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Special Report

The Strategic Defense Initiative: Its scientific, economic, and strategic dimensions

Proceedings of the conference sponsored by
the Fusion Energy Foundation and the Schiller Institute

April 22–23, 1986, Tokyo, Japan

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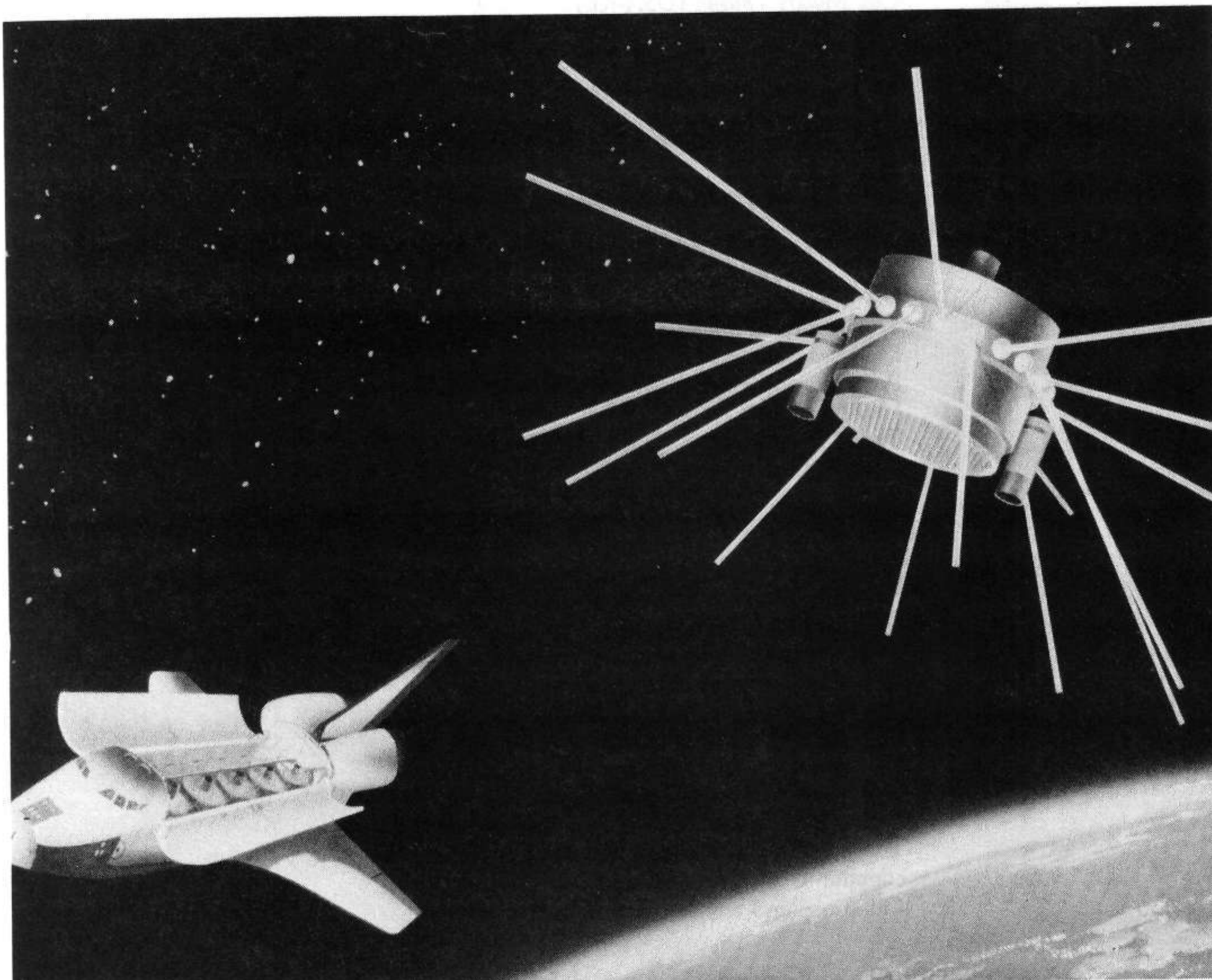
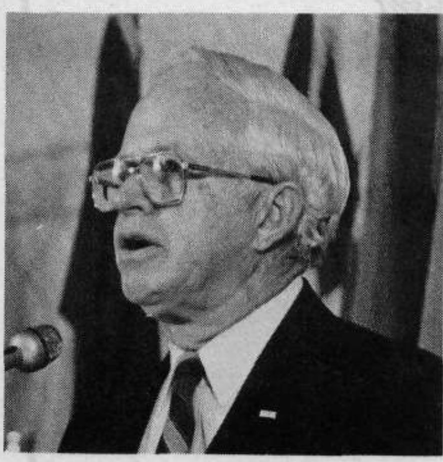


Christopher Sloan

Artist's illustration of an x-ray laser beam weapon satellite deployed into orbit by the Space Shuttle.

April 22

Panel I: The strategic dimension



Col. Molloy Vaughn (USA-ret.)

The Russians' massive force concentrations in the Pacific

Col. Vaughn served with the Far East Command and with NORAD.

President Reagan has defined the goal of SDI as rendering nuclear weapons impotent and obsolete. Aside from the moral and overall strategic dimensions of the objective, replacing the highly questionable doctrine of mutually assured destruction (MAD) by a strategy of mutually assured survival (MAS) is being considered at this point.

Four reasons for this change are:

1) Major Soviet advances in numbers, mobility, and accuracy in their ballistic-missile arsenal have put the survivability and the deterrent value of the U.S. land-based missiles and bombers in question. The U.S. Air Force estimates that only 3% to 5% of the land-based missiles and 25% of the SAC [Strategic Air Command] bomber force can be counted on for a retaliatory second strike after a full-scale Soviet attack.

2) The Soviet SS-20 and related deployments increasingly put in question the defendability of the territory of U.S. allies in the Atlantic and the Pacific.

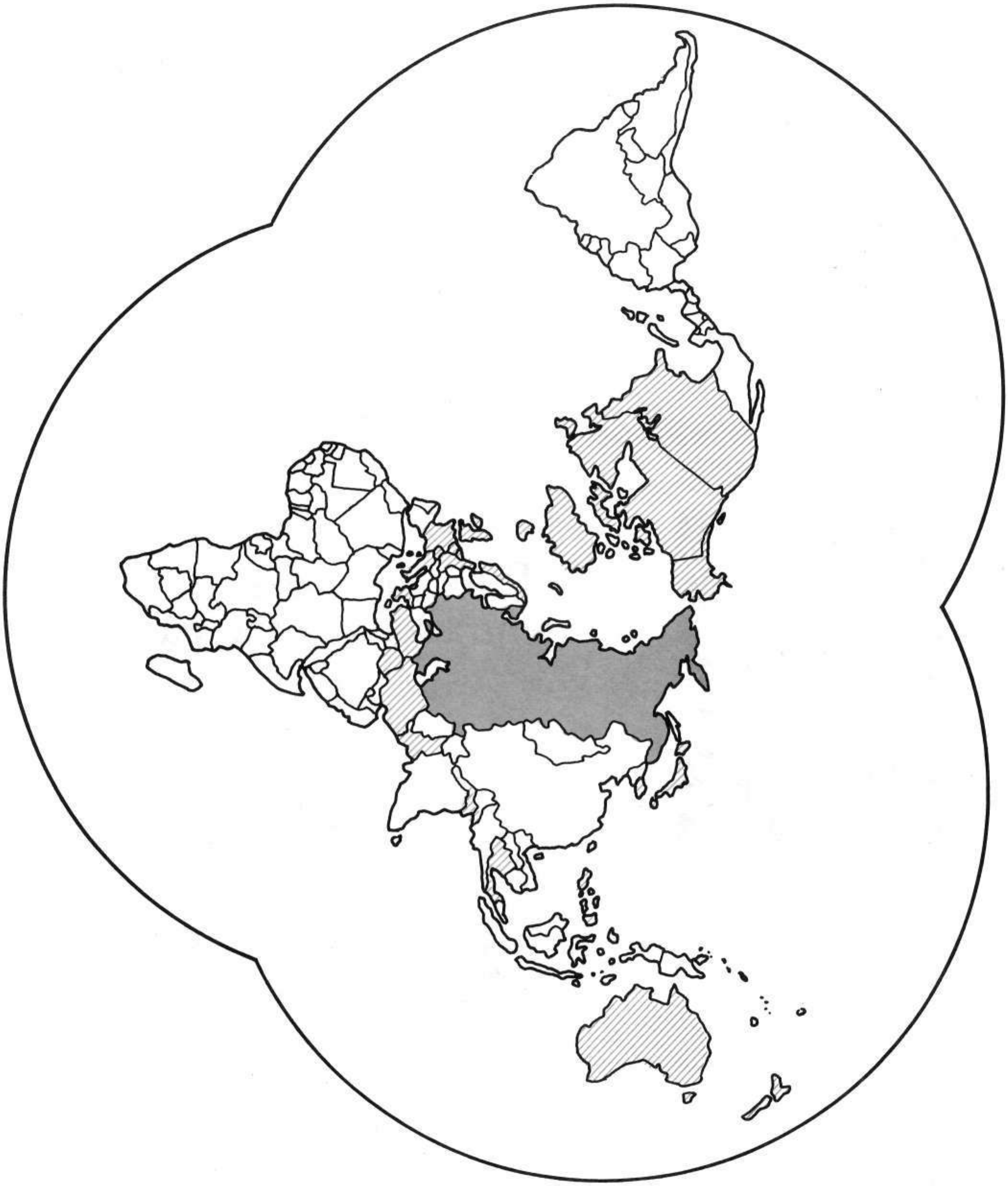
3) The massive Soviet conventional forces buildup and modernization reinforce the second point I've just mentioned.

4) The Soviet Union has developed and deployed a significant air defense and ballistic missile defense capability, which does not exist in the United States at this time.

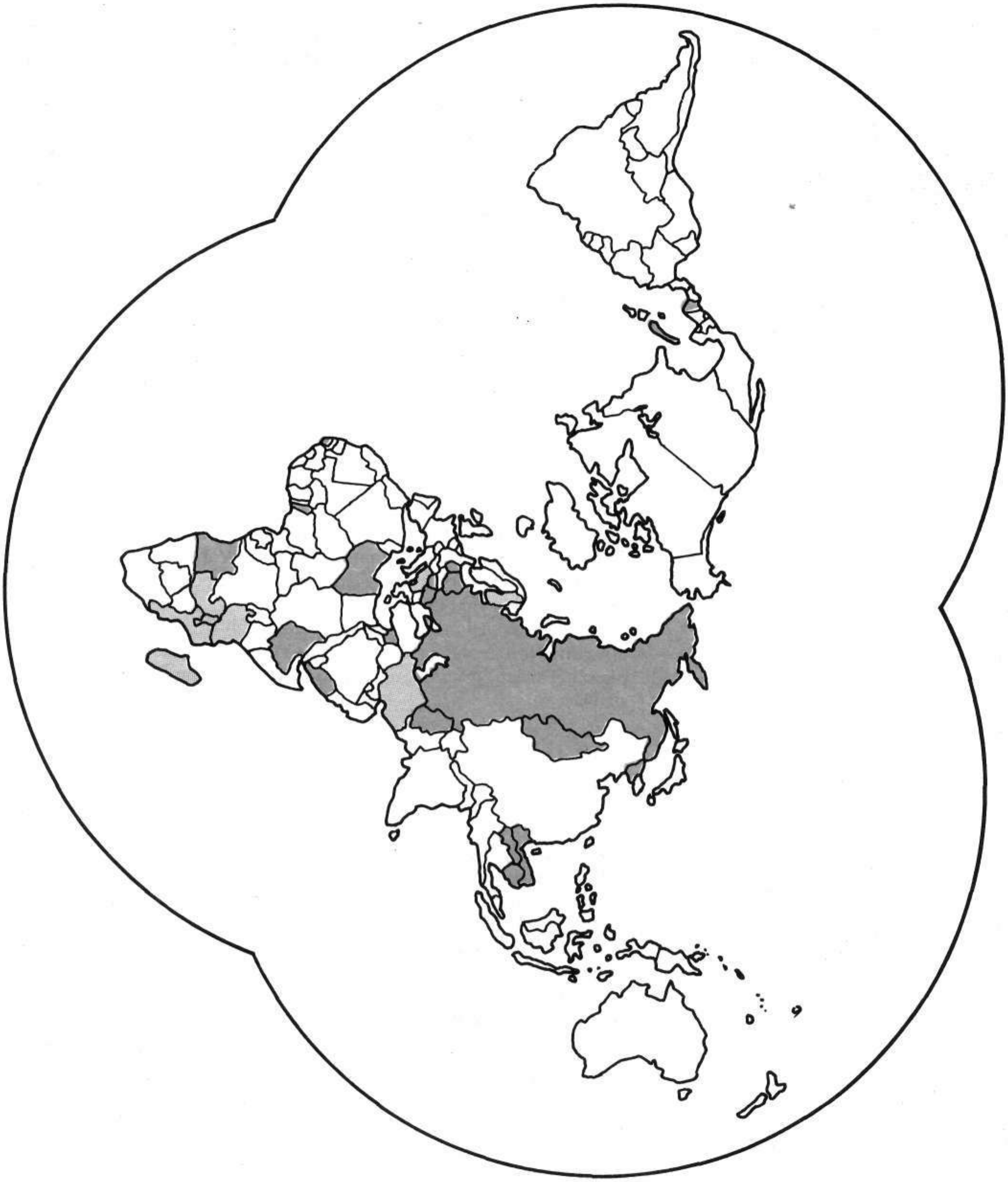
Force concentrations: 1965

I would like to now review the U.S.-Soviet balance of power in the Pacific Rim area as it was in 1965, 1975, and as of December 1985.

From 1950 to 1955, it is very easy to see that the United States and its allies surrounded the Russians (**Map 1**). The Russian embassy requested, at a meeting in Bangkok, that I make that point to be fair. In 1985, we see that Russia has broken out: They now have bases in In-



Map 1. Encirclement of U.S.S.R.—U.S. and its military allies, 1950–55



Map 2. Soviet satellite and Soviet influenced states, 1985

dochina, Angola, Ethiopia, Libya, Cuba, and Nicaragua (**Map 2**). So, they are no longer completely surrounded by American and allied missiles.

The Pacific Rim, as defined in this conference, goes from South America, around by the Aleutians, to the U.S.S.R. and Northeast Asia, down to Indochina, also including the Indian Ocean.

First: In 1965, the buildup of U.S. forces started in August, both for Indochina and Vietnam (**Map 3**). We had six Army divisions afloat, or en route, one brigade; the Navy had two fleets—the 1st and the 7th—reinforced; our Air Force headquarters were the 5th and 13th; and the 1st Marine division was already ashore, with the 3rd Marine division en route—building up toward a force of 500,000 troops.

At that time, the Soviet Union had only 17 divisions, 15 positioned off of China, on the Northern Chinese border and Outer Mongolia; 120 nonnuclear submarines, 3 cruisers, and a few other units. The Russian Air Force consisted of 20 to 30 bombers (Bisons and the Bears), older planes, and about 350 tactical aircraft (MiG-15s and 17s). There were even some IL-28s in that inventory.

The Soviet Union theater headquarters was not activated; they had their Far East Military District, and the other smaller districts. So actually, at that time, there were only about two divisions, with Vladivostok as the port.

In North Korea, there were 18 divisions. South Korea was scaling down the size of its forces from the Korean War to 28 divisions.

North Vietnam itself had 11 divisions, and South Vietnam had four army corps, but 400 fairly obsolete aircraft.

Australia stayed at about the same through this entire period, at one division; New Zealand had about one combat brigade during the entire period; Taiwan, from 23, decreased in size; and the Philippines went up slightly.

Force concentrations: 1975

In 1975, the post-Vietnam era, we see the change (**Map 4**). The U.S. Army dropped all the way down to two divisions, one in South Korea and one in Hawaii; one Marine division was in Okinawa; the Navy had one fleet—the 7th Fleet; and the Air Force included 5th, 7th, and 13th. We see something happening now for the first time. In 1975, the Soviets still had not activated their theater headquarters; they were still relying on the districts, but they were up to 45 divisions, and nonnuclear submarines. Their Air Force increased strategically, to 210 strategic bombers, and the first IRBMs appeared in the theater.

North Korea increased to 23 divisions, with very special brigades. South Korea was down to 23 divisions. North Vietnam had 18 divisions; South Vietnam was about to fall, and they were at 12 divisions.

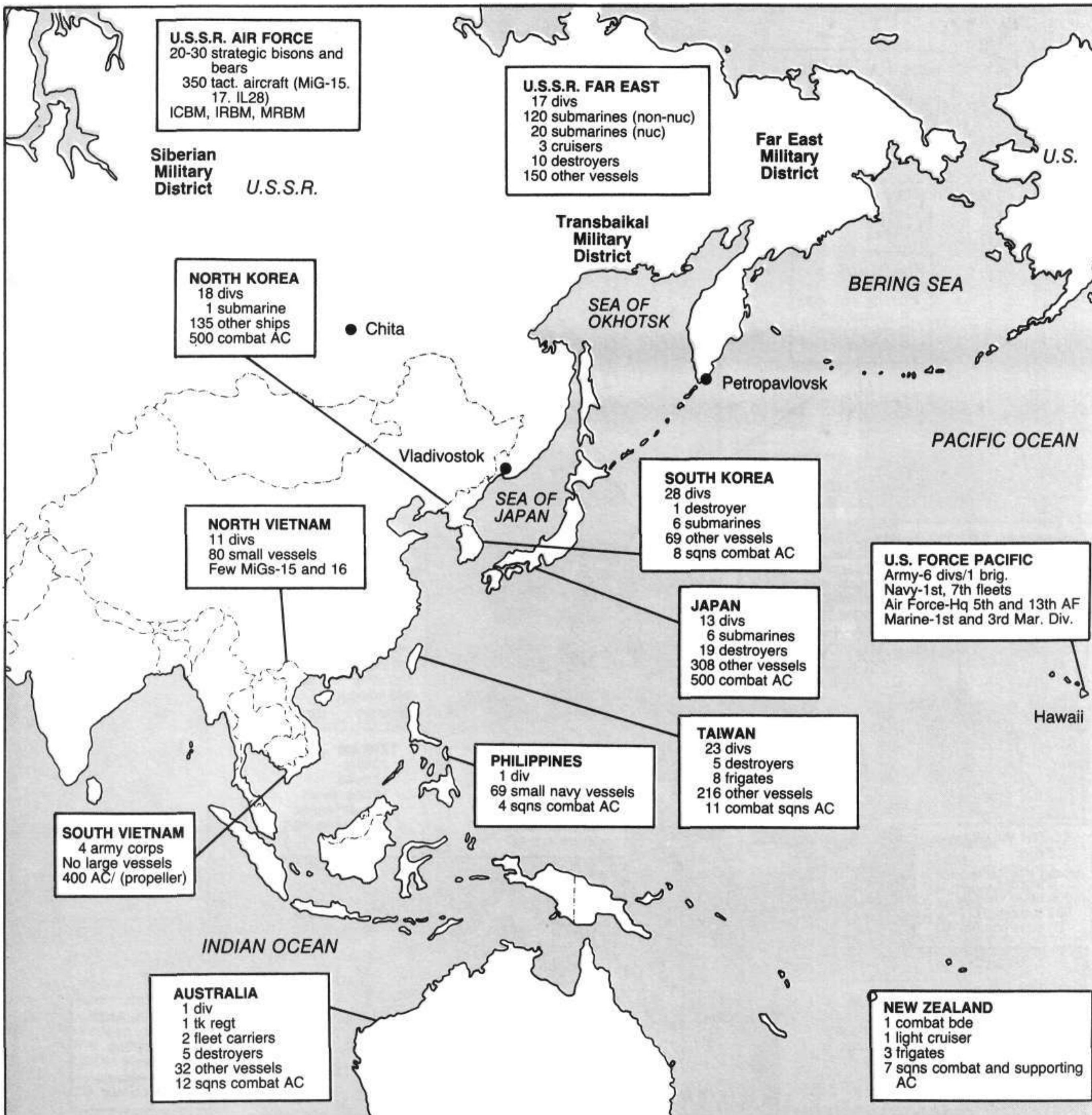
Force concentrations: 1985

Remember those figures. Now, make a comparison to 1985 (**Map 5**).

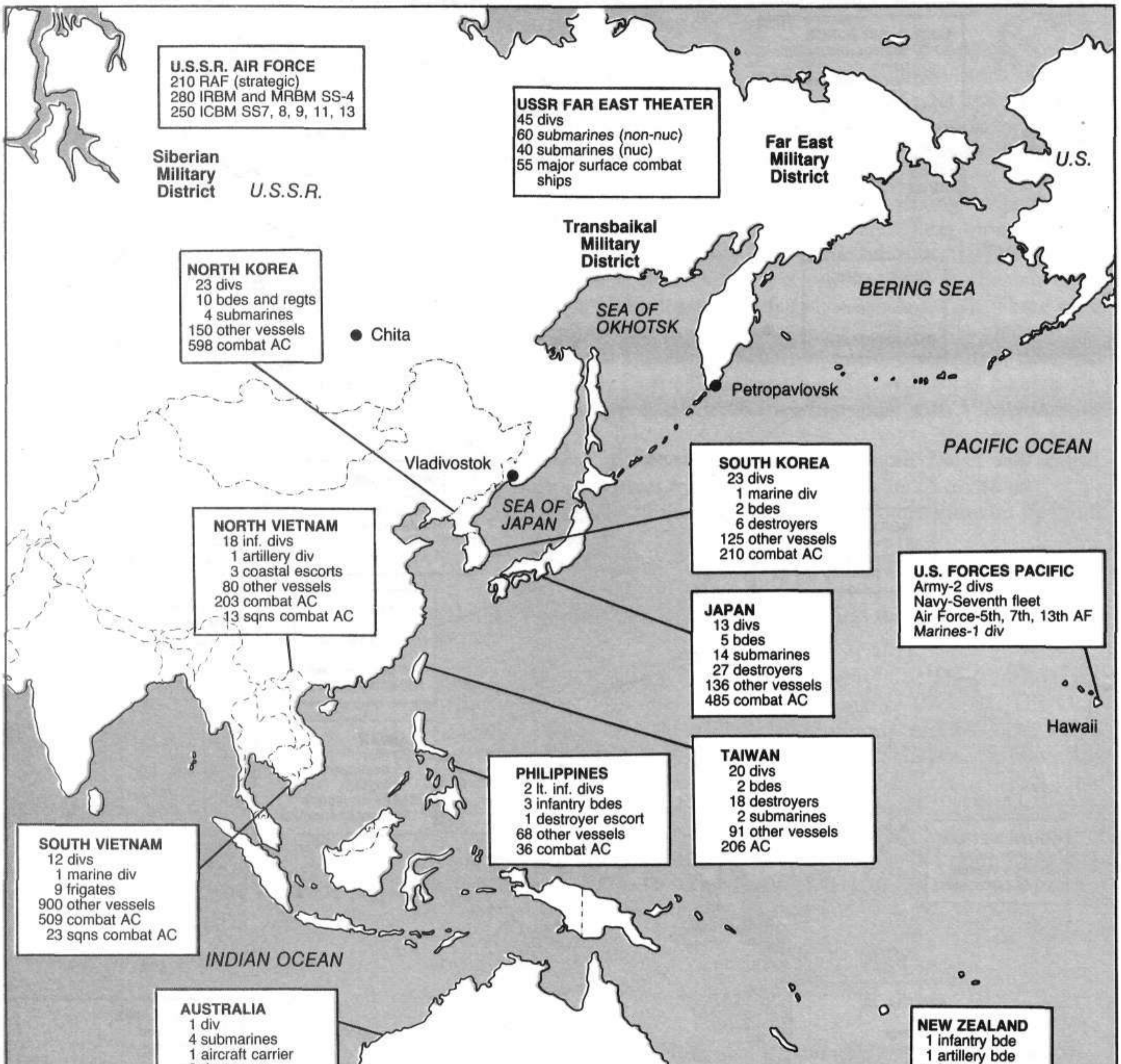
The United States remains at two divisions—one in South Korea and one in Hawaii; one Marine division; the 7th Fleet, and unfortunately, part of the time, this fleet must send an aircraft carrier or a battle group to the Indian Ocean, to reinforce that area of the world.

