreds of fast-burn boosters at an enormous cost. "If we can force the Soviets to use fast-burn boosters, we will make them very busy for quite a time," says Teller. "They will have to run hard just to stay in place." But whether the Soviets would be willing to do this without the actual deployment of a credible U.S. x-ray laser network, also at considerable expense, remains uncertain.

"If the laser works as predicted, it could be overwhelming as an offensive weapon," says Paul Brown.

Second, Robinson and others note that an efficient, powerful x-ray laser could provide exceptionally clear three-dimensional portraits of human tissue and crystalline molecules, making its successful development important for nonmilitary applications. "I'm very sanguine about the medical research aspects," Robinson says. "I'm more pessimistic about the defensive application." But such a laser might also be generated without a nuclear detonation as its power source.

Third, Yonas and Wood suggest that the x-ray laser might be used to attack the so-called "post-boost vehicle," a device released by the booster that briefly carries all the warheads and decoys. But such a device can be hardened, or split into many separate pieces, or perhaps dispensed with entirely, all of which could enormously complicate the attack. X-ray laser brightness, basing, and collateral nuclear effects would still pose serious problems. As Coll says, "the timeline will still be extremely stressing, but I don't rule it out."

Fourth, some experts are hopeful that x-ray lasers can be used to discriminate between warheads and decoys during the so-called "mid-course" period of an enemy attack, which lasts roughly 25 minutes or so. With a leeway of minutes instead of seconds, the lasers could be "popped up" from sites much closer to the United States, there would be less chance of deploying or firing them by mistake, and it might be possible to obtain political authorization. The rationale is that even a fairly weak beam might be capable of destroying the balloon-like sheaths erected around warhead and decoy alike. Critics such as Richard Garwin, a physicist and weapons consultant at IBM, suggest that in response, the Soviets might deploy balloons within balloons, but the feasibility of such counter-countermeasures is uncertain. Whether other weapons, such as neutral particle beams, can perform this job more efficiently also remains uncertain.

Finally, there is widespread recognition that the bomb-pumped x-ray laser will be a superb antisatellite weapon (ASAT). "If the laser works as predicted, it could be overwhelming as an offensive weapon," says Paul Brown, Livermore's associate director for arms control. "It could wipe out all the other guy's lasers and satellites." Hines agrees. "An x-ray laser surely looks as if it is a better ASAT than SDI weapon. . . . In fact, incorporated as a popup or a space mine, it would be just devastating to a constellation of satellites, be they weapons or sensors," he says.

Several analysts, who ask to remain anonymous, insist that this unsettling situation is not well appreciated or even widely understood in Washington. Two who participated in the Pentagon's recent study of SDI architectures by ten contractors and a special team of nuclear weapons designers say that hardly any attention was paid to the inevitable Soviet x-ray laser threat by the industrial groups. "They primarily focused on the near-term, and ignored the x-ray laser threat," says a scientist who reviewed the studies. As a result, he suggests, a considerable danger exists that "we could follow their advice and deploy a missile defense in the near-term that will ultimately be incapable of dealing with this threat."

In the end, the x-ray laser program thus serves as a powerful reminder that weapons created for defensive applications might ultimately be twisted and used for offensive purposes. In addition, it is noteworthy that to a certain extent, x-ray lasers may indeed be the *best* technology for destroying Soviet missiles during the boost phase; they are light, compact, quick, and powerful. But now even the insiders doubt that they will work. This does not mean that any missile defense is impossible, or that none should be constructed. It merely means that the defense may not be highly effective, because the leverage to be gained from attacking boosters will be unavailable.—R. JEFFREY SMITH

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COMMENT

The question of what to do next

IT is the most complex subject on earth, or in the heavens; but let us try to keep it simple.

Mr Gorbachev, beaming in Paris, has made his offer; and the flapping disarray around the capitals of the West is manifest. That disarray is not some surface commotion, some presentational perplexity. It is deep, and endemic, beacause the Soviet Union's new leader asks questions to which there exist no concerted replies.