Now, what does the Soviet Union have? They have now arrived at 52 divisions. If we equate two Russian divisions to one United States division, sizewise, you still come up with 26 divisions. Submarines are now at 31, and are their latest class submarines, the Yankee, and also the Typhoon: We've spied the first four launched; they've already been appearing in this area.

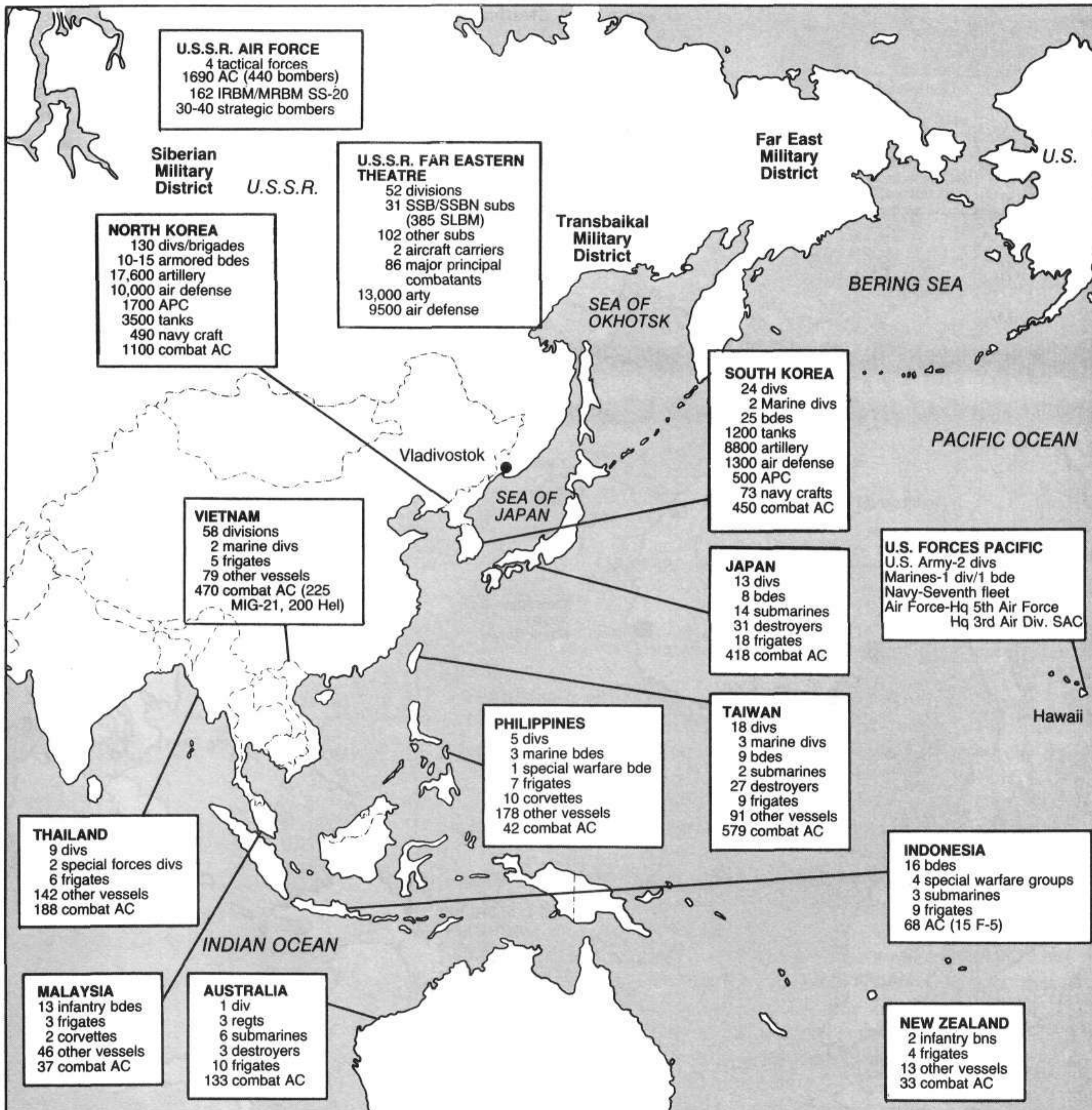
Two aircraft carriers, the first two that were actually launched, went



Map 3. Force deployments 1965



Map 4. Force deployments 1975



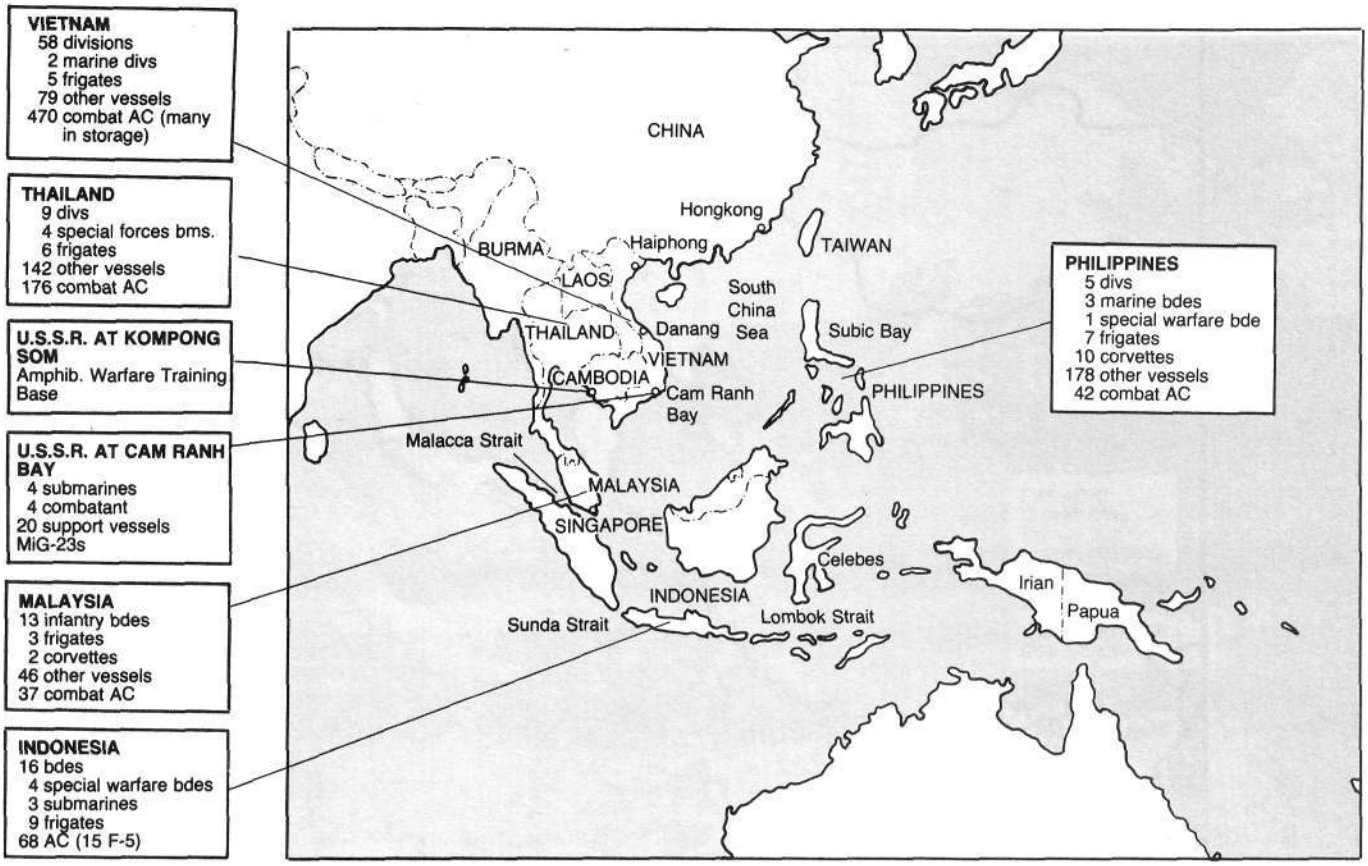
Map 5. Force deployments 1985

almost directly to Vladivostok, and they have also visited Cam Ranh Bay, Vietnam.

Last summer, there was a naval maneuver in the Northwest Pacific off Japan that dwarfed the Atlantic maneuver of that time by about 3 to 1.

The Soviet Air Force is now four tactical forces, ranging from 2,000 to 2,700 aircraft: 440 bombers, including some Backfire bombers, and we're expecting them to deploy the new Blackjack; and 1,500 fighters. The number of IRBMs, SS-20s, has risen to more than 135; that is, roughly 40% of all the SS missiles, the most accurate missile that the

Map 6. Soviet Southeast Asia Bases



Map 7. Force deployments in South China Sea

Soviet Union has ever developed—3,100-mile range and three warheads (MIRV).

North Korea is increasing rapidly: 39 divisions, 16 of the very special brigades; their divisions now have a total of 54 Frog missiles, which have a nuclear capability, river-crossing submarines, and 740 aircraft. They are getting up into the MiG-21 class now, with some MiG-23s.

South Korea is going down: 22 divisions, 2 Marine divisions, 11 brigades, and though their aircraft are fairly modern, they are not comparable to the North Koreans.

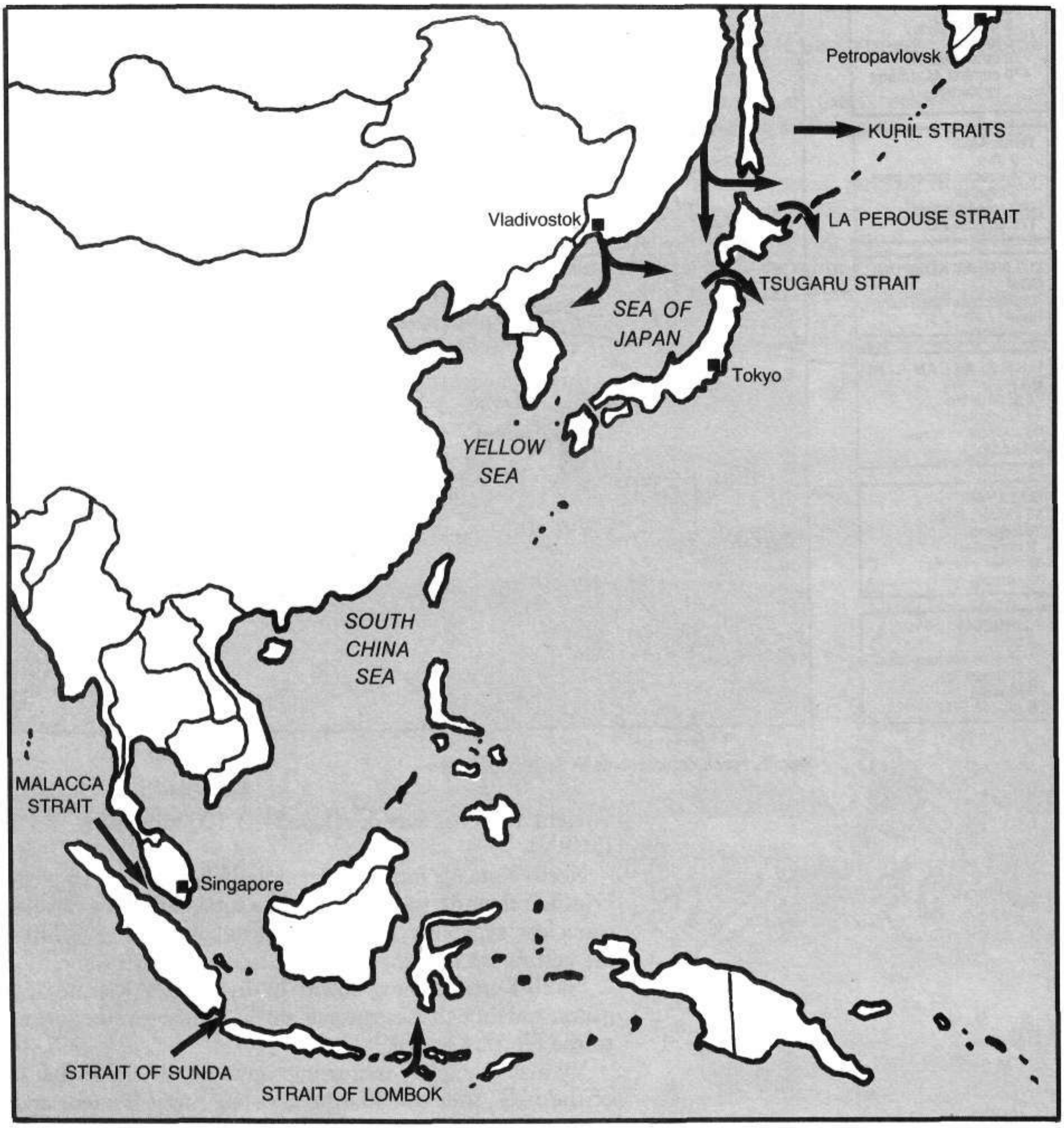
Vietnam is rapidly increasing: up to 58 divisions; that is, 28 divisions of the U.S. size; two Marine divisions, well-trained; and their aircraft are becoming more sophisticated.

Just before this conference, a new set of charts was made available to us that brings home the comparison to 1965. Two weeks ago, this was updated even further. (You see we have trouble keeping charts current.) North Korea is now up to over 700 maneuverable battalions, or a total of 80 division brigades, plus 40 special brigades—that is where we had only 43 divisions before. South Korea has 24 divisions this year.

The Special Forces are very specially trained troops for very special missions. South Korea has 7, and the Japanese, your own self-defense forces, are staying the same—13 divisions, and one special forces brigade.

But the artillery is startling: up to 17,660 for North Korea now. That is counting only the heavy mortars, conventional launchers, and over 4,000 pieces of long-range artillery. South Korea is at 8,800, less than half, and the Japanese self-defense forces are at 1,100.

If you are going to defend your troops, and there is a chance that someone might come in and hit you, you must have air defense. North



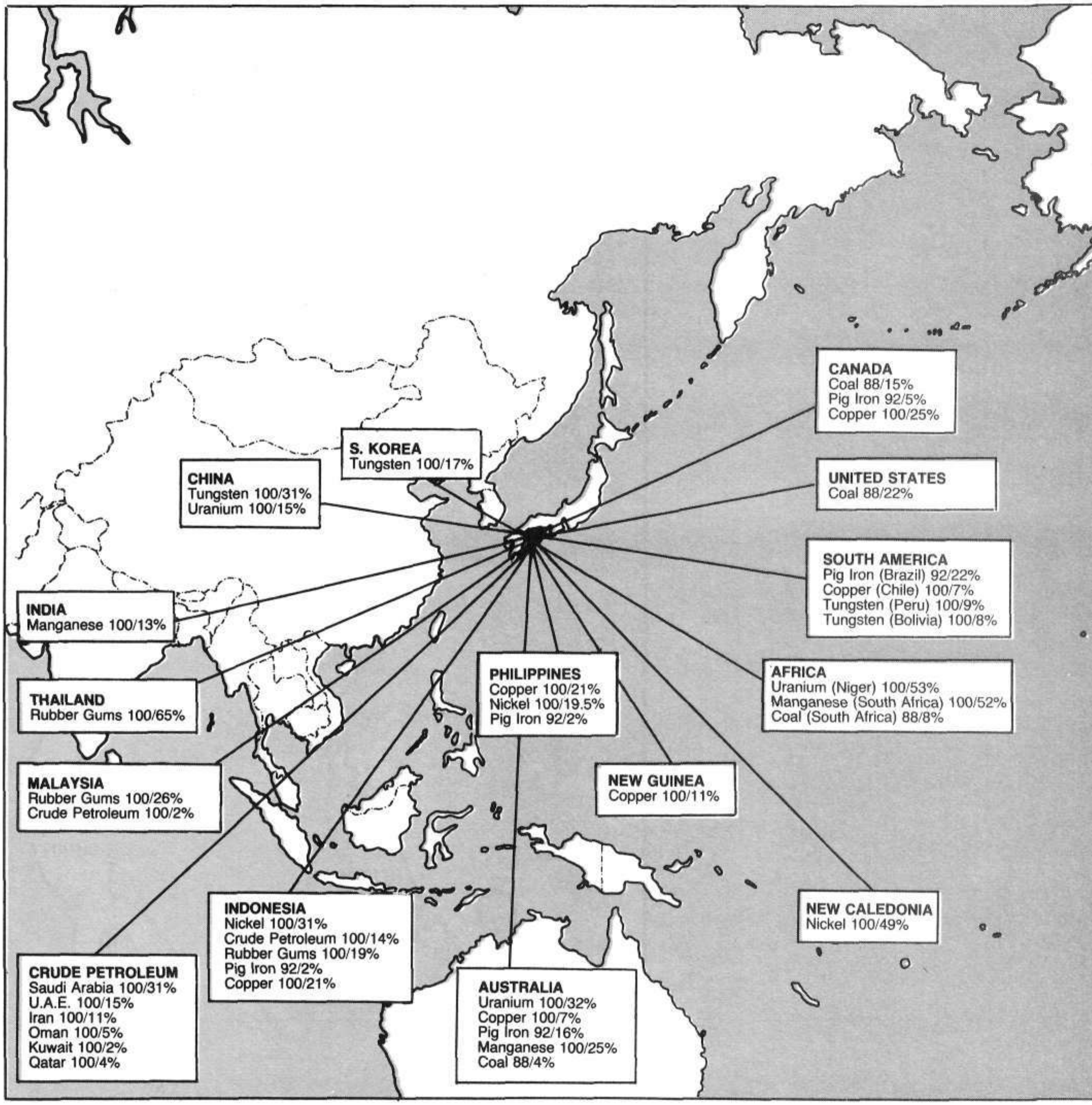
Map 8. East Asia military chokepoints

Korea has weighed its air defense very well, at 8,800; South Korea has 710—which includes guided missiles, by the way—surface-to-air missiles; and the Japanese self-defense force is at 490.

In the same time frame, look at tanks. The Soviets are now up to 3,500 tanks as of February. South Korea is 1,400; your self-defense force is at 1,070. North Korea armored personnel carriers have taken a rapid jump to 1,700. Infantry does not walk into battle anymore; they now ride, so they are rested for the fight. South Korea is at 700, and you are at 530.

The number of Soviet aircraft has jumped from 670 to more than 700; South Korea has about 450. The Navy: South Korea has 147; North Korea is approaching 600, all different types of navy units.

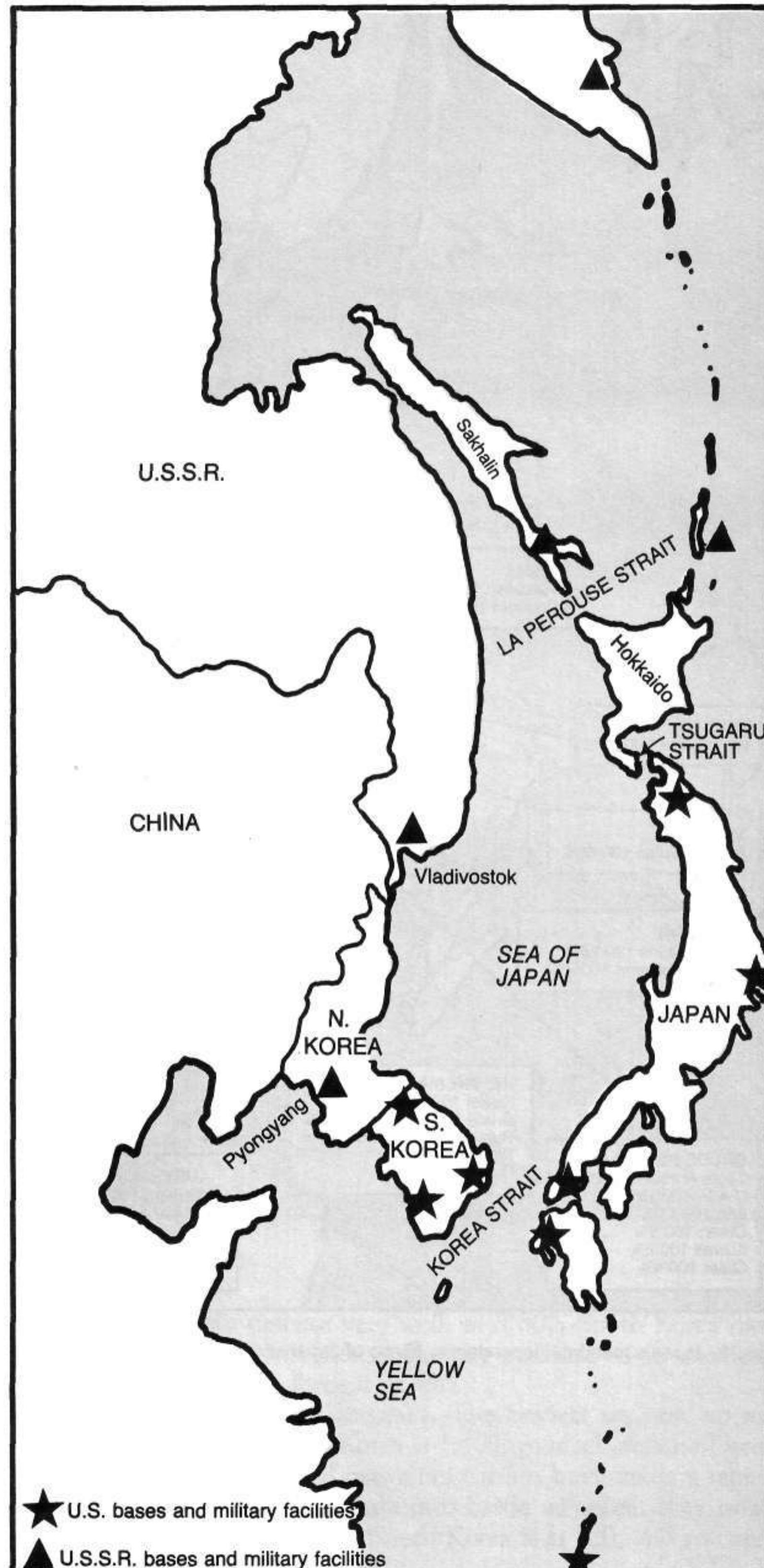
One final comparison of the Russian forces and the U.S. forces in the Pacific in the same time frame: 53 Soviet divisions to our 3. And not