At Geneva, in Paris, and soon at convenient venues around the world, Mr Gorbachev is talking about arms control. There are at least two senses in which arms control doesn't matter. If the superpowers possess enough nuclear armaments to blow up the world twelve times over then the fact that they agree to limit themselves to a six-times formula does not make Planet Earth a safer place. And, of course, the experience of the arms control agreements we've had — Salt I and Salt II — has proved greatly disillusioning; neither has stopped the arms race, or even brought a pause. Yet still there is a hunger for arms control. The very existence of dialogue, and of hard bargaining, offers reassurance that the two great powers, under shifting leadership, are concerned with practical coexistence. When that forum lapses (see the last collapse at Geneva) public unease is tangible. And, beyond that, the hope that something real and progressive may be achieved is a natural hope for rational mankind. What is the point of the Pentagon seeking to spend a trillion dollars a year when the rippling effect, through budget deficits and interest rates, is the destitution of the Third World?

So public opinion, in Minnesota and Mannheim, in Toulouse and Turin, demands arms control negotiation, and the assurance that it is being rigorously pursued. There are different national perspectives, of course. The French are happy with their own bombs. Middle America's attention, for the moment, seems fitful. But Western electorates, in general, clearly want something they would consider cheering to happen at Geneva. The leadership of the West — in Washington — is by no means as clear; and it is here that Mr Gorbachev exploits his golden opportunity.

The Washington arguments against any arms control are, no doubt, sincerely held. Mr Reagan himself expressed them cogently when he was undermining Jimmy Carter on Salt II. Mr Caspar Weinberger and Mr Richard Perle remain stalwart champions of that position from commanding heights within the present administration. Simply, they place an each-way bet. The Soviet Union is a ruthless, expansionist power, and thus an implacable foe. No agreement is worth having, because Moscow will never keep to it. The only way forward is to remain militarily strong, to strive for superiority, and to wait for the moment when the cost of the race cracks the lumbering, drink-sodden Russian economy, leaving America benevolently dominant once more, as it was in the twenty peaceful years after World War Two.

You don't need to endorse such views: you need merely to recognise that, for perhaps half the Reagan administration, they are an overt or covert article of faith. But because it runs against the weight of American public opinion, and the overwhelming weight of European opinion, it is never official policy, officially stated. Though his Secretary of State for Defence may not want Geneva accord, the President is obliged to profess his earnest aspirations for agreement. The game becomes irredeemably two-faced. You put forward plans which you know won't fly, so that they may be bathed in crocodile tears upon rejection. You nominate as your negotiators members of the old Committee for the Present Danger, men whose views on Soviet world domination are your own. And you weave and bob and bribe to keep the tacky ship of Alliance unity afloat.

But it *is* a two-faced game, and, like most such games, cannot be sustained indefinitely. A bright, aware adversary can pull it apart. Enter Gorbachev.

Here, it goes without saying, both profound scepticism and innate cynicism are well in order. Mr Gorbachev is not less threatening because he makes good jokes, smiles a lot, and wears well-cut suits. He is unappealing when he makes hyperbolic prophecies of world war. He is too cute by half when his manoeuvres seem coldly targeted: at a flailing Dutch government, for instance. The glad news from Mr Kinnock that he has promised to mothball 64 of his missiles when a Labour Government scraps Polaris exudes an air of naivety that may live to haunt Labour's leader. But when all these caveats are entered, there is now a serious offer on the table, for inspection and negotiation. Mr Reagan himself says so: the Soviets have "changed position"; they may "have gotten religion". And if that's not very convincing, then it is interesting to match the (doveish) views of the old Democratic arms control chief, Paul Warnke, with the (hawkish) views of The Economist. "The sheer size of the cut the Russians are proposing is impressive. If they had offered this before 1983, a treaty could have been signed and sealed by now."