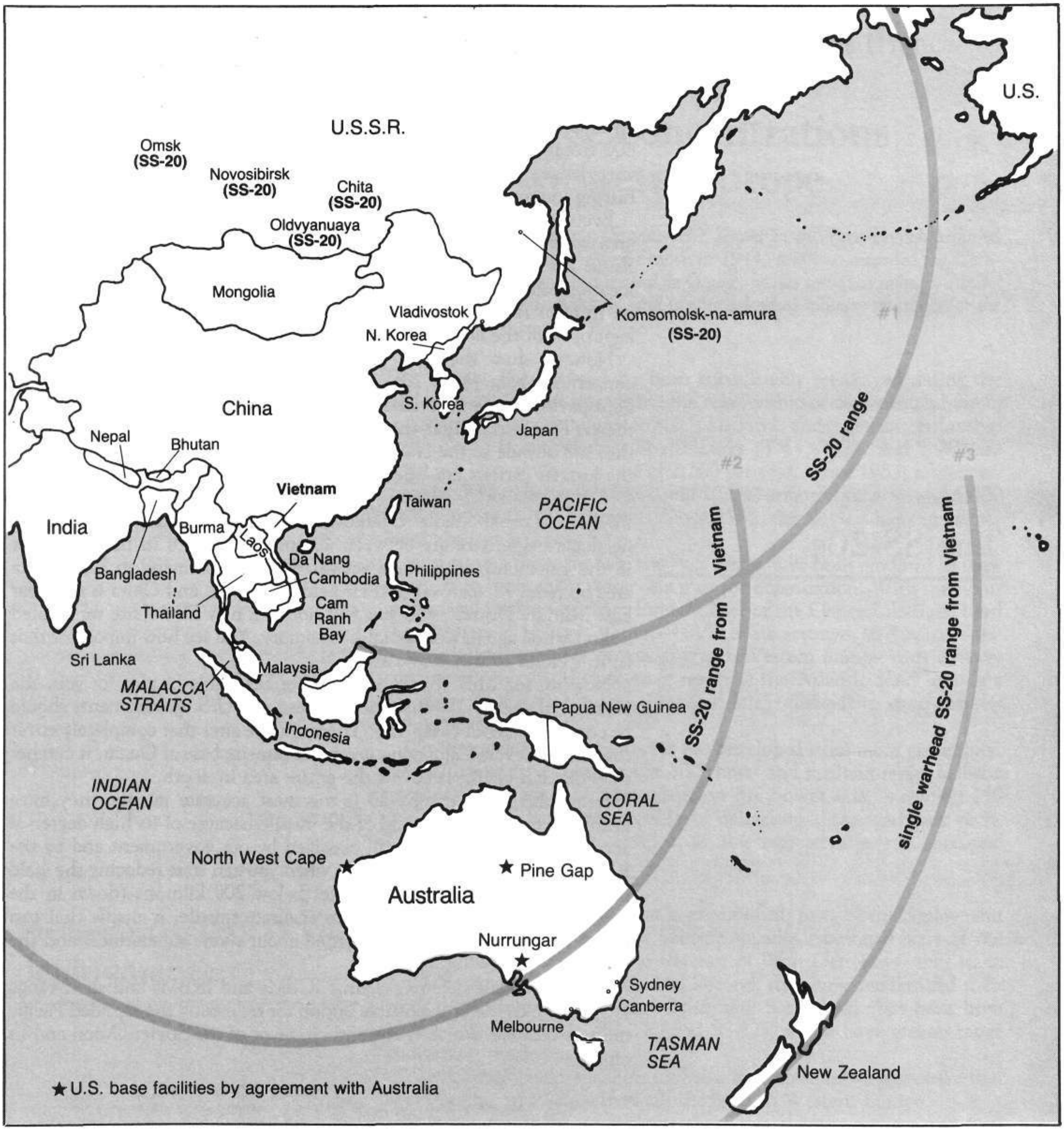
Map 9. Japan's resource dependence. [Ratio of Japanese dependence on imports (%) to share provided by designated country (%)]

counting submarines, in major capital ships, they have 89 and we have 39 in the Pacific. For artillery, counting all of our artillery units, it is 536 against their 13,000. In air defense, we have 72 Hawks, with our divisions; they have 9,500 air defense.

We have a total of 290 tanks to their 14,900; armored personnel carriers, 338 versus 17,000; antitank guided missiles of all types to try to stop the tanks, 622 versus 1,675; fighter aircraft, 365 versus 1,690; and that figure keeps changing in their favor.



Map 10. U.S./U.S.S.R. bases of interest to Japan



Map 11. U.S.S.R. SS-20 IRBM main bases

Strategic choke points

I will only refer to two countries on the map. Vietnam is the first deployment in the South China Sea area. What is interesting here is what has happened in the last 24 months (**Map 6** and **Map 7**). The largest Navy base we ever built overseas, Cam Ranh Bay, has been occupied by the Soviet Union; the Vietnamese have been moved out. I have been told that they are averaging about 30 ships in and out of the base at all times. They are keeping one wing of a mixture of bombers at Da Nang—the most sophisticated ones they have had in their inventory—and the fighters.

The third location is one that we found out about last summer. It is an amphibious training base at Kompongson in Cambodia. They had 800 troops there on maneuvers last summer, and that, of course, is a very dangerous location, for actually cutting off the Gulf of Siam, and hitting Indonesia and Malaysia.

Everyone talks of major choke points around the world. This is one area where we have major choke points (**Map 8**). We start from the Kurils on down through the Sea of Japan. The choke points in this location, the South China Sea, are very key ones for the shipment of oil in from Arabia, or other supplies; these choke points here must be kept open or the flow to this area of the world will be stopped (**Map 9**).

Now we show the U.S. bases and the Russian bases that Japan is concerned about (**Map 10**). Note the new Soviet submarine base, in Petropavlovsk, Kamchatka—75% of all their submarines are located there. That means that they are no longer in the choke point catch; they are outside of the choke points which covered Vladivostok, where the aircraft carriers are based, South Korea, and North Korea.

The SS-20s

In 1979, Marshal Nikolai Ogarkov activated a full-time Far East theater headquarters—there are between 40 and 100 SS-20s in this area. Just in the last month, they have activated a new command in Kamchatka area up here. Khabarovsk is their field command, and Chita is their Far East Military District; and you will notice a new SS-20 site we located a short while ago in Komsomolsk-na-amure. You see how important that is; it is closer to this whole area.

Now we see what that means. I have been able to plot for you, the location of the SS-20s that the Japanese and U.S. governments should be concerned about (**Map 11**). There are five sites that completely cover the area; it covers Cambodia, it catches our site base at Guam, it catches the Aleutian chain: It covers the entire area in depth.

Remember now, the SS-20 is the most accurate missile; they have been able to reduce the yield of the missile because of its high degree of accuracy. The accuracy is still classified by our government and by the Russians, but we can tell you, that when you can start reducing the yield of a thermonuclear weapon and get below 200 kilotons (down in the area of 180 kilotons), you have an accurate missile, a missile that can actually go in. So, we are concerned about navy, submarines, and the rest.

Ballistic missile defense, against ICBMs and IRBMs and short-range missiles, holds the only possible option for redressing the lopsided Pacific military balance, which is currently in favor of the Soviet Union and its allies.

Gen. Jean-Gabriel Revault D'Allonnes (France-ret.)

Soviet force concentrations against Western Europe

Gen. Revault D'Allonnes (France-ret.) served in the Free French armored cavalry during the liberation of France in 1944, and was awarded the Campagnon de la Libération by General de Gaulle; he has served as military attaché in various diplomatic missions, and is now a leading military strategist for the Gaullist or RPR party of France.

NATO vs. the Warsaw Pact

The Warsaw Pact forces have been considerably reenforced during the past 15 years. It is estimated that the relationship of conventional forces of the Warsaw Pact compared to NATO is 3 to 1, and that this relationship continues to be augmented. Soviet tanks (T-64, T-72, and T-80) are being put into service at a rate of 2,300 per year. Since 1983, moreover, there have been between 15,000 and 20,000 armored vehicles and 6,000 artillery pieces put into service. Since 1981, the Soviets have manufactured about 3,800 new fighters.

At the same time, the Warsaw Pact forces have been modified in their structure to bring them closer to a wartime organization. With the nomination of Marshal Ogarkov, former Chief of the General Staff, to head the Theaters of Military Action—TVD is the acronym in Russian—the mission of this theater became to attack Western Europe with a heavy concentration, with the object of reaching the Atlantic coast in only a few days. This conventional threat, which is difficult to stop, doubles the nuclear menace.

On the nuclear side, the threat has developed even more powerfully. NATO has at its disposal about 300 short- and medium-range ballistic missiles. There are 1,600 launchers on the Soviet side, including 250 SS-20s, mobile launchers capable of delivering three warheads each. These launchers can be reloaded, so this represents several thousand nuclear warheads.

Soviet missile deployments

The recent growth of this threat is exemplified, first, by the deployment three years ago of short-range ballistic missiles, stationed west of the Soviet Union and currently to the east of West Germany—that is, in East Germany and Czechoslovakia. Second, they have modernized their tactical missile force; the Frog, Scud, and Scaleboard class have been replaced by the SS-21s, SS-23s, and SS-22s, which have greater range and greater precision.

These developments make a suprise attack possible—a first strike that could destroy in a single blow all the arms in Western Europe.

It is not reasonable to separate these two threats, nuclear and conventional, because they complete and reenforce each other. They are closely tied.

With the precision of present missiles, a first strike of several thousand warheads—nuclear *and* conventional, that is, chemical, for example, or other systems—could, therefore, destroy the majority of NATO defenses: That is, all manner of nuclear defenses, the centers of command and control, infrastructure such as airfields, air defense systems, concentrations of land forces, barracks, depots, etc. A second salvo could then be shot off shortly after, since these launchers can be reloaded. This second attack would leave the NATO countries without any means of defense against a conventional assault, which might follow immediately thereafter.

The problem then is to find out if the strategic nuclear forces of France and of Great Britain will be in a state, will have the capacity, to enter the action—that is, if they are still credible and for how long. It is a discussion which goes beyond the time limitations that have been accorded me this morning.

I would only like to tell you my personal opinion. My personal opinion is that time is not working for us. I think it is more and more urgent for the countries of Western Europe to have at their disposal new defensive systems that would be fundamentally new technologies. And my personal conviction is that this is possible.

It is above all a problem of will.

Kevin Zondervan

The current status of the SDI

Kevin Zondervan, manager, concept analysis, Aerospace Corporation, California, is currently on leave from the company.

About three years ago, President Reagan set forth the objectives for the Strategic Defense Initiative (SDI). He set in motion a national research program to investigate technologies that might some day make it possible for us to defend against ballistic missiles.

In this speech, President Reagan reaffirmed his support for strategic offensive modernization and arms control efforts. He then challenged the scientific community to determine the feasibility of developing systems capable of destroying ballistic missiles before they can reach their targets.

Such a defense, he contended, could provide an alternative to reliance on offensive nuclear retaliation as the sole basis for strategic deterrence.

"... Let me share with you a vision of the future which offers hope. It is that we embark on a program to counter the awesome Soviet missile threat with measures that are defensive. Let us turn to the very strengths in technology that spawned our great industrial base and that have given us the quality of life we enjoy today.

What if free people could live secure in the knowledge that their security did not rest upon the threat of instant U.S. retaliation to deter a Soviet attack; that we could intercept and destroy strategic ballistic missiles before they reached our own soil or that of our allies?

I know this is a formidable technical task, one that may not be accomplished before the end of this century. Yet, current technology has attained a level of sophistication where it is reasonable for us to begin this effort."

President Ronald Reagan.
National address on military policy
March 23, 1983

In the long term, SDI could enhance the incentives for both the United States and the Soviet Union to safely agree to very deep reductions—even the elimination—of ballistic missiles and the nuclear weapons they carry.

A new strategy

SDI does not represent a major shift from the basic deterrent policy of the United States; rather, it represents a new strategy, a new means of achieving deterrence. On March 23, 1983, President Reagan instructed the U.S. military to find an alternative to the strategy of mutually assured destruction (or MAD, deterrence based on the threat of retaliation), a strategy the United States had been pursuing for the past 20 years. In effect, he returned the military doctrine of the United States to what it had been prior to the 1960s—a traditional military doctrine based on a balance of offensive and defensive strategic capabilities.

The shifts in the basis for deterrence have been forced by the development of better and better nuclear delivery systems. Ballistic missiles have become extremely accurate. Hard target kills (silo kills) are now possible from over 8,000 kilometers away. So, in order to maintain an effective retaliatory force, we must seek corresponding improvements or alternate solutions.

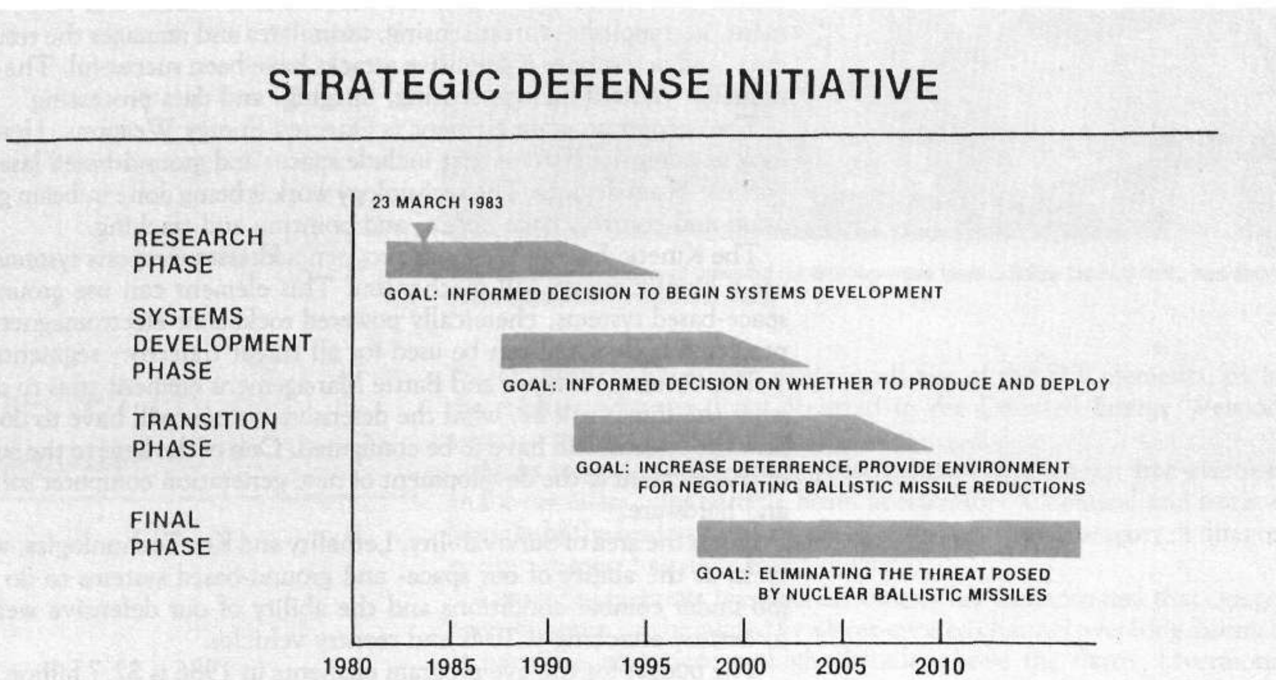
And that's what SDI is all about—an alternative to total reliance on more and more capable offensive nuclear weapons. The defensive system need not be perfect to accomplish this objective. It must, however, meet three important criteria.

First it must be effective; second, it must be survivable; and third, it must be affordable. Cost-effective, survivable defense is the key challenge to the Strategic Defense Initiative.

Five program elements

To consider defense-in-depth against ballistic missiles, one must first understand the character of a ballistic missile attack.

It starts in the boost phase. During this phase, the ballistic missiles



The Elements of SDI

- FIVE PROGRAM ELEMENTS
  - Surveillance, acquisition, tracking and kill assessment (includes discrimination)
  - Directed energy weapons
  - Kinetic energy weapons
  - System analysis/battle management
  - Survivability, lethality and key technologies

are undergoing powered flight. The missile exhaust creates an intensely bright plume which provides a very large infrared signature. The ballistic missile still has all its warheads attached. Hence, attack in this phase provides considerable defensive leverage.

In the post-boost phase, warheads and penetration aids are deployed in such a way as to attempt to confuse the defenses—still a lucrative target, but more targets to counter.

This is followed by the longest phase, the midcourse phase, when the warheads and penetration aids spread out and coast on a ballistic trajectory for several minutes on the way to their targets—the most challenging due to the discrimination problem.

In the terminal phase, the warheads and the decoys reenter the atmosphere—effective kill is essential here. Attacking ballistic missiles in all four of these phases is what is known as a layered defense system, a defense-in-depth approach.

To investigate the problem of countering a ballistic missile attack, the SDI has been broken down into five rather natural divisions or program elements. The first, Surveillance, Acquisition, Track, and Kill Assessment, accomplishes threat sensing, assimilates and manages the resulting data, and determines if defensive attacks have been successful. The technologies required include sensing, imaging, and data processing.

The second program element is Directed Energy Weapons. Here, we look at potential systems that include space- and ground-based laser and particle-beam devices. The technology work is being done in beam generation and control, large optics, and pointing and tracking.

The Kinetic Energy Weapons program addresses weapons systems that use a kinetic energy kill mechanism. This element can use ground- or space-based systems, chemically powered rockets or electromagnetically projected bullets and can be used for all threat trajectory segments.

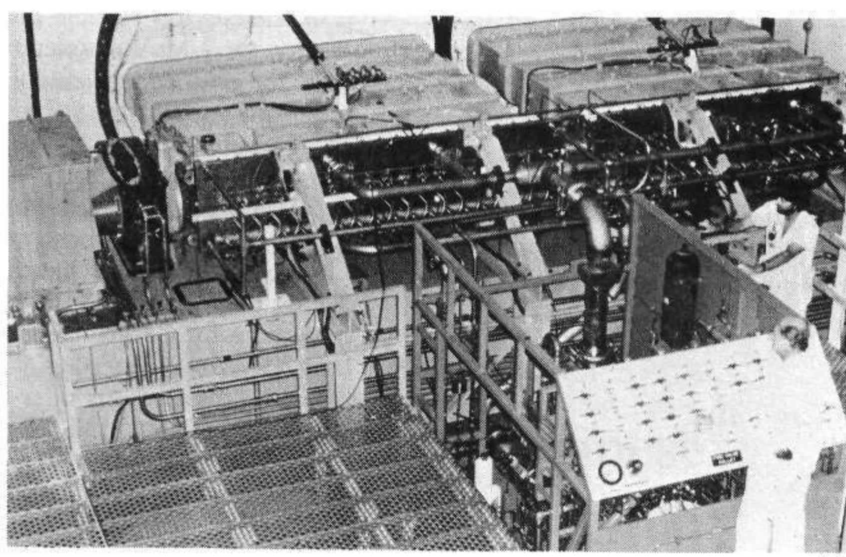
The Systems Analysis and Battle Management element tries to define what the threat will be, what the defensive systems will have to do, and how the systems will have to be configured. One of the keys to the success of this element is the development of new-generation computer software and hardware.

Last is the area of Survivability, Lethality and Key Technologies, which looks at the ability of our space- and ground-based systems to do their job under combat conditions and the ability of our defensive weapons to destroy attacking ICBMs and reentry vehicles.

The budget for the five program elements in 1986 is $2.7 billion. The proposed budget for 1987 and 1988 is $4.8 billion and $5.4 billion, respectively.

DOD

Higher power, narrower beams with a faster retarget time yield higher kill rates.



DOD

The Miracl laser, the most powerful continuous-wave laser outside the U.S.S.R., has shown beam quality near theoretical limits.

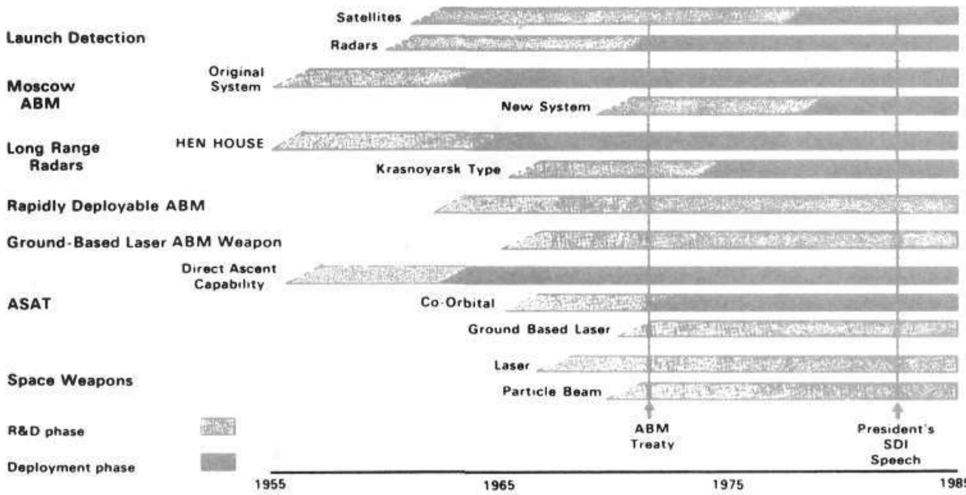
Directed energy weapons

While advances have been made in all five of the SDI elements, by far the greatest advances have occurred in the Directed Energy Weapons area.

At its inception, SDI encompassed chemical, excimer, free-electron, and x-ray lasers, and particle beam accelerators. Chemical and excimer lasers held the lead in thinking three years ago. Every category of directed energy weapon has since made progress.

Lawrence Livermore National Laboratory has demonstrated that charged particle beams can be guided by a laser-created channel over long distances at pressures equivalent to high altitudes above the Earth. Livermore's Advanced Test Accelerator, an induction linear electron accelerator operating at 50 million electron volts (MeV), has been used for propa-

Soviet ABM/Space Defense Programs



Soviet programs for ABM and Space Defense, which include advanced technologies and space based weapons, were in place prior to the 1972 ABM Treaty and have continued to expand in scope and size. During the same time period U.S. ABM Space Defense research has been limited in scope as well as the level of effort in terms of resources invested.

*Potential capability of the Moscow ABM system

gation experiments on the laser-channel concept. The beam has propagated over distances longer than the 80-meter accelerator length.

In the Neutral Particle Beam Program at Los Alamos National Laboratory, the 2-MeV Accelerator Test Stand has met its beam performance goals for that energy, and has recently been modified to include an additional acceleration stage, the drift-tube linear accelerator, which will boost output energy to 5 MeV.

Space-based chemical lasers have made advances in beam control. Beams from several medium-power hydrogen fluoride lasers have been combined into a single coherent output, and the large cylindrical Alpha I hydrogen fluoride laser is under construction. Such work aims at producing near-diffraction-limited beams with high efficiency. All major subsystems for a space-based laser have been emerging in experimental form.

Ground-based lasers offer the advantages of ground basing and high power. They would use relay mirrors, which would cost much less to transport to space than would complete weapons. Such lasers have the advantage of operating at visible wavelengths, which means small mirrors can be used. Laboratory experiments have shown the high energy potential of pertinent xenon chloride/krypton fluoride gas lasers. A Los Alamos krypton fluoride laser recently produced 10 kilojoules (kJ) of energy. And this past September, the excimer deuterium fluoride mid-IR (infrared) chemical laser Miracl, the most powerful continuous-wave laser outside the U.S.S.R., showed its potential by causing a vaporific deflagration of an empty Titan second stage sitting on the ground to simulate conditions near second-stage burnout. Miracl had previously shown beam quality near theoretical limit in tests at the High Energy Laser System Test Facility at White Sands.

As the SDI program got under way, the excimer laser seemed the leading candidate for ground-based, high average power, but recently the free-electron laser (FEL) has moved to the fore as a consequence of experiments at Livermore, Los Alamos, and Boeing. Livermore has produced a very high power microwave pulse with high efficiency, and Los Alamos has operated a free-electron laser in the near-IR. As a consequence, technology development to scale the free-electron laser to visible wavelengths will be intensive.

The strategic race

In closing, the Strategic Defense Initiative is a program of vigorous research and study focused on advanced technologies. The objectives of SDI are to find ways to provide a better basis for deterring aggression, strengthening stability and increasing the security of the United States and our allies.

SDI has been proposed none too soon. The United States finds itself in a race with the Soviet Union, a race in which the United States is currently behind.

The Soviets never accepted the doctrine of mutually assured destruction. They have been actively pursuing defense against ballistic missiles since as early as 1962. Marshal V. D. Sokolovskii wrote in 1962 in his well-known book, *Soviet Military Strategy*:

"Possibilities are being studied for the use, against rockets, of a stream of high-speed neutrons [a type of neutral particle beam] as small detonators for the nuclear charge of the rocket. . . . Special attention is devoted to lasers. It is considered that in the future, any missile and satellite can be destroyed with powerful lasers."

It is not known exactly how far ahead of the United States the Soviets are. In the single area of nuclear-pumped x-ray lasers, the Soviets are estimated to have a five-year lead.

Testifying before the U.S. Senate Armed Services Committee, General Abrahamson stated that the United States could not duplicate a 1982 Soviet x-ray laser technology experiment until 1987. Indeed, the entire U.S. effort in nuclear-pumped x-ray lasers was spawned by results reported in the Soviet technical literature in the mid-1970s. The fact that all Soviet reporting in this area ceased in 1978 further supports the claim that the Soviets are ahead in x-ray laser technology, and wish to remain so.

The SDI is not an option for the United States. It is not an option for America's allies. It is a program which must be vigorously supported and pursued to counter the Soviets' current strategic superiority.

Makoto Momoi

Why the delay in Japanese participation?

Makoto Momoi is a guest research fellow at the Yomiuri Research Institute in Tokyo.

Containment of the Russians?

Although another speaker said this earlier, I would like to mention that "containment of the Russians," which has been heard frequently since the war, cannot be done simply with manpower anymore—in other words, manpower for military forces is not important anymore. For example, earlier, it was said that about 35% of the 130 submarines located in the Pacific Ocean are being relocated from Petropavlovsk Kamchatski in southern Kamchatka peninsula. Perhaps it is more than 35%.

"Containment," and "naval blockade" both have problems, but in reality, Soviet military power exists in many different areas of the globe. We must drop the idea that the Russians will never or intend never to attack from two fronts. The Russians may be thinking that with their naval and air forces and their missiles, they can attack from several fronts.

With these fears, can we still believe that Japan will be safe if there is a war? There is no way that the Pacific Ocean will be safe. Even though the United States or the Russians may not use the Pacific Ocean as a second battlefield after Europe, it is possible that military forces will be mobilized in the Pacific Ocean.

I believe the following three points have led up to the SDI. First, containment of the Russians is now virtually impossible. Second, land-based retaliatory forces are becoming weaker, or more obsolete. The reason is, as explained earlier, that Soviet weapons are now very precise in their aim. In this case, the circle of equal probability, or the CEP, has become smaller. And third, with Russian military forces in action all over the world, the Soviet forces have made U.S. weaponry appear weaker—or so the Russians think, although I wish they would think otherwise—and so they have "psyched" the countries of the Pacific Ocean, including Japan, to believe that the Soviet Union is stronger than the United States. I believe the United States is losing other countries' trust in its reliability. From an American point of view, the United States is losing its leadership status among its allies.

Perhaps saying that Russian containment is virtually impossible is an exaggeration, but we must be concerned about the following dangers: weakness of surface weapons, the situation of the military power balance between the United States and the Soviet Union, and what other countries think about this balance.

When you think about the three points mentioned earlier, it is obvious that the United States must do something about it. I believe this is how the original idea for an SDI program was formulated. There are three items concerned with the now-famous speech by Mr. Reagan.

First, although this may be inconvenient as it has the same three letters as the Strategic Defense Initiative, there is the small *sdi*. The *s* stands for sensor and surveillance, and the technologies involved with it. The *d* is for detection and discrimination of the data. Finally, the *i* stands for interception. People stress the importance of interception when discussing the small *sdi*, but I believe, for Japan, the concern is with sensor and surveillance, and a part of discrimination. We have neither the resources nor the knowledge for interception. So, when we were shown the slides concerning interception, we were shocked.

Second, while bettering offensive powers and the development of its technology, putting an effort into lessening the enemy's attack was considered. These needs will eventually arise.

I think that what I am going to say is rude to another country's president, but I believe the speech given by Mr. Reagan in 1983 has given the wrong impression to some people. Mr. Reagan said that instead of increasing retaliatory nuclear forces, or taking political hostages, which is inhuman, it would be better to protect our people from the enemy's attack. This idea was revised a year later—now SDI has been designated to supplement the already existing retaliatory nuclear forces. Therefore, there is no way that such retaliatory nuclear forces will ever be gone completely. Perhaps in 20 to 25 years this may change.

Efforts are put into destroying enemy missiles during the first, boost, postboost, or midcourse phases. Although future research will change the figures—10% of the missiles are eliminated in each of the phases—the percentage of survivability will increase. For this reason, MAD has recently been changed to MAS—mutually assured survivability. So, knowing that the survivability will increase, more efforts will be put into blocking the missiles.

And finally, the third point, which is the most important: SDI is one of the most advanced fields in America. To reestablish itself as the leader of the world, America is developing SDI to satisfy other countries. This may not be a good metaphor, and maybe the foreigners here today may not understand this, but in Judo, it is as if the United States is doing a mat hold to the rest of the world. Instead of containing, the United States is trying to "pin down" the Soviet Union with its technology.

I see the efforts made by the United States aimed at becoming the technological leader, but as we have seen toward the end of the previous presentation, I believe the Soviet Union has enough resources to catch up with the United States. There are rumors that the Soviet Union has stolen lots of information concerning research and development. Even if the material is stolen, the Russians must be able to understand the information, so they are advanced in the sense that they have enough knowledge to decipher the material. Therefore, I think we should not misjudge the Soviet Union's abilities to create and mass produce its own SDI system. If we extrapolate from the data we see on this list, it will take four to five years, or at the earliest nine months, before the Russians will catch up with the United States. Therefore, the Russians may be currently developing an SDI system, or maybe they already have one.

An interesting concept is a low-yield, say less than 5-kiloton, underground nuclear explosion in which a certain energy range is directionally targeted. This directionality is probably now physically possible.

Therefore, the Russians believe they must catch up with the United States, and they will. Perhaps in some areas, they are already ahead.

Strengthening the alliance

A bigger problem is when Mr. Reagan is about to finish his term, if the Russians say they have successfully developed or tested an SDI system, Mr. Reagan cannot say for sure that such a system does not exist. The Russians will therefore have a psychological advantage over the rest of the world, even if they don't have an SDI system. But if the Russians do say they have created an SDI system, with the way the Russians have been developing, we cannot say that the system does not exist. I am not saying that this will happen the day before Mr. Reagan quits, but the Russians may say that they have successfully tested a system at an early date. If that is the case, research on SDI must be speeded up.

Since SDI research requires a lot of time, it is necessary to have other countries cooperate in the research to shorten the time. A problem is raised here: If Japan will not cooperate, will the United States terminate its research? I think the answer is no. I am sure that they will continue, even though more time and effort will be spent single-handedly. Therefore, if Japan cooperates, less time is required. Moreover, the United States wants Japan to cooperate as soon as possible, since with cooperation, the results will be helpful to the Western countries, and so the ties between the United States and the Western countries would be bettered. For this reason, the United States has not been pushing the Japanese to strengthen its defense forces in the last year and a half to two years.

A certain cabinet member recently said that Japan should strengthen its defense forces. His real intent was to see Japan cooperate in the SDI research so that the United States will further strengthen its ties with the allies.

I believe it is wrong for Japan to think that it will get something in return if it gives what the United States really wants. This is a Japanese way of thinking. Granted, some of the SDI technology will be useful to the Japanese, which the United States will welcome. If none of the technology will help Japan, the United States won't be disappointed.

I believe the SDI is made not only for military purposes, but also to be used as a political tool to strengthen ties between countries. Therefore, Japan should cooperate in the research to strengthen its ties with the United States.

A long time has passed since Mr. Reagan made his speech three years ago, and one year has passed since Mr. Reagan and Mr. Nakasone mutually understood their points of view on SDI. From the Western allies, the United Kingdom, West Germany, Canada, and within this month, Italy, have started their research on SDI.

Another point for Japan to be aware of is that it should not worry about Europe's reactions toward Japan hesitating to cooperate. I will be attending a conference concerning problems in outer space of Europe and the United States in Italy. While I was consulting people to prepare for the conference, I heard something I didn't want to hear. Some people would rather not see Japan cooperate in the SDI research. I hear a lot of people in Europe have ill feelings toward Japanese technology, but moreover, they believe the Japanese have a special contract with the United States which says that Japan will not have to increase its domestic forces if it will participate and spend quite a bit of money on SDI research. They believe that additional forces will be supplied to the Pacific Ocean by the United States from Europe, leaving Europe open for attack. I believe there is no need to worry about this. What I hate to hear from close friends is that the nonparticipation of Japan would help Western countries, the United States and Europe, economically, and in terms of military affairs.

If Japan falls behind in space technology, there is a good chance that Europe will have an advantage over Japan. Furthermore, the United States will use that as a good excuse to reduce its security commitments toward Japan.

A supporting actor

There are many domestic reasons for not participating. Problems such as the protection and security of information flow remains. But in the long run, in terms of general security, Japan should aggressively play the role of a supporting actor. Since cooperation by Japan is already late, the level of the contents must be higher. If the contracts made with the Ministry of Defense are passed on to private corporations, several constraints will be put upon them.

Moreover, the competition will be great, so corporations that come in late will lose out. Therefore, since Japan has been hesitating to participate in the SDI program, it has been losing out. Are there any other options left for Japan? If Japan refuses to participate in the SDI program, it will have to think about how its relations with the United States will change. Will refusing worsen them? Therefore, Japan cannot just immediately refuse to participate in the SDI program. Since it took one and a half years to understand the SDI, Japan cannot refuse after all that. I regret that Japan has not participated in the program from about the time they sent their second research group from private corporations.

I believe the economic and technological spinoffs and results of the technology spreading will be talked about in the conference this afternoon and tomorrow. We must also not forget about the military technology aspects. I am sure there are several different results from the technology spreading.

I would like to mention three things before concluding. First, most military weapon plans are created once the technology nears completion; and then the technology is spread. With SDI, the technology is spread before it nears completion, which is very rare. So Japan cannot wait or hesitate to start its research. Therefore, participation must begin when it is still in its research and development stage. The difference with, say, nuclear weapons is that the technology is spread at the R&D stage.

Second, in view of aggressively getting involved with the research, and since Japan is starting late, it would be better to concentrate on certain aspects of the technology rather than moving into all fields of SDI.

I am sure that the Liberal Democratic Party, the government, and the industry people will have their own thoughts on SDI, but we also must start thinking about how far Japan can contribute to the different fields of SDI. For instance, Japan can concentrate on sensor and surveillance. As long as Japan does some sort of subcontracting job for the *d* and *i*, and it appears to be doing something, and the government approves it, that will be all right. Nevertheless, I believe the government should stress the sensor and surveillance aspects.

Third, we must consider the security aspects of the surveillance. Some people talk about sending up a Hinomaru satellite or a surveillance satellite—this is not the issue. The issue is that the SDI system only works when a global surveillance system is set up using satellites. Now, can this global surveillance system be linked to local surveillance systems? In Europe, ideas of creating space systems located in the extreme regions of, say, TDA and TDI in a three-dimensional configuration, linking ground radar systems and space surveillance systems, have been suggested. In Japan, surveillance systems are often referred to as nonmilitary systems. Therefore, the Japanese believe that this system is worthless, but I think they should reconsider that. If they criticize the system in public, the government may think that people will oppose the system. I think that Japan should emphasize it for security purposes, and for spreading its technology. Well, perhaps criticisms shouldn't be made.

Once these points are made, the issue raised is not whether Japan is able to refuse to participate; rather it is whether Japan saw all the evidence before they refused. I don't think what I am going to say can be translated into English, but . . . Japan has been lagging in the development of nuclear energy applications and guidance missile systems because arguments say that these applications and systems are military in nature. For instance, this is why China launched its first satellite before Japan did.

To know what kind of economic impacts the SDI will have when used in a gravity-less environment is very important; but more important, Japan should have participated in the SDI program when other countries, especially European ones, were chartering the American Shuttle and sending scientists to do research—like the Germans did. We should know what they are doing.

Since the decision for Japan to cooperate has been delayed for so long, the United States could not get the help from Japan in order to further its allegiance to the Western allies. Many debates were held in Japan during the delay—and now the Japanese government cannot aggressively take actions. Therefore, the government can either tacitly approve the situation, look the other way, or let private corporations work on it—a move the French didn't even take. I am worried about Japan losing the competition with European corporations for Defense Department contracts. Therefore, the last thing I want to mention is that Japan should set goals and focus its efforts to contribute to the SDI program if they decide to do so.

April 22

Panel II: The economic dimension

Dr. John Cox

The economic dimension of the SDI challenge

Dr. Cox, a laser physicist, is president of Future Tech in Gainesville, Florida. He has worked on the nuclear-pumped laser concept for both NASA and the U.S. military.

Two aspects

There are two aspects of the economic dimension of the SDI challenge. The first relates to the need to produce and deploy the defensive systems at a cost lower than the countermeasures. The other relates to the technology spinoffs to the private sector, a feat which the Japanese have shown to be second to none in doing.

At present, the current state of the art in defensive systems relates to countermeasures that are nuclear, in the form of defense, or aggressive counterstrikes from a nuclear attack. The SDI philosophy is to produce a nonnuclear response, a response in which the actual population—the people, civilians—are not targets of the responsive force. There are a number of technological issues which must be solved to develop a nonnuclear deterrent to nuclear war.

The speakers earlier today discussed a wide variety of technological advancements that are required to achieve this goal. In the past, our defensive measures have been essentially retaliatory strikes, and antiballistic missile defense. To produce a nonnuclear strike, a number of new technologies need to be employed: These are basically the actual weapons themselves and the electronic communication systems that are necessary to coordinate and execute them.

The SDI has identified a number of advanced technology development centers required to attain this goal. There are five individual programs established by the SDI that are administered by a number of military agencies and the private sector in the United States. One technological development center is *systems*: the overall systems coordination and integration. Another center is *sensors*: electronic sensors for the acquisition of targets and determination of the status of various effective countermeasures. Another development center is *directed energy*: These are typically laser and particle beam and other exotic energy systems. Another is *kinetic energy systems*: These are basically supersonic or very fast bullets, if you will, that are considerably faster than the launch vehicles themselves. The other sector is basically a collection of all of the other relevant and key technologies, lumped into one program, and these can be categorized as *survivability*, *lethality*, and *others*.

There are, in fact, about 25 individual research programs that have been identified by the SDI Innovative Science and Technology Office. These are too numerous to go into detail, but each offers a new opportunity to exploit the technology and provide benefits to the private sector. I will list these now.

Technological issues

One of the crucial requirements is ultra-high-speed computing, in order to integrate all of the systems and respond to the threat posed by a nuclear launch. When nuclear warfare became an issue in the 1940s and 1950s, it took many hours or most of a day before a launched weapon arrived on its target. At present, a submarine sitting off the coast can deliver a warhead in a matter of minutes. It is important to be able to determine the status of a launch, if it is in fact a real threat, and react to it. High-speed computing and integration, therefore, are very important.

Laser satellite networking is necessary to coordinate ground-based and space-based laser systems with the targets.

Integrated detection, estimation, and communications theory, is another aspect of software integration of the computer systems and the actual hardware that are doing the work.

Advanced materials and structures is concerned with producing lightweight launch vehicles to support the battle stations in space, as well as hardening targets. There are a number of new materials and structures being investigated now, which provide promise for very lightweight, very strong structures, such as the carbon-carbon composite materials used on the Space Shuttle.

Another area is advanced propellants—propellants that produce very high specific impulse—that would deliver these very heavy payloads into orbit on short notice for the pop-up programs, as well as maneuvering the space-based permanent stations.

Advanced pulse power would be used both for power generation of the battle station, and for providing a power source for high-energy laser systems. Advanced electrochemical power sources are also being examined, in the philosophy of a nonnuclear system, which includes not only nonnuclear weapons systems but nonnuclear power sources to support these systems.

Optical sensor technology is probably one of the most important aspects of these program elements and also represents some of the most obvious spinoffs to commercial technology.

The high-power beam combination systems, which basically take a number of low-energy, inexpensive systems and combine them on target, present a number of challenges that overlap several other areas.

Sensor survivability and reliability is another issue which is covered by a number of topics.

The rest revolve around either advanced technological development of various weapons systems, or the defense of the system in various environments, both nuclear and natural environments, posed in the confines of space and the upper atmosphere.

An example: the x-ray laser

As I said before, it would probably take too much time to delve into all of these areas and opportunities. I have chosen one new technology to elaborate on, to give you a feel for what is involved in these new technologies and how they may benefit mankind in other dimensions besides defense. To that end, I have chosen the x-ray laser, whose feasibility has been demonstrated at this point, but which requires a great deal of technological innovation before it can be realized. I believe that Dr. Winterberg is going to complement this discussion with the applications of this new x-ray laser technology, and how it will benefit medicine and science.

To begin, I would like to discuss the motivations behind development of such a laser. It is well known that the efficiency of such a device is very minute. Only one millionth, (one part in 1 million) of the energy produced is actually delivered by the laser. That is, it takes 1 million joules of energy to produce 1 joule of energy in the x-ray region. This problem casts a shadow over the effectiveness of the device, but if you examine the real issue of delivering this energy to the target at some distance, you will see that by going from the infrared region of the spectrum (in which most chemical lasers work today) into the x-ray region, the ability to deliver a given amount of energy on target, at some distance away, is enhanced a millionfold. This is due to the diffraction limit of the radiation produced by the laser. It turns out that by decreasing the wavelength by a factor of 10, you can realize a 100-fold increase in intensity at the target. In going from the infrared region of the spectrum to the x-ray region, this is 1,000 to 10,000, thus producing 10 million times more intensity at the target.

The other aspect of this motivation for the x-ray laser is the ability to devise a countermeasure against the effects of laser pulses. Reflecting and defending against infrared radiation from a laser is very straightforward; it is quite another matter to defend against x-ray pulses. A simple mirror or thin armor coating will defend against most infrared lasers, whereas with x-rays, it is quite difficult to shield and defend against such a pulse.

So that is the basic motivation for the x-ray laser: You can deliver a much higher power density and much more penetrating radiation than is currently possible with chemical lasers.

Nuclear pumping

There are two methods currently being investigated right now, to produce an x-ray laser. One of them is actually driven, or pumped, by another laser. The second is produced, or pumped, by a nuclear explosion. Now, obviously, the nuclear-pumped device has very limited commercial application, whereas the laser-pumped system, however inefficient it is, has a wide variety of commercial applications.

The nuclear-pumped version of the x-ray laser is based on the fact that 85% of the energy produced by exploding a nuclear weapon in space is produced in the form of x-rays. That same weapon detonated in the atmosphere, in contrast, produces most of its energy in the form of infrared or heat radiation and blast wave.

If the weapon is detonated in space, as proposed, the x-rays can thereby be focused or collimated through passive devices and can produce an enormous intensity of x-ray energy at a large distance from the source. The x-ray laser takes a huge source of isotropically emitted x-rays and collimates and focuses that radiation on a target. While this is a very inefficient and poor method to produce radiation, due to the fact that you have an enormous energy from the source, it represents a very feasible source of a laser weapon.

Laser pumping

The laser-pumped version of this device was studied first in Russia, and was then investigated in the United States, and now is being studied at Osaka University's Institute of Laser Engineering in Japan. This device is charged or pumped by a visible light laser (used now to study laser fusion) and produces a very hot plasma, due to the intense laser interaction with a solid target. The plasma has an extremely high temperature, something on the order of about 10 million degrees Celsius. Under these conditions, the majority of the electrons surrounding an atom, such as selenium or other heavy metal, are stripped away, producing the required population inversion to achieve lasing. Coherent radiation produced in this environment produces extremely bright pulses of x-ray radiation, on the order of about 10 megawatts per line emitted from the source.

There are a number of technological issues that must be resolved before such a system can be realized and used to produce both weapons and other research tools. These include a more efficient source to produce the hot plasma required, the optics required to collimate and direct the laser energy, and the new materials necessary to enhance the conditions of the plasma.

Economic spinoffs

I would like to talk now about the economic implications in the form of spinoffs to the private sector. There are a number of past examples of military spinoffs which have invigorated the economy since World War I and World War II. The most obvious examples are consumer products used today that benefit the private sector. These include radar, the computer, the transistor, and the microwave oven. Some of these are consumer items and some of these items are used for aircraft safety and maintenance.

It is most difficult to conceive how these technologies could be developed through purely profit-oriented motives normally associated with consumer items. It is said that necessity is the mother of invention, and that the father of invention is greed; normally, consumer items are born with the father of invention. So it is left up to the military, traditionally, to produce the need for these exotic technologies which require many millions of dollars to produce, and sometimes many years before the actual profit can be realized by the manufacturer.

It is quite often said that the military has produced the most spectacular innovations and developments for which the United States has become known. But I would like to take a moment to say that the Japanese have shown a genius in converting these ideas and prototypes built for the military into products which are affordable and can be highly competitive on the open market. While I do not suggest that the Japanese participate directly in the defense buildup, it is their genius in converting an expensive technology to an affordable technology, through mass production and innovative manufacturing techniques, that is a very important aspect of the SDI challenge.

I suspect that that is the very reason why Caspar Weinberger, the Secretary of Defense, asked the help of the Japanese to put their genius to task here, to convert our highly expensive, critical technology to an affordable technology, which can not only be cheaper than the countermeasures afforded by the Soviets, but will also spin off into the private sector and be enjoyed by millions of people.

The present opportunities afforded by the SDI challenge, in my opinion, far exceed the combined opportunities provided by the military and space developments. The areas I talked about earlier represent the forefront of technology in almost every area of scientific advancement that we are now undertaking. These technologies typically require many hundreds of millions of dollars to develop, and under the burden of that investment, it is very difficult for the private sector to take the gamble and risk involved to produce these systems. Therefore, the bulk of the risk is absorbed by the military. Once the technology is demonstrated, then it is a simple matter to make it a cost-effective device so that the private sector can benefit from this technology. Thus, cooperation with the military spending and military thrust in developing new technology, and the ability to take that technology and cheapen it and simplify it, is a very critical step in realizing the SDI challenge.

I'd like to conclude by mentioning something about a visit I had to the Osaka Institute of Laser Engineering. I have seen the equivalent institutes and laser laboratories in the United States, and I must say that the effort that the Osaka Institute has put together outshines the efforts produced by its American counterparts. I am very impressed with that Institute, and I believe that it is an example of the Japanese ability to take existing technology and bring it to a level of achievements not duplicated elsewhere. And based on what I have seen, I believe that the Japanese can provide a very important and very advantageous part when cooperating with the American ability and drive to delve into and produce new ideas. It is this cooperation, I believe, that will make the difference between failure and success.