Alas, as always, there is a catch. That catch is Star Wars, the Strategic Defence Initiative. Ronald Reagan remains inflexibly attached to it, though the grounds for his attachment are covered in swirling mists. When he embraced the concept it was a first for America, which would be shared with the Russians to make a safer world. Now, according to the Pentagon, America must pursue it at all costs because the Russians are doing it anyway and have a ten-year lead. Meanwhile flamboyant tests of the programme continue while France peels away, Sir Geoffrey Howe issues coded groans of dissent, and Mr Reagan's own technical assessors pour cold water on his dreams.

Most of the immediate response to Mr Gorbachev's almost feline initiatives has centred on his offer of unilateral talks with France and Britain. President Mitterrand, predictably, has closed the door on that for the moment. Britain, one guesses, has shut it still faster, though propelling Sir Geoffrey forward to obstruct lines of vision. But no one should mistake the shufflings in the game for the reality which underlies it. The Europe of the early eighties, with a perceptible conservative tide flowing as cruise missiles were deployed, is not the Europe of today. Chancellor Kohl is no favourite for re-election. Mrs Thatcher has a mountain to climb. If there is a constructive summit next month, and the reality of negotiation thereafter, then the fabric of the Alliance will hold, though its strategies and relationships may change. But if Geneva is perceived as a charade because America is not truly serious, then the electoral consequences may be shattering. A pragmatic British Prime Minister might, at the moment, be thinking long, hard, and laterally. Trident is a Budget migraine, ripe for cancellation the moment the government changes. To abandon it weakly now would be unthinkable for Mrs Thatcher. But to bargain it away as part of a Geneva process which is generally acclaimed would do more than send Nigel Lawson dancing in the streets: it would utterly outflank the Opposition parties. And there is, in any case, a reality to Mr Gorbachev's ploy. The reality of a nine or tenfold increase in Britain's nuclear strike capability, something which cannot practically be ignored in any arms control equation. With one bound, then, the lady might be free — if she had the imagination and the conviction of her own assessment of Mr Gorbachev: "A man I can do business with".

But first things first. The Gorbachev wheeze, at this moment, is much akin to his Dutch dabble. It is designed to fracture Nato resolve: and cleverly pitched, because it goes with the logical grain. Any sensible initial response, then, does not involve members of the Alliance flaking away into bilaterals. It begins at Geneva, and before that at President Reagan's own New York co-ordinating summit. That meeting was transparently designed as a propaganda forum in which his assorted junior partners would utter emollient words of solidarity and faith. But now it should be something much more.

Thus far the Great Communicator's considered reply to Mr Gorbachev has been an off-the-cuff press conference in a soap factory, a random SDI test, and the recall of his senior public relations wizard, Michael Deaver, to White House colours. It is pathetically inadequate. No one expects the West to troop meekly along Mr Gorbachev's proffered route. This is a negotiation. A negotiation means detail and grind and compromise. But it also means the desire to reach that compromise. If Mr Gorbachev falls by the wayside on substantive issues, that will be one thing. But what is seriously in question today is President Reagan's willingness and desire at the start. If the allies in New York aren't convinced of that, then they must say so; because the facade of unity, inevitably, will collapse in any case; and because the damage that flows tomorrow will be infinitely more far-reaching than honest, open doubt today.

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(The following is an excerpt)

HUMAN COMPLEXITY

HUMAN beings have two sides. No doubt they have many sides, but considering them as two-sided is likely to give more light on human behavior. They want, for example, to have answers, to settle things so that they need no more attention; but then, after a time, they grow bored with a settled state of affairs and look for something else to do. In one of his rather wonderful stories Don Marquis told about a man who died and went to "heaven." There, he found, everything was just as he wanted it. He lived in a place that fulfilled his dreams and anything that seemed missing his faithful attendant immediately produced. After a time—actually only a few months—the setting palled and he told the attendant how he felt. The heavenly servitor suggested that he do the house over in medieval style—"heavy furniture you can put your feet on without worrying about it, and stately stone walls with high ceilings." The man mused and then said, "Well, I'll probably get tired of that too. You know, there are times when I almost wish I was in Hell." The angelic presence quietly replied: "And where do you think you are, sir?"