Dr. Friedwardt Winterberg

Problems and solutions in SDI technology

Dr. Winterberg, a research professor at the Desert Research Center of the University of Nevada at Reno, is a pioneer in inertial confinment fusion and the father of the concept of impact fusion.

I would like to talk here about certain aspects which are often overlooked in the context of the Strategic Defense Initiative.

First of all, I think we can say without any exaggeration, that the greatest technical triumph so far achieved by man, is the landing of a man on the Moon and bringing him back safely to Earth. The success of this project is often quoted in support of the SDI, in the sense that it is argued: What the scientific community for a long time considered to be quite unfeasible—manned space flight—turned out to be eventually feasible. Scientists who were once considered utopians, like Goddard and Oberth, who proposed space flight in the 1920s, were vindicated. And it is argued, that it is very often very difficult to predict in particular what is technologically feasible by extrapolating from our scientific knowledge.

However, I would add here a note of caution. It is certainly true that there is no basic physical law which would make SDI impossible. However, in comparing the success or the potential feasibility of the SDI with the landing of the man on the Moon, I would like to remind you that the Man in the Moon did not fight back in our effort to get there, but the Russians certainly will fight our efforts to make an SDI.

Consider the prediction or the assessment of the scientific community in another very famous goal, which plays a great role these days—the goal of controlled thermonuclear fusion. There, the difficulties appear to be enormous, but the scientific community has given it a relatively optimistic chance for success. The reason for this, of course, is understandable. Already in 1952, it was shown that with a fission bomb as a trigger, we could ignite a thermonuclear reaction.

Unfortunately, such a thermonuclear explosion is too large to be of use, at least for many applications. I should say that there are certain possibilities for use of even such large, or larger, nuclear explosions—for space propulsion, for excavation, and other things, apart from military applications. But, there is very little doubt, that to ignite a thermonuclear reaction, much less energy should suffice. And in particular, it is expected that the energy required to do this could be drawn from a powerful beam, whether a beam of light—a laser beam—a beam of charged particles, which can be electrons, ions, or even a fast-moving projectile. I did omit the other possibility in between: a beam of microparticles, a beam of dust particles accelerated to high velocity.

There is a complete spectrum of particles, and in each case, the concept is the same. We bring some particles, whether they are photons or even a projectile, to a state of kinetic energy, and then upon impact it will release thermonuclear energy.

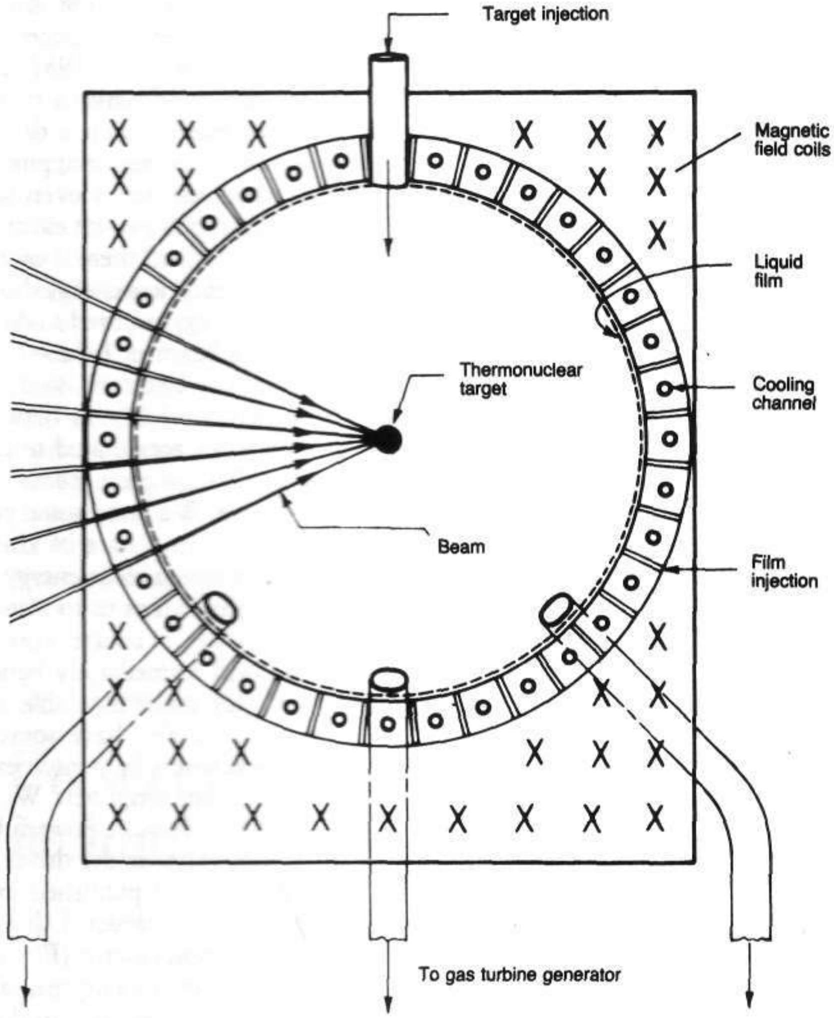
Now, this brings us to something very interesting: One spinoff of the SDI, which is, of course, concerned with the generation of very powerful beams, will immediately benefit thermonuclear research, in the sense that it may make available the technologies to produce these beams. However, we also have something more, because if we release a thermonuclear reaction, a microexplosion, we can then do something which I call a beam amplifier: We can produce beams which are maybe a thousand times more powerful, by using the thermonuclear reaction, the microexplosion, as the driver for a secondary beam.

In an article I published in a book almost 20 years ago, I included a proposed design which I think was the first concept of a thermonuclear microexplosion reactor (**Figure 1**). The principle is that a target, which is about as big as an aspirin tablet, is ignited by beams. How that works, now, I will not go into in detail; the important point is that magnetic field coils surround it, making a combustion chamber where a little microexplosion, a little hydrogen bomb, is ignited, maybe several meters in diameter. Then, there are magnetic field coils; at the moment that the microexplosion is ignited, a fireball expands at a velocity of 1,000 kilometers per second. It has a very high conductivity; it pushes the magnetic lines of force to the side; and the result is a very large electromagnetic pulse, which can have the magnitude of a gigajoule. For example, if the microexplosion releases an energy of gigajoules, then an electromagnetic pulse of gigajoule energy with a very short duration can be produced. Then, we can use this pulse—you notice, megajoule beams are needed to ignite it—to drive a secondary beam.

In **Figure 2** we have, first, a generator which produces a beam; a microexplosion; then, the magnetic loop, which is essentially the entire chamber, that charges up a generator for a secondary beam, bringing us to an amplification of the energy output (versus energy input) by a factor of thousands. A part of the energy release goes back to recharge the capacitor bank for the beam generator to produce the beam, or to charge the capacitor bank for the next microexplosion. So, we get an enormous amplification and can produce beams of enormous power.

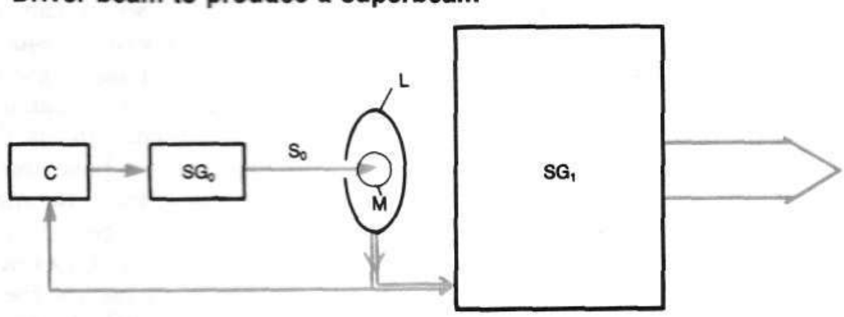
Of course, that is one of the problems of SDI: We always hear it said, "We need all the power plants of the world to drive such beams." Of

Figure 1
ICF reactor concept (Winterberg 1969)



Source: F. Winterberg, *Physics of High Energy Density*, Academic Press, 1971.

Figure 2
Driver beam to produce a superbeam



A thermonuclear microexplosion inertial confinement fusion reactor (M) generates through magnetohydrodynamic loop L a large electromagnetic pulse power which drives SG_1 machine to produce superbeam S_1. Thus, a thermonuclear microexplosion driven by a much smaller driver beam, in the megajoule range, generates a superbeam in the gigajoule range. Part of the energy picked up by the MHD loop recharges capacitor bank C to produce the driver beam S_0 through beam machine SG_0.

course, if we can make thermonuclear microexplosions, we have a very elegant way to amplify input energy by a factor of 1,000. And of course, the input energy can be recovered through a certain branch in the loop, for the next shot.

This is a very good example of how fusion research will immediately benefit SDI research, and vice versa, of course: SDI research will benefit fusion research.

The targeting problem

Apart from the energy problem in SDI—which I think will get a tremendous push from controlled fusion, a tremendous enhancement through the achievement of controlled fusion—there is another very difficult problem in SDI, which is frequently overlooked by SDI enthusiasts. That problem has to do with the fact that the Earth is curved. In other words, if some missiles are launched in the Soviet Union, we cannot shoot them down from America, because laser beams do not follow the Earth's curvature. One way to solve such a problem, which I do not think is very satisfactory, is the idea of fighting mirrors.

The Earth's curvature forces us to do two things. Either we must have a very rapid pop-up system—in other words, some kind of defensive system must be popped up from the surface of the Earth to a very high altitude, so that it can see the target over the horizon—or, we need space battle stations. (Of course, these problems would also be less severe if the Earth were hollow, or were flat; there are some enthusiasts of the flat-Earth theory, living primarily in the Netherlands, who also write me once in a while. I like to call the hollow-Earth theorists "hollow-heads," and the flat-Earth theorists "flat-heads.")

First of all, let me speak about the concept of mirrors in space very briefly, and the problems associated with it. Of course, many, many solutions have been discussed. I would like only to say one thing: When I flew from Los Angeles to Tokyo, they showed a movie, and suddenly, there was some kind of laser defense beam activated—it was the first movie I saw about the SDI. Somehow accidentally a missile was launched, and it was floating somewhere in space; and then, a laser beam was shot up with a mirror. However, it didn't work.

Now, that's probably one of the few cases where Hollywood is actually right. The movie still had a happy ending for some other reasons, which were not related to this incident. For a laser guidance system to find a target is extremely difficult. This is better illustrated by the recent shootout President Reagan had with Qaddafi, where a laser-guided smart missile missed by about 1 mile. In the Hollywood movie, the beam *almost* zapped the missile—it didn't do it, but almost.

The point is, the targeting problem is extremely difficult, but I think it is solvable. Tremendous advances have been made with infrared sensors. These advances in infrared sensors, in which, by the way, the United States is clearly ahead of the Russians, give good reason for optimism that this problem can be solved.

Energy storage in space

One other problem in connection with the SDI, is the question of how the energy can be stored in space. Now, if we are on Earth, we can use the beam amplification method to get extremely powerful beams. But it wouldn't help us to curve the beam, because it cannot be curved, unless we have fighting mirrors. If instead we are in a space battle station, it is first of all important to raise the question, what kind of energy storage devices do we have? We must, somehow, in a space battle station, store the energy.

Figure 3
Basic energy storage systems

	ε erg/cm³	ν cm/sec	$\theta=\varepsilon\nu$ watt/cm²
Kinetic	10^{10}	10^{5}	10^{8}
Electric	10^{6}	3×10^{10}	3×10^{9}
Magnetic	10^{10}	$<10^{9}$	$<3\times10^{12}$
Chemical	10^{11}	10^{6}	10^{10}
Nuclear fission	10^{19}	10^{9}	10^{21}
Nuclear fusion	10^{18}	10^{9}	10^{20}
m_0c^2	$\tau 10^{21}$	3×10^{10}	3×10^{24}

x in erg/g nuclear fusion or 10x nuclear fission

With magnetic insulation and beams in torus values for ε and ϕ in between nuclear and nonnuclear are possible.

Figure 3 involves the different orders of magnitude of the energy storage capabilities we have.

First, there is kinetic energy storage, electric, magnetic, chemical, fission nuclear, fusion, and finally, antimatter. The energy storage of nuclear devices is much, much larger than chemical, typically larger by a factor of 10 million. One thing is strange, that fusion should have less energy density than fission; but that, of course, is only if we express it as energy per cubic centimeter. In terms of energy per mass, fusion is about 10 times better.

This involves another very interesting concept: magnetic insulation. If you have a large magnetic field of 100,000 gauss, it can prevent electric breakdown. What we need is a very good vacuum; then we can produce very large voltages. For example, if we have an object or conductor which is surrounded by a magnetic field, in the vacuum of space, shielded by a magnetic field of 100,000 gauss, and it has a dimension of 10 meters, you could charge it up to 10 billion volts.

We can also store energy in a beam, and then we can use it in connection with the free-electron laser (**Figure 4**). Also, a beam is magnetically insulated; the magnetic field holds a beam together, and we can bring in an enormous amount of energy in a beam. So, the magnetic insulation concept appears to be extremely important. And, with magnetic insulation, you are between chemical and nuclear energy.

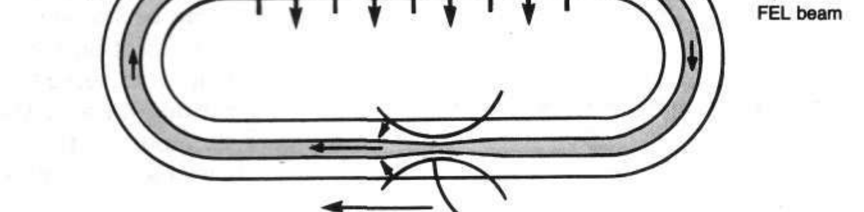
We can, for example, create very large storage rings, which can store megajoule energy, and the beam can run around for a year. Now of course, we cannot use a racetrack which is many miles long, we must have a compact one, and the current must be much larger. But again, this appears to be, in principle, possible.

A fission renaissance

By just comparing the numbers, it is clear that the use of nuclear energy sources in space is almost an indispensable requirement for a space battle station. That, of course, means that certain fission reactor concepts, which were shelved in the 1950s, when fission reactor development was a hot item of research, will be revived in the context of the SDI. For example, the sodium-cooled nuclear reactor, which was actually developed by the United States, was found to be not competitive with the light water reactor, but for space power applications, entirely different criteria are relevant. First of all, the reactor has to be very compact, and it must have a very high energy-production density. So, the SDI will definitely result in a renaissance in the development of nuclear fission reactors.

I would like to give you one exotic concept, which for a power plant, unfortunately, is not feasible, but which, perhaps, for space power ap-

Figure 4
Schematic of free-electron laser

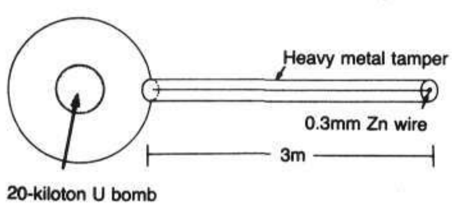


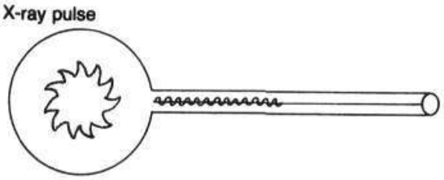
plications may be feasible. It is an idea which was proposed a long, long time ago, to make something like a fission combustion engine. We have a certain fluid in a piston, the piston compresses the fluid, it becomes critical, heats up, and then the piston is like an internal combustion engine; it is pushed down by the cylinder and drives the flywheel. The problem with this idea, which is an old idea, is that the fluid, unfortunately, is very corrosive. But of course, concepts like this, or also gas core reactors, may be quite interesting. The piston-driven fission gas reactor is particularly interesting because it works with higher densities. Gas core reactors at high temperatures can work only with relatively low densities; the reactor would become very large. But of course, it could produce a very large power.

Dealing with countermeasures

One other very important problem, in the context of the SDI, is that we must somehow foil attempts to destroy a space station. For example, it was asked here by one of your colleagues, how can one counter this objection against the SDI: One has a space battle station, and a rocket brings a load of sand into orbit, in the opposite direction; a typical orbit speed is about 8 kilometers per second; so, if a load of sand goes in the opposite direction, you would have 16 kilometers per second, and definitely, the space station would be destroyed.

Of course, that means that the space station must have some kind of propulsion unit, and therefore, of course, we need ion propulsion. In other words, the SDI battle station must always be able to avoid an astronomically predictable orbit. Normally, of course, if you have a space station and there is no propulsion, then it will be on an orbit which can be predicted with famous astronomical accuracy. In order to avoid that, and therefore to foil the attempts by, in this case the Soviets (or whoever wants to take countermeasures) to bring that thing down, the space station should be capable of changing its trajectory. Even if it can only change it slightly, it can avoid being destroyed.





So, a space battle station must be equipped with a nuclear propulsion unit. Chemical propulsion would be unsuitable, because the specific impulse is totally inadequate; chemical propellants would be used up very rapidly. But if you use, for example, ion propulsion, in combination with a nuclear reactor, the specific impulse is roughly 1,000 times larger, so the fuel or the propellant in that case would last 1,000 times longer.

The x-ray laser

I would like to speak now, very briefly, about one of the most exciting SDI developments, the x-ray laser (**Figure 5**). In the x-ray laser, the idea is essentially that one has an exploding atomic bomb—it can also be a hydrogen bomb—and a tube. Inside of the tube, there is a wire—it can also be a plasma. The x-rays emitted from the nuclear explosion, before the explosion destroys the whole arrangement, pump the material of that wire. Contrary to what you would think, this is a continuous wave laser, because the x-ray transitions and the whole assembly will last about maybe 10 nanoseconds. So, there will be many transitions of the excited to the ground state.

Now, there is one problem with the x-ray laser: The beam, unlike a regular laser, would have some spread. An x-ray laser weapon would essentially be a nuclear device with a sequence of pipes attached to it. The spread is determined through a ray which has an opening angle equal to the diameter of the pipe divided by its length.

To overcome the spread problem, the ultimate solution is something very, very interesting. I do not know if it has ever been considered: With an exploding bomb, one also gets an extremely large current through the

Compton effect, which can go up to billions of amps. Now suppose we have such a current. Then, one would produce magnetic fields approaching those magnetic fields you have in a neutron star. Now, if that can be done, then one gets into what in plasma physics is known as the lower hybrid resonance. We get, as in a pinch effect, a magnetic field which is in the direction around the wire, and the electromagnetic pulse would propagate around the *z* direction. In the hybrid resonance, if the magnetic field is very, very large, so that the electron-cyclotron frequency is comparable to the laser frequency, then the plasma can guide the beam with high precision.

It is quite conceivable that this is one of the concepts considered by Livermore; I do not know. If that works, that would definitely be the ultimate solution: One uses the plasma effect through a magnetized plasma, whereby extremely large magnetic fields can be produced. Whether that can be done, I do not know, but rough calculations show, with the magnetic fields to be expected here, one reaches the lower plasma hybrid frequency. Then, of course, one could produce a beam which practically could go more than 100,000 miles. Then, you could actually place such an x-ray laser, for example, in a geosynchronous orbit and would not have to worry about the pop-up system; otherwise, you need the pop-up system.

I should like to mention the following. If we can make an x-ray laser with a macro-explosion, of course we can also make an x-ray laser with a microexplosion as well. And of course, that would have tremendous implications in biological research, because then we could make holograms, x-ray holograms of biological living tissue.

For an x-ray laser to be popped up from the surface of the Earth, would require a combination of thermonuclear microexplosion technology that would drive an electromagnetic gun (**Figure 6** and **Figure 7**). If we have a driving force to drive such a gun, thermonuclear microexplosions would take place here in these different reactor chambers; then the enormous current pulse could activate coils. Then we could launch an x-ray laser—which essentially consists of an atomic bomb with a sequence of pipes attached to it, each pipe directed to a different target—launch it above the horizon, and then, of course, it could be directed onto the booster target.

First of all, if the plasma focusing of the laser beam is in fact possible—

Figure 6
Multiphase megagauss electromagnetic gun driven by a thermonucleaar microexplosion reactor

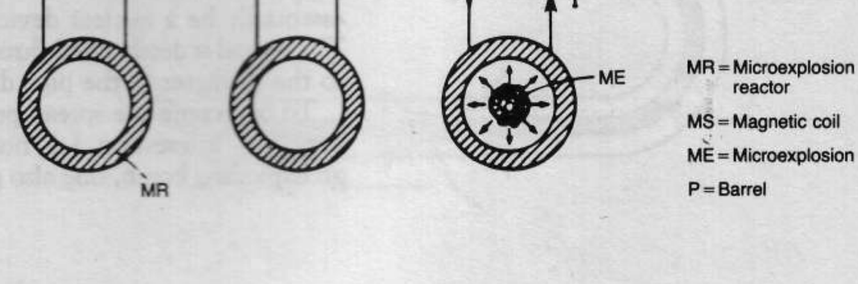
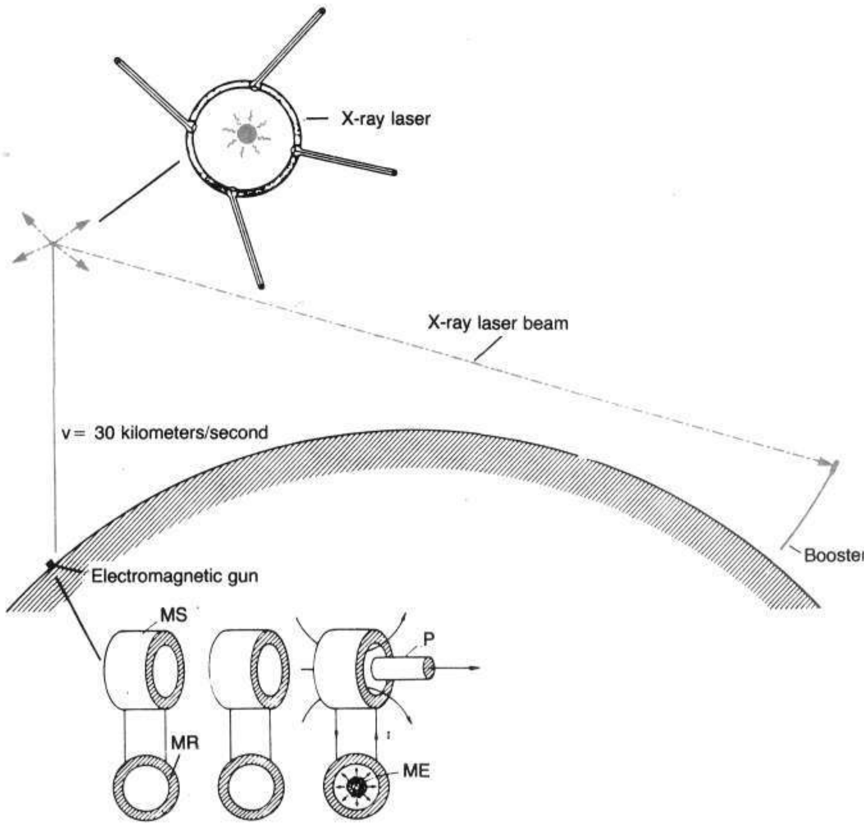


Figure 7
Electromagnetic guns to launch x-ray laser systems



Huge electromagnetic guns in northern Canada could pop-up x-ray laser systems at 30 kilometers per second to kill Soviet rockets in the boost stage.

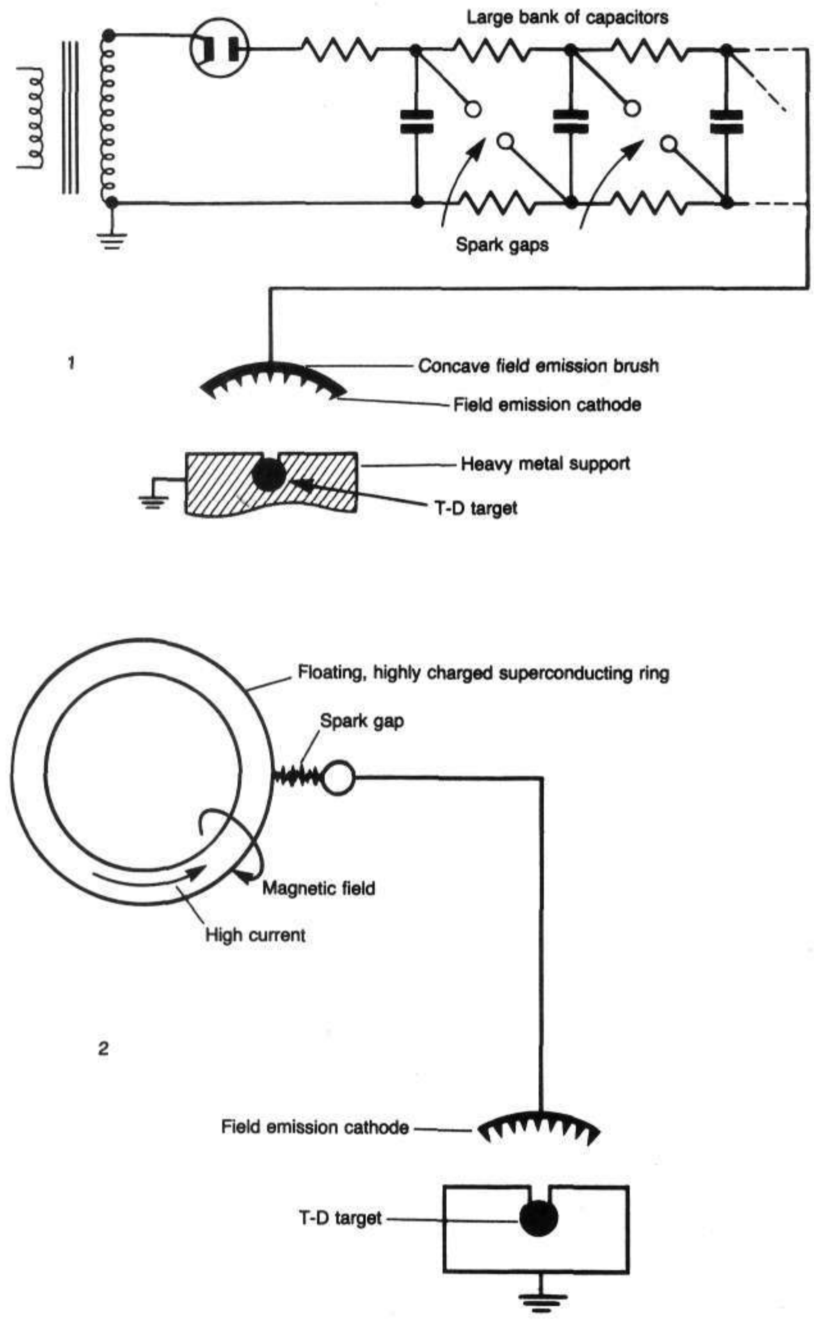
for example, with the magnetic lens effect I described—then of course, all the fast boosters which would reach their final speed at a lower altitude could also be destroyed, because such a laser beam would be so powerful it would simply punch a hole through the atmosphere.

MIMAS: the ultimate SDI concept

I would like, finally, to make a few remarks on the concept of MIMAS called "nuclear peace"—the ultimate goal of nuclear peace. MIMAS stands for magnetically insulated macroparticle accelerator system (**Figure 8** and **Figure 9**). It emerged out of some ideas I had a long time ago. At that time, I had suggested that if one uses a floating, superconducting ring suspended in ultrahigh vacuum, and charges the superconducting ring up to a very high voltage, then one could draw the energy from the superconducting ring and bombard a target. (The magnetic field prevents a breakdown—this is the magnetic insulation concept.) If the ring has a dimension of meters, and if the magnetic field is of the order of 100,000 gauss, which could be done with superconductors, then one could charge up the ring to a billion volts—a voltage which has never been achieved otherwise.

Of course, when you have such rings in space, they would be very large—not just a meter but maybe tens of meters. A nuclear power plant would be attached to it which would charge the ring up. That could be done by projecting an electron beam away from the ring; the ring would be automatically charged positively—and then one would have a microparticle gun.

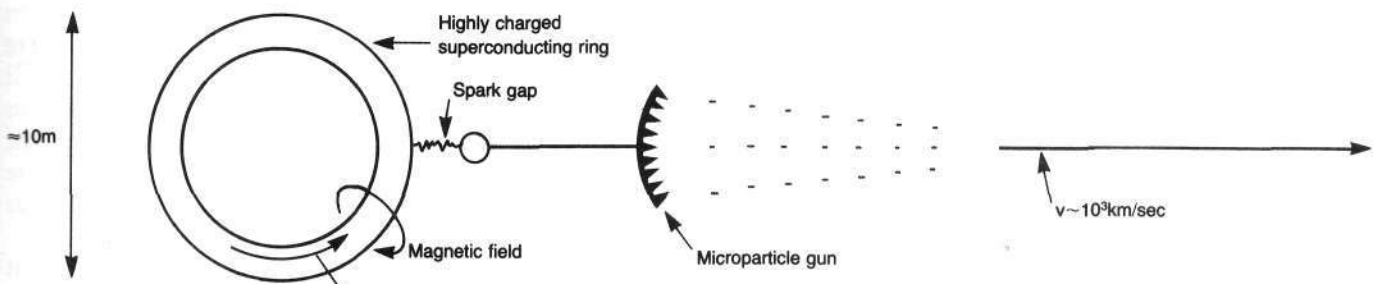
Figure 8
Magnetically insulated macroparticle accelerator system



What are the advantages of placing such a ring in space? First of all, by its very large magnetic field, it could not be attacked easily by other kinetic energy weapons, because these kinetic energy weapons would vaporize in the extremely large magnetic fields. One could thus make a beam weapon, simply by releasing microparticles, which are small dust particles, a beam of which would propagate at 1,000 kilometers per second, propelled by this very large electric field of the ring. In the MIMAS concept, the thing could act as a beam weapon, and at the same time automatically defend itself, because it shields itself by the very large field.

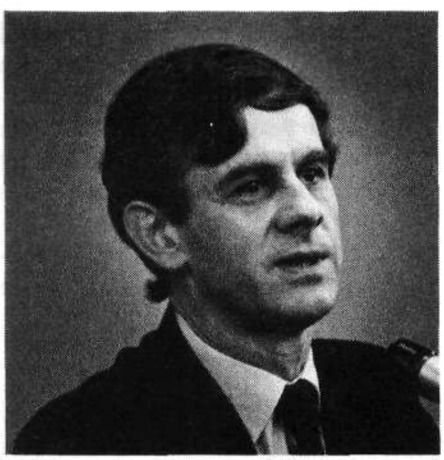
The Shuttle would bring the material to build these rings; one would

Figure 9
Magnetically insulated macroparticle accelerator system



have a large number of such rings; and the rings could, against any kind of missile attack, launch a barrage of fast-moving tiny projectiles moving at 1,000 kilometers per second, which is completely sufficient to destroy all the missiles which could be launched from the surface of the Earth.

Both superpowers would have, according to that concept, such magnetically insulated satellites. The satellites could not be destroyed; they would be shielded by their own magnetic fields. This is probably the ultimate SDI concept.



Uwe Henke von Parpart

The technological revolution promised by SDI

Mr. von Parpart is the director of research at the Fusion Energy Foundation, Washington, D.C.

Professor Cox and Professor Winterberg, I think, have given you some idea of the tremendous scientific and technological possibilities of SDI. Even those of you who are not scientists or engineers I think will have gotten some impression that what SDI implies is not just a small step forward in technology, but rather the opportunity of rapidly developing new technologies which, only a few years ago, were still regarded as utopia. This is the most important implication of SDI: We may in fact be able to skip entire stages of technology, by trying to bring, through military research, certain new technologies ultimately into the production process which, without SDI, we could not even have thought about until the next century.

If the last two years of SDI research are any indication, then it should be quite clear that the advances that were made in two years already have proven every serious critic of SDI of three years ago wrong. It is important for this audience to understand that arguments which I myself or Professor Cox or Professor Winterberg might have had against SDI—many of these arguments have been disproven already in the course of only two years of concentrated SDI research.

This is a very typical experience that we have had in the United States and, in fact, elsewhere in the past: that once a specifically task-oriented scientific technology program is launched, we cannot simply look at the original ideas and then try to make a prediction of how long it will take to implement them. But sometimes, entirely new ideas will come in sideways, if you will, which will make some of our original ideas obsolete before we even begin to implement them. The exciting prospect of SDI research is that this possibility of skipping entire stages of technologies is directly implied. SDI research is not like ordinary defense research, because it is research at the very frontiers of science with the immediate need, at the same time, of trying to implement these ideas as rapidly as possible.

The only other example in this century for this was the development of nuclear weapons during World War II. As you know, nuclear fission as a scientific principle was not even proven until 1939. And even in 1942, when the Manhattan Project started, nobody expected that nuclear weapons could be constructed in a short period of time. However, the United States then concentrated 40,000 of its best engineers and scientists on that effort; simultaneously, in parallel, they developed many different concepts, and then selected out from the different concepts those that were most promising. And the effort succeeded in less than one-third of the time that the most eminent scientists had expected in 1942.

The very same kind of possibilities are implied by SDI. From an economic standpoint, what this means is that our entire production apparatus—the production technologies that are now in use—may approach obsolescence in a period of only five to ten years. This is the broadest implication of this type of research.

The economic impact

Now, what I will report to you about, at least in summary, are several studies that the Fusion Energy Foundation has carried out since 1982 on the economic impact potential of SDI. Nineteen hundred and eighty-two, of course, was the year before the SDI was announced, and the economic impact studies that the Fusion Energy Foundation carried out had a good deal to do with the ultimate decision in the United States to go ahead with the project, because one of the questions that had to be answered was—is this not only scientifically feasible, but is it economically feasible? And I want to address myself specifically to this issue of economic feasibility, and not only what you might call microeconomic spinoffs, but macroeconomic implications.

I would also like to say here, at the beginning, that I believe that the Soviet Union is not necessarily principally concerned with the military implications of SDI. They have talked about it a great deal, and whatever they talk about a great deal is something that I find one should probably dismiss as not being the essence of the matter. What the Soviet Union has not talked about is the expected strategic-economic impact of SDI.

If you had been watching the United States, how we behaved economically during the 1970s, and watched this from the Soviet standpoint, you probably would have been very, very happy indeed. Because without any external threat, we managed to damage our economy in the United States to such an extent, that the United States manufacturing sector managed no average productivity gain in the entire period between 1972 and 1982. This is a very important thing to understand. We have had some productivity gains in the economy overall, but almost all of those have come from agriculture and not from the manufacturing sector.

Incidentally, to my mind, that is the real problem of U.S.-Japan economic relations. The reason why Japan has a trade surplus is that our own manufacturing sector is not competitive in productivity with the Japanese production sectors—not for any other reason. Everything else, and this is just an aside, is so much nonsense and fog and smoke, but not the reality. And also as an aside, if I may make one brief statement on this: The idea that the United States is now recommending that you change *your* economic policy in the way *we* did in the 1970s, strikes me as patently absurd. Unless you simply want to travel down the same road that we did, please do not take this advice.

Now, as I said, I believe that the Soviet Union is more worried in a certain sense about the economic impact potential of SDI than about the military potential. There is every indication that if we can bring these new technologies on-line in the reasonably near future, and if we simultaneously can get collaboration between the United States, Japan, and Western Europe, then we will have a dramatic advantage over the Soviet Union in economic-strategic terms, because our economies are quite capable of transferring military research into applications in the civilian economies.

By the very structure of the Soviet economy, they are almost entirely incapable of doing that. The Soviet Union is capable of copying certain military technologies and developing, for example, an almost perfect replica of the F-16 fighter in a relatively short period of time. However, these developments in their military production sector, which are under the control of the GRU (military intelligence), do not usually even so slightly benefit the civilian sector.

In our economies—in the United States, in Japan, and in Western Europe—there is no significant distinction between civilian and military research. Yes, I know that officially there is in Japan, and I know officially there is in Europe, and officially there is in the United States, but if TRW produces something for military purposes, the same engineers will be thinking about civilian applications, and what is true for TRW is true for Mitsubishi.

So, I think we have the capability of technology transfer from military research to civilian research, and the Soviet Union has tremendous difficulties with that. So, their greatest fear must be that if we collaborate in SDI research and development, they will be left far, far behind in overall economic advance during the next decade. The strategic implications of that will be enormous.

The most important strategic thing that could happen in the world today is if the U.S. economy recovers in depth. I don't mean the kind of phony recovery we have had over the last three or four years. Right now, we are simply financing our recovery by extracting capital from the developing sector, which is an extraordinarily strange thing: that the world's largest economy should have become a net capital importer from the developing world. This must be reversed. But if we can revive productivity in the United States, the strategic long-term implications of that will go well beyond any specific military matters that we could be discussing here.

A tenfold productivity increase

Now, in light of this, I would like to also say another brief thing. I was asked recently by a Japanese economic journalist: Well, the SDI research program is laid out for about $32 billion between now and the year 1990. How much of this, as a percentage, might Japanese companies capture, if you in fact decide to participate? And then this journalist asked me also: What is going to be the market demand for some of the products that may become spinoffs from SDI?

I told him that I could make an educated guess about both of these problems. I could say, maybe you can capture 10%, maybe 15%, I don't know. But frankly, that is not what matters. What matters is for Japanese industry to be in on the ground-level of the type of research that has been discussed here before in technical terms. That will be your most significant advantage. Not a few hundred million dollars of defense contracts. Those are real, those are important, those are useful, but ultimately it is *not* what counts. What counts is to be/in on the ground-level of such research.

Then he asked me about market demand. I said, "Well, let me ask you a question. If I had asked you in the year 1960: What is going to be the market demand for semiconductor-based products, what would you have said?" And then he laughed, and said, "Well, of course, I would have vastly underestimated this."

The same thing is true for SDI. We cannot predict what will be the market demand. The only thing we can predict, is that the type of technologies and scientific advances now being discussed have the potential of improving average productivities in industrial production about 10-fold—that is to say, by about 1,000%. We investigated in our work a very large range of new SDI-implied technologies, and the average productivity gains of introducing these technologies into the production process, ranging from high-energy lasers, to laser welding, to new materials, new structures, new propulsion systems, etc. There was not a single case in which at least a fivefold productivity increase was not realized.

Now please consider that in macroeconomic terms. Any country that realizes a 5-10% annual productivity increase considers itself very, very happy indeed today. If we could get 500-1,000% increases over a 10-year period, this would be the most massive productivity push in industry that we have experienced in the post-World War II period. We believe that these figures are quite realistic. I cannot report to you all the details of our work; for those of you who are interested, we would certainly be willing to make it available to you.

The return on research

Now, let me give you some simple and interesting figures which, if you are not aware of them as yet, may at least give you some indications of what SDI implies.

Table 1 is something that you can actually read in almost any newspaper now, so it will not be any great news to you. But these are essentially the SDI research budget projections as they exist right now. The total for 1985 was about $1.3 billion; 1986, including certain elements of ballistic missile defense not covered by the research budget, gives you $3.7 billion; and then essentially you will be scaling up, by about $1.5 billion every year, so that a total of $32 billion in constant 1986 dollars will be reached by the year 1990.

Now, in 1974, some economic analysts in the United States were asked by NASA to make some estimates of the return on research money that

Table 1. SDI budget

(millions $)

	1984	1985	1986	1987	1985-90
Surveillance, acquisition and tracking	367	546	1,386	1,875	
Directed energy	323	376	965	1,196	
Kinetic energy	196	256	860	1,239	
Systems analysis	83	99	243	273	
Support	23	190	267	327	
Total	992	1,397	3,721	4,910	32,151

NASA had spent. That is to say, what was the relationship for every research dollar spent by NASA in terms of return to the civilian economy. The estimate ranged between $14 for $1 in research, all the way up to $23. But let's just take the lower figure. Then, the research impact of SDI, if you multiply $32 billion by 14, will give you about $450 billion in overall benefit returnable to the economy, if SDI is successful at a level of productivity enhancement similar to NASA. Since the SDI program is much broader than the space program, and since it implies a much larger variety of different technologies, I think there is absolutely no question that the multiplier 14 is going to turn out to be a relatively conservative estimate. So that gives you at least a general idea of what is involved.

Now, the other point is this: We know historically that the relationship between research and development, and procurement cost in military matters, is about 1 to 20; that is to say, for every dollar that the Defense Department spends on research, if the weapons system gets developed, you will spend about $20 for procurement. So that would give us a very rough estimate of what the total deployment cost of SDI would be after 1990—that is, roughly in the range of $500-$600 billion. We may say it's going to be less, it may be somewhat more, but basically if you want any estimate at all that makes sense, I would say $500 billion overall is a reasonable assumption. So, that is the simple financial scope of SDI.

The present top 10 SDI contractors in the United States are: Boeing, Lockheed, McDonnell Douglas, LTV, Teledyne, Rockwell International, TRW, Hughes, Avco, and Litton. The contract total for 1983-1984 was $1.5 billion. I don't think there is a single surprise there. Even if you did not know it, you could have guessed it. But it makes the point that I made before: All of these companies, of course, are also massively involved in civilian research and development, and the internal transfer of technologies from the defense side to the civilian side is something that can happen very rapidly and very readily.

Technology spinoffs

Now, in order to assure that technology transfer from the military to the civilian sector in SDI does occur, as Mr. Zondervan pointed out this morning, the SDI Office has created a special office for innovative science and technologies. The specific areas of research are listed here, and the reason I put up this list, is to give you a sense of the scope of SDI research.

1) Reliability of electronics: This means, for example, fully self-correcting chips and circuits.

2) Nonlinear optics: beam combination, phase conjugation technologies, investigation of penetration of beams through the atmosphere, which in turn will give us interesting insights into atmospheric science itself.

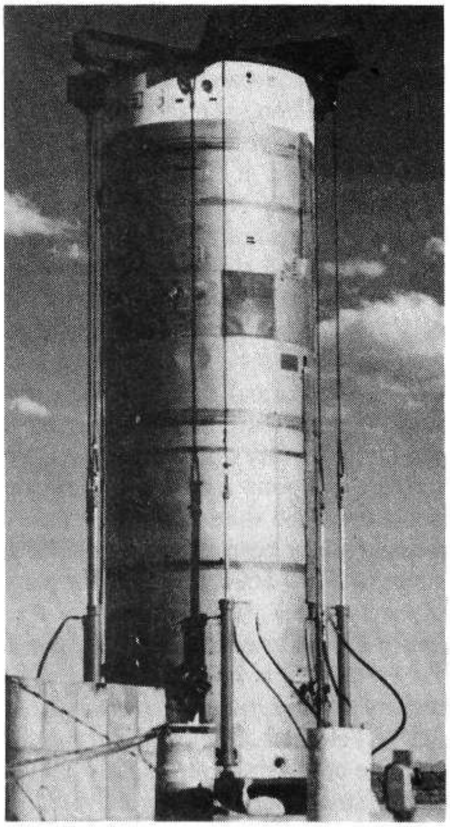
3) Short and ultra-short wavelength lasers and free electron lasers: As pointed out before, the x-ray laser is not necessarily pumped by nuclear explosive devices, but can be pumped by a different laser, by a more conventional type of laser. And probably the major advances in biological and especially in cancer and related research that we will get by being able to use x-ray holography will allow us to actually look at the living cell; we will not have to kill biological cells any longer in order to investigate them. This will be dramatic, and will probably foreshadow some of the most dramatic advances ever in biological research.

4) Advanced accelerators.

5) Power sources.

6) Advanced materials and structures.

7) Energy-materials interaction.



U.S. Department of Defense

The High Energy Laser System Test Facility at the White Sands Missile Range, N.M. Much to the surprise of many, the Mid-Infrared Advanced Chemical Laser, MIRACL, destroyed the second stage of a Titan I booster missile in a Sept. 6, 1985 test.

Let me focus on points six and seven. These different materials composites that are being investigated by SDI, in just two or three years of research have produced new results which nobody was able to predict, even a short time ago. But most important, we are now testing these materials under very, very extreme conditions. That is to say, we take any new advanced material and we are hitting it with a high-power laser or a particle beam, rather than ordinary stress testing. And we are learning enormous amounts about new materials. You saw Mr. Zondervan this morning show the Titan booster that was hit by a laser—a very small laser, not very powerful. Every scientist who observed that experiment was absolutely astonished by the effect. It was expected that the laser might burn a hole, that it might produce a crack. Nobody had expected, however, that the laser would actually explode the booster; it was a totally unexpected effect. It shows you that, when we are testing new materials in this extreme environment, we will be able to make advances that had not been expected.

Most likely we will, in a very short time, have new types of materials which will permit the construction of self-supporting airframes—we will no longer have to put sticks into the wings. And the advances in aircraft technology that could be gotten from that are extremely significant—they might reduce the cost of airplane construction by more than 50%.

8) Survivability, hardening: "Hardening" is a very interesting point, because it addresses the question of building engines, various kinds of engines; not only for spacecraft, but engines for an ordinary automobile, that may possibly be surface-hardened without having to do hardening of the entire cylinder or the cylinder head. There are major advances possible in this field.

9) Ultra-High-Speed Computing: I think the most interesting ideas and concepts here will be in optical computing for which Bell Laboratories and other laboratories in the United States now have major SDI contracts. To give you an idea, we are talking about, even in the moderate range of SDI, about 5 giga-ops (operations per second), for those of you to whom that means something. And in overall battle-management, on some occasions, we might have to go up to 1,000 giga-ops, so the advances in computing speed and in necessary associated software architectures required are major, and if they do occur, obviously the economic implications are almost entirely impossible to estimate.

In 1984, there were 4,800 scientists directly employed in SDI-related work. By 1987, this figure will have grown almost fourfold to 19,000. By 1990, it will again increase three times; and during the actual deployment phase, we will probably have at least 160,000 scientists and engineers involved in SDI-related work. This would be almost double the number of scientists and engineers involved in the Apollo project at its high point in 1966.

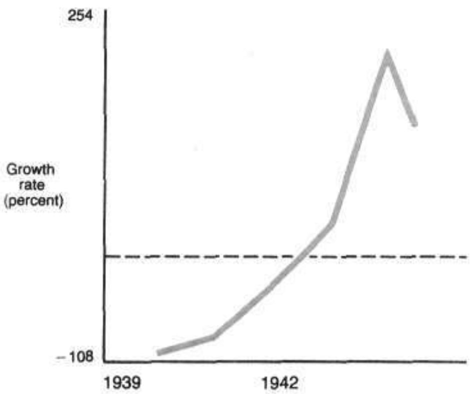
So, not only are there new technologies, new materials, and new computers to be gained from SDI, but, if you will, also new scientists, new people, and new talent. And in the long run, that is more important than any specific scientific advance, material, or new gadget that we could create.