We hunger, in short, for answers, but then we may decide that questions are better than answers. Yet the hunger is insistent and we develop the scientific method to get answers. We get them, but soon—or late—we discover that the trouble with an answer is that it has only limited application. And then some mathematician—one of the managers or proprietors of scientific method—works out a proof that, always, some of the axioms of a closed system are secretly unstable, causing the system to break down. The equations are no longer dependable; new or better axioms are needed to keep the system going. Then, usually, we get them. An Einstein adds to a Newton, and the resulting arrangement, the experts say, now works for matters Newton's system couldn't explain or deal with.

Where did the scientists get the new axioms? Out of themselves, the mathematicians tell us. But even the new axioms won't last forever. They may work for a hundred years or so, but eventually they break down. Then the scientists—those whom we call the *creative* scientists—get busy and do the necessary patch job, which lasts for a time. Nature, you could say, is like us; eternally it gives answers and then raises questions. The rule that applies is known as Gödel's Theorem, which can be looked up.

A while back (June 26) we had an article on story-telling. The point was that the good story-teller leaves you with a question to think about. A story that ends in finality consumes itself. We want a tomorrow and a finality has no tomorrow. Nothing is left to do. What could be worse than having nothing to do?

At a more elevated level of inquiry, we are drawn to thoughts of immortality because of the prospect of more things to do. Dying, we say to ourselves, cannot be the end, the absolute end. Somehow, we must go on. Yet we may be very tired, ready for eternal rest, for the peace of virtual nonentity. We may feel like the exhausted old English cleaning woman, who had etched on her gravestone,

> Now don't you be grieving
> Or weep for me ever,
> For I'm going to do nothink
> Forever and ever,

but the time will come when a mop and a pail of dirty water will seem like accoutrements of paradise! We'll want to get to work.

The human quest for engagement seems good evidence of this. From its earliest years, the child is alert for new experience, looking for things to do. Delight comes easily to the young child; the world seems filled with novelty, with objects to be seen, touched, and handled, absorbed into the child's life, manipulated and made familiar. Then the time comes when the familiar is taken for granted, when it seems a stable part of one's being, reliably there but no longer of great interest. The new claims attention, and is to be understood and controlled by being related to the structures of awareness that we have already established.

So it is throughout life. We call this process of assimilating the new to the old, making ourselves "at home" in the world. It is also called "learning" and there can be no end to it since the world is such a big place.

Here, too, humans are two-sided. There is the part of us which relates to the world, to other people and objects, with our requirements, wants, desires, and needs, leading to the development of structures of knowledge about the world—how the things in it work and what must be done to make them serve us. We name this knowledge science; we acquire some of this knowledge for ourselves—what we use from day to day—but eventually,

as it becomes complicated and difficult, we delegate the gathering of scientific knowledge to individuals who have a particular talent for the rules governing finite things. These specialists develop impressive powers over matter and its motions, and we honor them by putting them in charge of our schools and universities.

Their task, we believe, is to instruct the young in the techniques of getting what we need and want. Occasionally, when a scientist presumes to be able to tell us what we *ought* to do, instead of just how to do what we want, we demote or punish him, as in the case of J Robert Oppenheimer, the nuclear physicist who surpervised the construction of the atom bomb that incinerated Hiroshima. He later opposed construction of the H-Bomb, with the result that he was no longer allowed to serve his country as a member of the Atomic Energy Commission, doubts having been cast on his "loyalty." What had he done? He had allowed a "moral" conception of human behavior to intrude in his scientific thinking. He thought that the advance in destructive power of the H-Bomb would be *wrong*.

This introduces the other side of human beings—how we think about ourselves—what we have to say about the meaning of our lives. We are continually making choices affected by what we think is desirable or undesirable, good or bad, more rarely by what is right or wrong. How do we make up our minds about such things? Here the scientists, as scientists, seem of little or no help. As human beings, when their inner side comes into play, they may have strong convictions, but as technicians they are supposed to be morally neutral.

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