Now, I want to briefly return to the macroeconomic studies that we carried out in the context of SDI.

Historical models

In order to test our ideas, we looked at the U.S. war economy between 1942 and 1945. **Figure 1** is representative of about 50 graphs that we produced, analyzing the war economy. We looked at overall productivity in terms of the relationship of output to unit labor input in totals. In

Figure 1
Productivity: output per unit of capital investment



the initial period of the war, when the United States primarily resupplied Britian but was not itself involved in the European side of the war, no new technologies were being introduced into military production. Under those conditions, productivity in the relevant production sectors actually went down. The reason is relatively simple: We tried at that point to produce many things very quickly with inadequate means. We put a lot of people to work on military production, but did not give them adequate tools to actually carry out the job. However, by 1942, certain entirely new technologies and methods were being used for military production. And the productivity gains that the U.S. economy made, especially in the course of 1943-1944, were absolutely astonishing, outdistancing anything, at least in recorded U.S. economic history. Of course, this was under very special wartime conditions, and you may have to correct for this, but basically it gives you a sense of what happens when you retool in depth in economic infrastructure.

The figure shows not the totals for productivity, but simply the growth rate of productivity. Until 1942, we were actually still at a level of productivity growth that was below breakeven. Right after that, productivity increased at a very rapidly increasing exponential rate. Without going into the details of our study of SDI-implied technologies and their productivity impact, something quite similar to these types of productivity gains are very much implied by what SDI is actually all about. This is what I think we should all reflect upon when we're discussing economic and technical collaboration in the SDI context.

Some SDI projects

Now, I want to run through a series of relevant technologies very quickly to show you some of the major points.

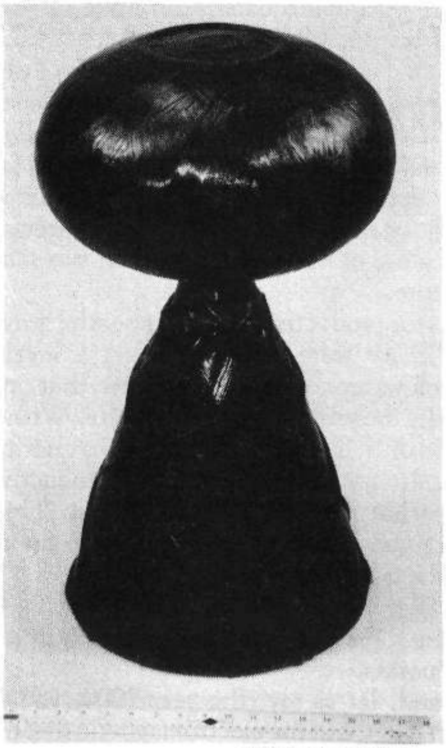
Taking the years from 1850 and, let us say, the year 2000, you will be struck by what interesting wavelengths of the electromagnetic spectrum industry characteristically operated on. Until very recently, we basically used only the infrared range of the spectrum. With the new technologies, the major gain that we are going to make is by moving into the shorter wavelengths of the electromagnetic spectrum: We will be able to concentrate energy better for production. That is the major thing implied by all of this. Or to put it differently, we will reach higher energy flux density, more energy per unit time and per unit area. That is all that productivity ultimately is about: How can we use energy and concentrate it in order to make production more efficient.

The Shiva laser at Lawrence Livermore is going to be used to attempt to produce commercial energy from thermonuclear micro-explosions. A similar program—and in fact by now, a larger program, as Professor Cox pointed out earlier—is now actually under development at Osaka Laser Engineering Laboratory. But fusion energy, obviously, as you all know, is ultimately the principal energy source that we will have to count on on this planet, maybe not tomorrow, maybe not even 10 years from now, it's not all that important. But clearly, the beam developments in SDI will speed up the time when so-called inertial fusion is going to come on-line.

In the process, we will be bringing on line things like flexible laser-based machine-tool stations. I don't think I have to explain too much about this to this audience. These kinds of devices are now under development in Japan. We can only expect that lasers, especially high-energy lasers, will become a lot cheaper to produce and a lot more readily available, and better understood in the near future, so that these developments can proceed.

A laser built by, I believe, Avco Laboratory, is now used for production for metal-cutting. Again, nothing particularly new. The interesting thing in SDI is materials/energy interaction studies: We're learning a tremendous amount about what is actually the best way of using lasers, especially with very hard materials.

We will also be introducing a plasma steel-making furnace, in which you can produce in a few seconds the amount of steel that normally would take several hours to produce. Especially for specialty steels, this is very important, and again, it is now being pursued in the context of SDI, precisely in order to produce certain types of specialty steels that cannot be easily produced otherwise.



U.S. Department of Defense

Model of an advanced flexible rocket nozzle. Made of carbon, the nozzle can contain the rocket thrust. Then, by moving the nozzle mechanically, the rocket can be steered with high precision in short periods of time.

As was indicated earlier, we might be able to drive an x-ray laser, not with a nuclear explosion, but perhaps with a small fusion reactor. The SDI Office has given out about 20 contracts to universities and other laboratories for the development of very compact fusion devices.

The Soviets some years ago developed a concept for a magnetohydrodynamic power generator based on thermonuclear reactions. This was published at that time by E. P. Velikhov, a top Soviet laser and fusion researcher, who is now one of the people in the Soviet Union who goes around the world and says that SDI is not scientifically feasible. Thank you very much, Mr. Velikhov.

In fact, I will relate a brief story which is interesting. I was at a fusion conference in Leningrad in the summer of 1981, and then visited the Lebedev Laboratory in Moscow, where they do a lot of their laser research. In the evening, I had dinner, I was invited by some Soviet scientists—I think I should perhaps not name names—but in any case, they told me over dinner, "Look, wouldn't it be a great idea to use lasers for ballistic missile defense?" This was in August 1981. And I looked at them, and thought, "Yes, probably it's a good idea, we better think about it fast." So, Soviet scientists have been thinking about this without any question in more detail and with more precision than we have in the United States for a longer period of time. Anybody who doubts that, should simply question some of your own scientists and ask them what Soviet scientists know about that from their own standpoint in scientific conferences.

One aspect of magnetohydrodynamic devices is so-called super-capacitors: Capacitors today can store about 100 joules per kilogram. SDI has now demonstrated capacitors that can store up to 20,000 joules per kilogram, so you can see energy storage is going to make some major steps forward. What that means for industry again, I think I do not have to elaborate.

New materials are being used for rocket nozzles that are flexible and can be moved in order, for example, to withstand very concentrated energies, and be used to move a battle station around.

A new type of gyroscope has been developed to replace the present type of gyroscope, based on fiber optics. This, of course, is another area in which, in fact, Japanese industry has a significant lead over other world industries, in fiber optics—not specifically with regard to gyroscopes. In fact, your space agency doesn't like gyroscopes, because there are some people who say that if you put a gyroscope in somewhere, it might be used for military applications.

I cannot go into more details, but I think it should be clear that what is implied in economic and technical terms by SDI research is broader than any similar research program in the past. Therefore, quite apart from all specifics, to jump into this at this point, I think is the right thing to do. More importantly, I would like to emphasize that there have been some people in our government who have themselves questioned whether SDI might survive the Reagan administration. I think if you see the kind of research that is now going on, the kind of efforts that are now being made, it doesn't ultimately matter what happens after the Reagan administration. On these kinds of programs, I do not think there is any way of turning back.

Ozeki Tetsuya

The economic implications of SDI for Japan

Ozeki Tetsuya is an editor at the Research Institute of Jiji Press, Tokyo.

What I'm going to speak about is by-products of SDI, which started about three years ago. Whether or not it is going to be a practicable idea is still questioned, still a controversial point in the United States as well as in Japan.

A typical example is Sen. William Proxmire, who submitted a report on March 11 in which he mentioned that money was wasted for intercontinental ballistic missiles, whether or not SDI (Strategic Defense Initiative) may be possibly applied. The conclusion of whether or not SDI could be applied for ICBM defense is not reached. The massive investment or propensity to invest in SDI should be questioned, if this is the kind of report submitted by a senator.

As for the participation of Japan, some questions have been raised. In the morning, it was mentioned that European countries are hopeful that Japan should not participate in SDI. This is what Mr. Momoi mentioned. In the United States, they have some questions against the capabilities that Japan has, on various occasions. The *San Francisco Chronicle* of April 9 stated that already in December of last year, a rider was added to a defense budget bill submitted to Congress, that says, when it comes to SDI, it should be bought from the United States. The potential contracts related to SDI that by 1990 could total $32 billion, are in the scheduled budget. Of course, it is not appropriated yet, it must be approved by the Congress before it becomes a reality. According to the *San Francisco Chronicle,* about 1% of the $32 billion of R&D would go to manufacturers outside of the United States.

An adventurous dream

But both of those reports are out of focus. As Mr. Henke von Parpart mentioned, SDI is a precision child of President Reagan. If President Reagan retires after three years, some people doubt the survival of SDI, and especially the Democratic Party takes that viewpoint. Sen. William Proxmire, who is very strict about spending, naturally is against SDI. But as you have noticed during the morning discussion, SDI is not only a strategic or tactical concept. It is conducive to a new technical explosion based on a new set of rules. It will open up a new frontier of technology and industry. It is a grandiose adventure of technical explosion. It has already been set off and nobody can stop this current.

Mankind has accumulated and upgraded technical capability by experience, but we have come to a kind of deadlock. This is exemplified by the Space Shuttle project, which is related to SDI, and which on

Jan. 28 exploded in front of our eyes. The causes are now being investigated, but probably it is because there are some bottlenecks accumulated in the process of technical development. It was a kind of a primitive cause, as people became rather loose in observing or controlling technology.

But what about technical breakthroughs in the future? There should be some, to be rather optimistic, since SDI was conceived as a breakthrough of scientific innovation and economic spinoffs. Labor productivity in the United States is declining and is not competitive against Japan. United States industry must think of some other ground rules since the existing ground rules may not be effective for improving productivity in the United States.

Not only technical or economic spinoffs, SDI will give an adventurous dream to mankind as the diagrams and graphs indicated. It's a grand project which cannot be changed at the discretion of one political party or one government. So whether or not the Reagan administration continues two more years or longer, already the process has been triggered. There is no return.

Japan already participates

Whether or not it is desirable for Japan to participate in SDI, I would have to say that Japan has already participated in a sense. For example, the memory chip, the dynamic random access memory drum. Such silicon chip production in Japan, exported to the United States, is considered to be one of the friction sectors between the United States and Japan. The 258 kilobyte dynamic drum, no longer a high tech product, still has 75% of the United States market. In some areas, 90% of market share has been taken by Japanese products, and this is the very cause of the semiconductor friction. That semiconductor is massively used in civilian or private use in Japan, but it is used for military purposes in the United States. The key part of American military computers, then, is manufactured here, and the market share of that element made in Japan is 75-90%. If there is $32 billion budgeted for five years to come, 1% of which will be procured from outside, Japanese manufacturers already occupy a very large share of the components used for SDI.

Whether or not Japan or Japanese manufacturers decide to participate is a different matter. You have already taken a step to participate in SDI. The opposition parties would say that Japan has been involved in the strategy of the United States, and they would vehemently criticize this, but it is too late. Because of the status of Japanese technology and technical advancement, we have already been involved in the SDI even if some don't like Japan participating; it is too late. Even if the Japanese manufacturers do not like to participate in SDI, it is too late.

Then, what future course should be taken? It is a question of whether or not we should take this opportunity; whether or not we should recognize the reality. If you don't want to recognize this reality, and if you choose not to participate in SDI, that's all right. Then you'll be involved as one of the subcontractors and you will serve the SDI concept of the United States as a subcontractor. Probably, moneywise, it is the same amount of money.

But in that case, Japan is learning the ground rule already set by others. Japan will be the follower, and we will end up with SDI friction. And it is crystal clear that we will be involved in SDI friction if we are just following, so we should take a positive attitude and contribute in a small way to establish a new ground rule.

As for the technical orientation or direction, if we participate in this process, the lead time will be shorter. If we don't participate, we expect the lead time will be much longer; and we will be a dropout in the next process of technical development.

Some American industries do not like Japanese participation, probably because they don't want Japan to take the ride. Color TV and automobiles invented by the United States were all taken up by Japan, and Japan is very successful in all of those areas. And this is the reason why some of the Japanese industries are deploring their status. These Japanese industries do not like a new technology if they are content with obsolete technology. But it would not be wise just to throw away this SDI technology in the wastebasket and just leave.

Required technologies

We don't know how effective, how efficient SDI will be for Japanese industries, but you should use your own brain, your own hands, your own eyes to see how much effect SDI would give. The United States is urging Japan to participate in the SDI project, and I don't have to emphasize this point because all of the speakers for today have made this same point. The super high-speed computer, for example, the super compact computer which can be mounted and save space, has not been realized yet. We do need a gallium arsenide semiconductor. The Japanese manufacturers have already made products using gallium arsenide as a computing element. The super high speed chemical calculation computer has been made into a product using gallium arsenide by Japanese manufacturers. And this is just one example of the technical capability of Japanese manufacturers.

And some American people have wanted Japan to participate from the very beginning, and all of the six speakers of today said that Japan should participate from the very beginning, to contribute to the ground-rule establishment. Then what are the new technologies that we can expect from SDI? First of all, sensor technology and high speed computing are areas of new technological development. But besides those, machine tools and new materials and the ultimate energy, which is a fusion reactor, will be introduced in this framework.

What is often neglected in Japan and what is important in the future, is military versus nonmilitary. The demarcation line between the two will become thinner in the future. For an example, a Japanese cargo ship off the coast of Nashi island collided with the American George Washington nuclear submarine. This Japanese vessel was sunk. It was treated as just an ordinary accident, which took place several years ago. But this gives us a lot of concern not only for American nuclear submarines, but also Soviet submarines which are navigating around Japan. Even with the technical capabilities of Japan, we cannot locate these vessels. With American cooperation we may be able to identify them, but otherwise, we cannot identify them and we cannot even give them warnings to avoid collision. This is not only the defect or shortcomings of technology for defense, but also threatens the navigation of commercial vessels.

Currently, in order to detect submarines, we have to depend upon magnetic devices and sonic technology. With the development of SDI, infrared laser and visible ray, close to the blue spectrum, might be used. Blue is close to ocean blue and can penetrate deep into the ocean. Such detection technology can be developed jointly by the United States and Japan. And if that technology is developed, not only the present location of Russian submarines, but also any dubious vessels can be detected. We could notify the U.N. organization, whenever we found such unidentified vessels, and commercial ships could avoid collisions.

Those new areas will emerge one after another whether we like it or not. So we should decide how Japan should cope with that new situation.

April 23

Panel III: The scientific dimension

Dr. Jonathan Tennenbaum

Technologies to take man into space: A 100-year perspective

Dr. Tennenbaum is the director of the Fusion Energy Foundation, West Germany.

Figure 1 shows the leading short-term and medium-term technological spinoffs of the SDI. These technologies are already essentially known, and the SDI will greatly accelerate their perfection and commercialization. However, the greatest long-term impact of the SDI will be to open up entirely new technologies, based on what Dr. Teller has referred to as "new physical principles." Is it useless speculation or science fiction to try to predict such long-term spinoffs? I think not.

Although scientific and technological innovation is, by its very nature, a highly discontinuous process, it still obeys certain laws. Rather than discuss these laws in general, I shall briefly present some graphic material based on historical studies of technological evolution.

Technological evolution

Figure 2 illustrates the development of primary energy-producing machines, from 1750 to the present. The vertical axis represents energy-flux density, the amount of watts per meter squared of the decisive energy-transforming surface in each technology. Observe that each new basic technology permits a "jump" increase of 50 to 100 times in the energy-flux density. This parameter is the most important criterion for the productivity of a given technological level. It is remarkable how regularly these technological "jumps" are ordered. We find a general exponential increase in energy flux density at an average rate of about 4.7% per year.

A similar exponential increase is seen in the domain of technologies for generation of coherent electromagnetic radiation (**Figure 3**), while **Figure 4** illustrates the spectrum of energy-flux densities in present-day technology. We see a clear grouping according to basic economic sector

Figure 1
Technological spinoffs of the SDI

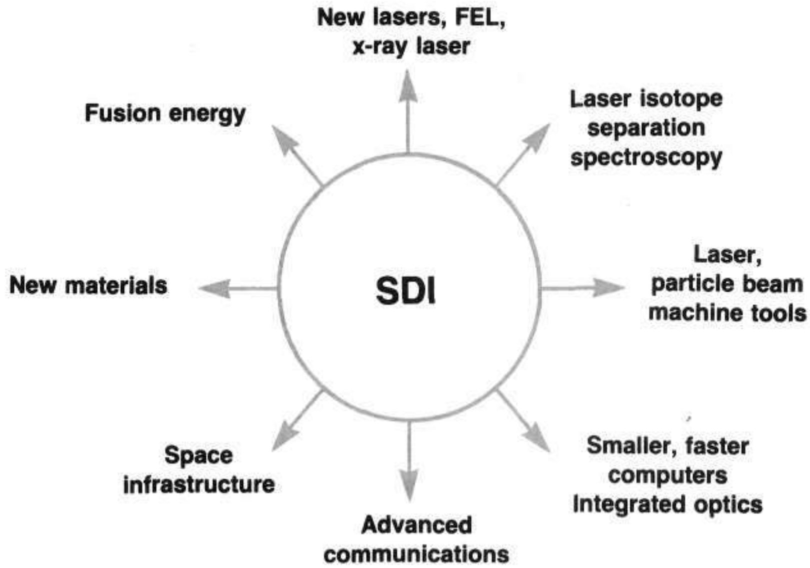
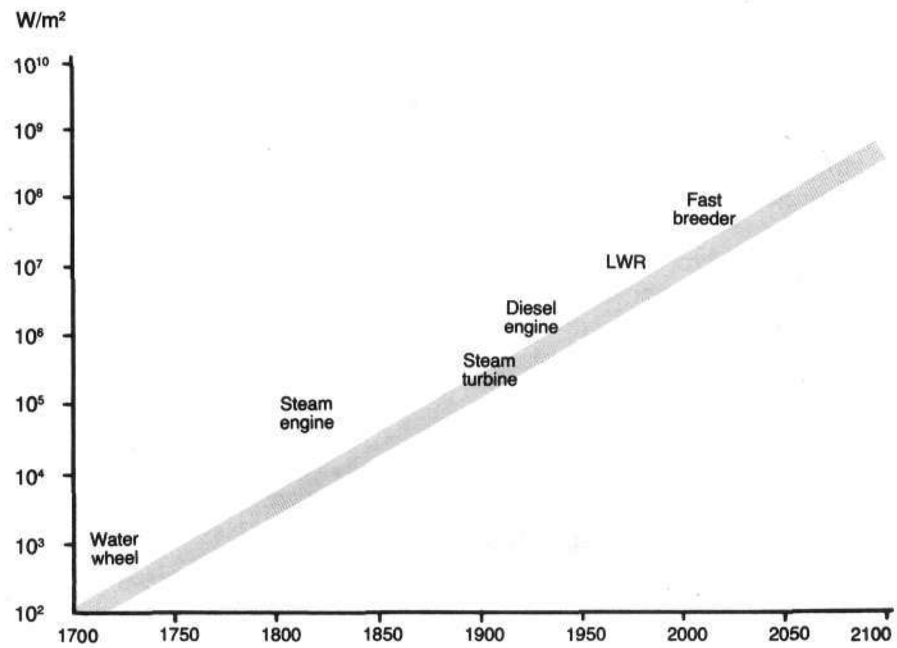


Figure 2
Development of primary energy-producing machines



(households, transport and construction, energy and basic materials, military and science research).

In the language of the physicist, we should say that the evolution of technology, and economic growth based on technological development, are quantized. This is illustrated in **Figure 5**. Every period has its own characteristic "species" of technology, and its own spectrum of energy-flux densities. If an economy tries to continue growth without creating a quantum jump in energy-flux density, then that economy will approach a saturation point. The efficiency of investment will drop toward zero. This is visualized by spiral action on a sphere, whose "saturation point" is the North Pole. At that point, either technological revolution occurs, or the economy begins to slide backwards.

Figure 3
Technologies for generation of coherent electromagnetic radiation

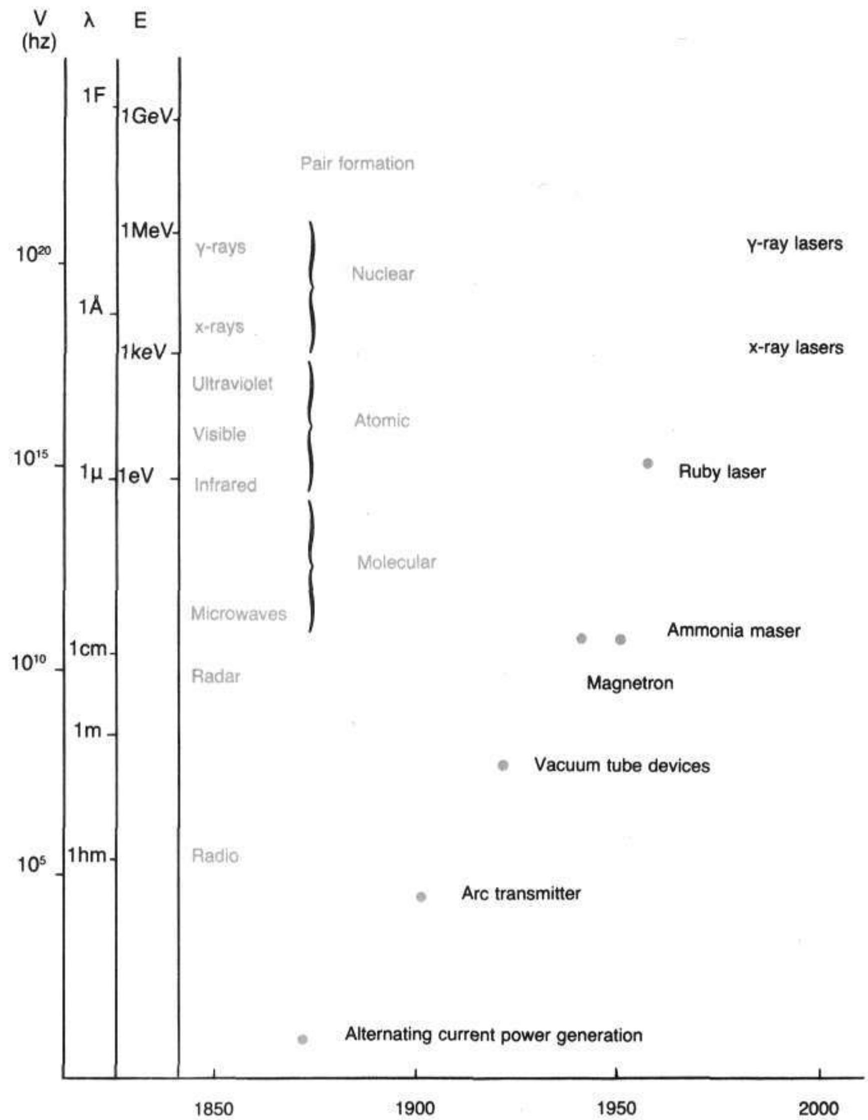
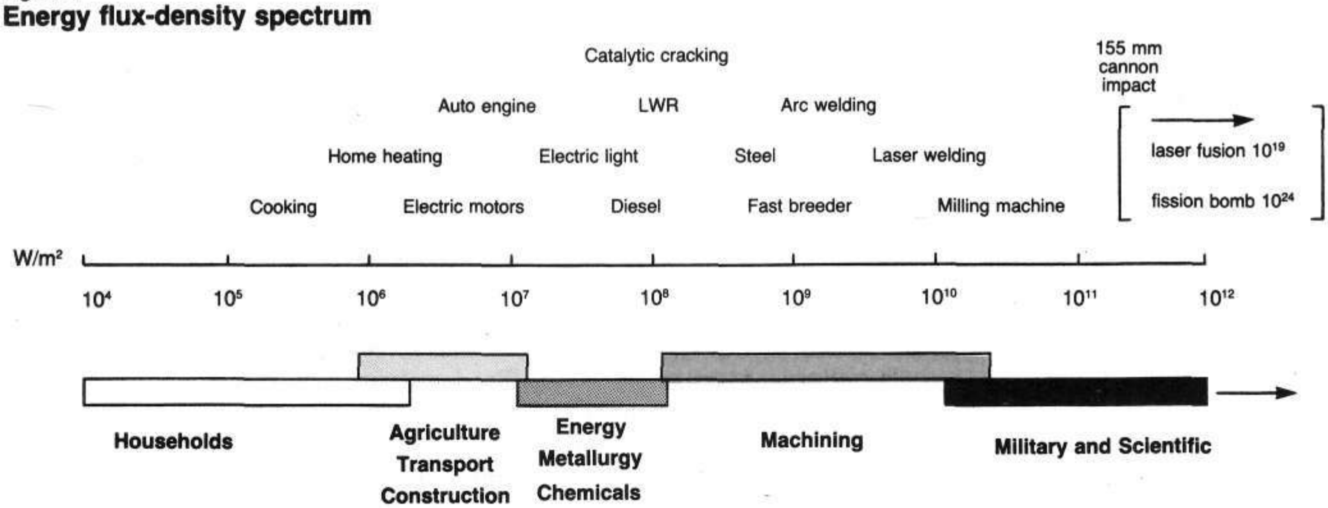
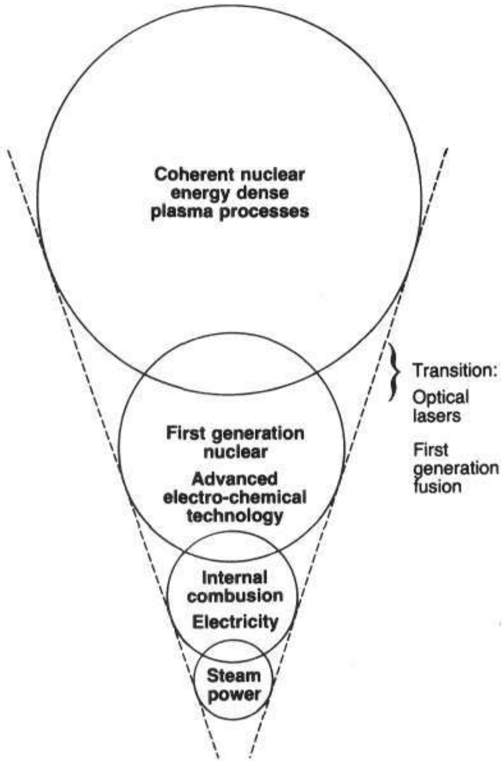


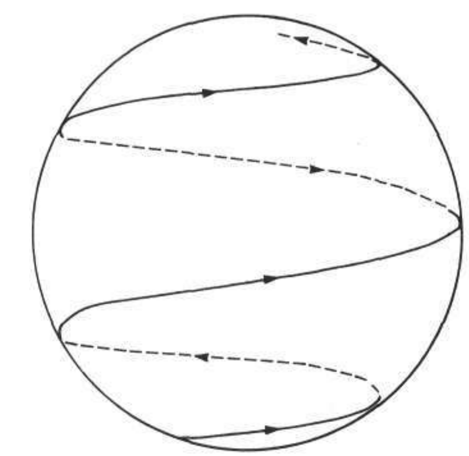
Figure 4
Energy flux-density spectrum



The next technological manifold

Figure 5
Evolution of technology





These considerations allow us to project key aspects of the next big jump in technology. **Figure 6** summarizes some of the parameters of this new "technological manifold," which can be expected to be attained within the coming 75 to 100 years. The essential point is an increase of 50 to 100 times in the energy-flux density of basic energy-producing technology. Let us consider some of the implications of this.

The energy released per gram of fuel in today's nuclear fission reactors is about 1 million times that of chemical fuels (coal, oil, and so forth). Yet, our nuclear reactors do not reach more than, at most, 10 times the energy-flux densities of fossil fuel plants. This fact expresses the limitation of present materials, machining methods, and control systems, as well as the limitations of our basic knowledge of physics.

One of the most important medium-term spinoffs of the SDI will be the realization of controlled nuclear fusion by the method of inertial confinement—detonation of fusion microexplosions by laser or particle beams. The application of magnetohydrodynamic energy conversion, as proposed by John Nuckolls of Lawrence Livermore National Laboratory, promises to make laser fusion reactors as much as 50% cheaper in energy production cost than today's coal or nuclear energy. However, the energy-flux density in Nuckolls's design is not much higher than in fission breeder reactors—approximately 2×10^8 watts per square meter. Therefore, laser and laser fusion technology as presently conceived is only transitional. It does not constitute in itself the necessary quantum jump.

This conclusion is strengthened by the second key projection of our 100-year perspective: the increase in per capita energy consumption from the approximate 10 kilowatts (kW) to 500 kW (for the United States). This value would be reached in only 75 years, assuming a modest growth rate of 5.3% per year. To reach this value amounts to reducing the social cost of energy production to about 2% of its present cost. That is hardly conceivable on the basis of fission or even first generation fusion technology as presently conceived.

Something fundamentally new is required in science and technology. The crucial new element, I believe, will be the development of coherent, "lased" forms of nuclear energy, starting with the gamma-ray laser.

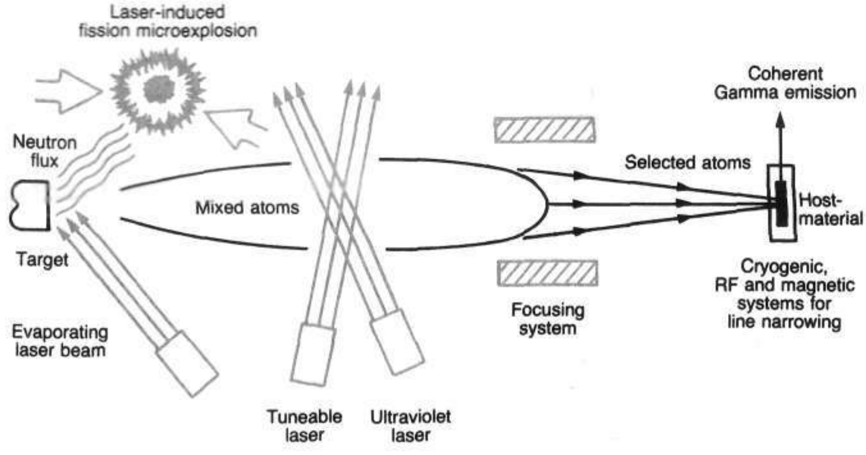
Figure 6
The next technological manifold—characteristic parameters

	Projected	(Present)
Flux-density of primary power generation	$5 \cdot 10^9 - 10^{10}$w/m^2	(10^8w/m^2)
Per capita energy production	500kW	(10kW)
World population potential	40 billion	(12 billion)
Life expectancy	>100y	(75y)
Percentage of GNP in research and development	>10%	(3-4%)

The gamma-ray laser

Assuming that the SDI is fully implemented, the development of gamma-ray lasers within the next 10 to 20 years is virtually certain. **Figures 7 and 8** show three possible schemes for building such lasers. I shall describe only the first one, which illustrates the relationship with the SDI particularly clearly.

Figure 7
Scheme for nuclear isomer laser (Letokhov)



In the first step of this scheme, a powerful laser (of the type used in laser fusion) compresses a pellet of fissile material to critical density, triggering a chain reaction which produces a powerful burst of neutrons. These neutrons impinge on a target of special material, creating by absorption excited nuclear isomers of intermediate lifetimes. A second laser pulse evaporates the target material into an atomic beam, from which the required isomers are separated using a process of two-step photoionization. The latter involves utilization of an extremely sharply tuned optical laser, tuned to a hyperfine structure line present only in the atoms whose nuclei are in the specified isomer state. The atoms excited by this laser are then ionized selectively by a second laser pulse, at a particular ultraviolet wavelength, and focused for ion epitaxy deposition upon a host surface to form the laser material. In this way, a population-inverted gamma-ray laser medium is created. However, lasing can occur only when the "detuning" (called inhomogeneous line broadening) of the nuclei by thermal effects, hyperfine interactions, gravitational red shift, and so forth, are eliminated. This "retuning" can be accomplished using a combination of techniques including rapid cooling to very low temperatures and application of intense magnetic fields and tuned radio frequency pulses.

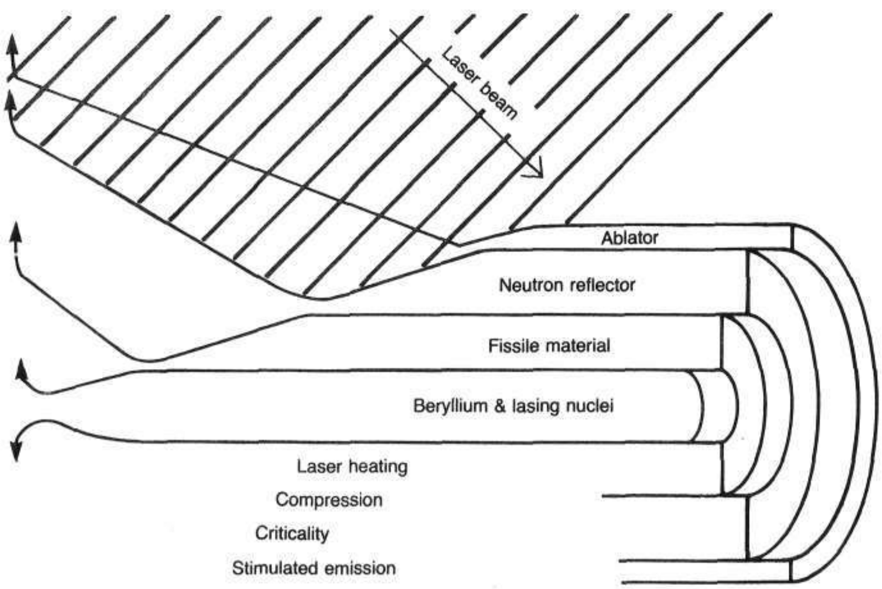
There are other approaches to building gamma-ray lasers, which we cannot go into now. The scheme just mentioned, however, illustrates well the kinds of combined, highly "tuned" nuclear, laser, cryogenic, and solid state processes which will dominate the next technological manifold.

With the gamma-ray laser, man begins for the first time to truly control nuclear phenomena. As opposed to the chaotic, thermal processes of fission and radioactive decay of today's nuclear reactors, the gamma-ray laser involves coordinated, resonant decay of trillions of excited nuclei all at the same time.

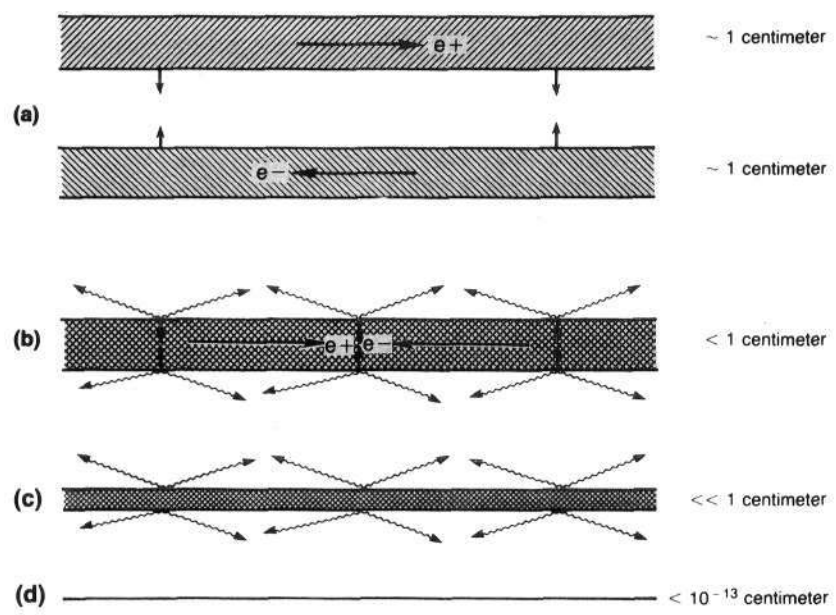
The most important application of the gamma-ray laser will be to scientific research. With its help, we may hope to master the vast range of nuclear transitions as well as we master chemistry today. At the same time, an entirely new field—nonlinear nuclear physics—is opened up by the possibility of multiphoton events at the extreme energy densities achievable with the gamma-ray laser.

I would like to mention one fundamental scientific issue in this context. Recent experimental and theoretical work by Professor Erich Bagge in Kiel, West Germany, indicates that presently accepted views of two of

Figure 8
Traveling wave Mössbauer laser



Electron-positron Laser (Winterberg)



the most basic processes of particle physics—pair production and beta decay—are fundamentally wrong. According to Bagge, the long-sought-after solar neutrinos do not exist. Instead, beta decay and pair formation are to be understood as phase changes, analogous to ionization of the vacuum, in which energy in the ordinary sense is not conserved. I cannot go more into this matter here. The crucial point is that the gamma-ray laser will allow us to generate electron-positron pairs in a coherent regime, thus opening for direct investigation the most elementary events in particle physics.

New energy sources

Although it is not possible to predict exactly how, the creation of the gamma laser and subsequent fundamental progress in nuclear physics will lead to revolutionary new energy sources and energy forms.

Some idea of this is provided by **Figure 9,** which lists a number of polarized and catalyzed nuclear reactors under study at this time. Spin-polarized fusion and fission processes not only can have much higher reaction rates, but also can release their energy in the form of polarized directional particle beams. This permits direct electricity generation, finally eliminating the stupid steam engine which we still must connect to our nuclear reactors today. In addition, such polarized beams constitute a new energy form for direct application to industrial processes.

Present research into muon-catalyzed fusion at room temperature represents only the very beginning of development of "cold" nuclear reactions. Over the next 100 years, "nuclear batteries" based on these kinds of processes will emerge to replace the use of chemical fuels (and even to some extent electricity) for the storage and transport of energy.

Such batteries will provide coherent energy at high flux density, for example, for land, air, and space vehicles. A large percentage of primary nuclear energy production will be consumed in nuclear processes, including the coherent excitation ("charging") of various types of nuclear batteries.

Along with energy production, the entire spectrum of technologies must take a quantum jump upward in energy-flux density. I can only examine a few critical areas.

I already indicated that the properties of present materials strongly limit the energy-flux density of today's nuclear reactors, and industrial processes in general. Increasing the energy density by a factor of 50 means that the primary working medium for tomorrow's primary industry will be plasma. Although new materials will be developed to handle such plasmas, the most important factor in mastery of these higher densities will be to utilize self-organizing magnetohydrodynamic (MHD) structures generated by the plasmas themselves. In effect, these structures constitute new types of materials. Drs. Winston Bostick and Vittorio Nardi of the Stevens Institute of Technology in New Jersey have demonstrated that MHD structures in a tiny plasma focus discharge can mimic a big particle accelerator, by creating huge electric and magnetic field gradients (magnetic fields up to 100 megagauss) which no ordinary material could withstand. (Such highly magnetized, nonthermal plasmas will be one of the primary media for polarized nuclear reactions and their energy conversion, for example, to electricity or coherent electromagnetic radiation.) At a lower energy density, the work of Tylco and others on nonequilibrium plasma furnaces has demonstrated that plasma shock waves and vortex structures are highly efficient means for reducing and processing metallic ores.

Real-time control of plasma processes defines an extraordinary challenge for computer technology. The characteristic times for phase changes

Figure 9
Polarized-catalyzed nuclear reactions

Spin-polarized fusion—Anisotropic emission of reaction products
DT ↑↑ enhancement of reaction rate 1.5
DD ↑↓ enhancement by 2.5
D He^3 ↑↑ suppression of neutron production

Polarized fission—Anistropic emission of fission fragments

Moon-catalyzed fusion
Resonance formation of $ddte^-e^-\mu^-$ molecules at room temperature
Each μ^- can catalyze >200 reactions

Fissionable isomers ?

Exotic nuclear reactions?

in dense plasmas are on the order of milliseconds down to tens of nanoseconds (plasma focus).

Space colonization

The mastery of coherent forms of nuclear energy is linked in an essential way with the large-scale exploration and colonization of space, for a number of reasons:

(1) Future plasma and particle physics experiments will require huge volumes and distances in high vacuum, which is only available in space. Therefore, an increasing percentage of fundamental scientific research will have to be done in space.

(2) All hypotheses in nuclear physics must be compared with the evidence of astronomy. There is massive indication of hitherto unknown coherent nuclear processes in exotic types of stars. Space colonization will permit us to create huge synthetic apertures, through multiple observatories distributed in space, giving us the ability to resolve objects of kilometer size at the center of the galaxy.

(3) Mastery of coherent nuclear energy and related technology will require large-scale production of 100%-perfect crystals and 100%-pure substances, such as can be produced only in weightless environments.

(4) Conversely, only the energy parameters of the "next technological manifold" permit sustained large-scale space activities.

At present, a passenger taking a transcontinental airplane flight from Washington to Tokyo consumes the equivalent of about one week of his or her per capita energy production (4-5 gigajoules). At the projected per capita energy production of 500 kW, the energy consumption of one week will be enough to go into orbit!

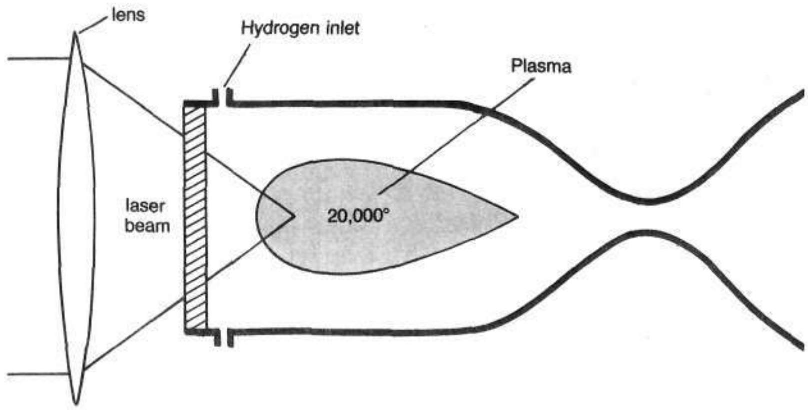
Currently, the cost of putting one pound of payload into orbit is about $1,000. This is about 10,000 times the cost of the energy (such as electricity on the Earth's surface) required theoretically to gain low-Earth orbit. The Space Shuttle main engine (high pressure hydrogen-oxygen) already approaches a saturation value for what can be done with traditional chemical rocket technology. Again, the key question is energy-flux density.

The laser railroad

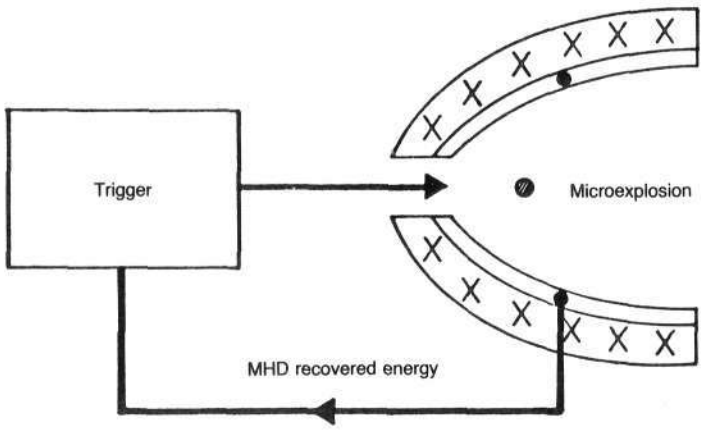
Figure 10 illustrates two promising space propulsion technologies, which could drastically reduce costs. I shall focus on one in particular, because it is very closely linked to the SDI: the "laser railroad" first proposed by AVCO founder Dr. Arthur Kantrowitz, and recently reviewed by Drs. Lowell Wood and Roderick Hyde of the Lawrence Livermore National Laboratory.

This scheme utilizes a high power, ground-based laser as the power source for a launch vehicle. The laser must track the vehicle on the way up. The laser beam is focused by internal optical systems aboard the launch vehicle to obtain 20,000°K or higher temperatures, permitting an at least threefold increase in exhaust velocity compared to the best chemical rockets. An autobus-size space vehicle could be boosted into space, with only about one-half of its starting weight consisting of propulsion mass. A 1-gigawatt average power laser (for example, a free electron laser) would be able to place about 15,000 tons of useful payload per year into orbit, boosting a continuous series of "space cars" one after the other. The estimated cost into near-Earth orbit, assuming present electricity costs, is about $30 per pound, according to Wood and Hyde. At the reduced energy costs projected for the next technological manifold, the cost per passenger, including 1 ton of life support systems and baggage, will be comparable to the cost of a trans-Pacific plane ticket today. Most

Figure 10
Laser thermal propulsion



Fusion propulsion (Winterberg)



likely, the "laser railroad" will be used for human passengers and sensitive equipment, while construction materials will be lofted using electromagnetic accelerators at a much smaller per-pound cost. Both of these technologies are "elementary" spinoffs of the SDI.

Manned space activity

To summarize the priorities for manned space activity; these center on the Moon and Mars. Phase I would be permanent scientific stations on the Moon, with extensive exploration and a manned landing on Mars. Phase II would establish mining and industry on the Moon and there would be extensive surveying and exploration of Mars.

The bulk of space equipment would be manufactured on the Moon, exploiting weaker gravitational field to access Earth orbits and other planets. The Moon becomes populated by industrial cities. Permanent scientific colonies and some production facilities are established on Mars, and there is the beginning of "Earth-forming" of Mars—creation of an atmosphere and climate similar to Earth, using biotechnology and large infrastructure projects.

The industrialization of the Moon has been worked out in great detail by the late space scientist Dr. Krafft Ehricke, including future Earth-Moon trade flows. Hopefully, there will be no isolationism! Ehricke demonstrated that Moon industrialization will be highly profitable (**Figure 11**). The development of industries on the Moon would be for the

Figure 11
Metals on surface of Earth and Moon
(kg/ton)

	Earth	Moon (Mare Regions)
Chromium	0.09	2.6
Manganese	1.0	1.7
Titanium	4.5	30.0
Iron	47.0	130.0

Figure 12
Land Areas
($\times 10^6 km^2$)

North America	24
Earth	149
Moon	38
Mars	142

production of technologies, including space vehicles on the Moon, in order to launch most of our space activities from the Moon. **Figure 12** is a comparison of land areas of the Earth, the Moon, and Mars, showing that the colonization of Mars would approximately double the available livable area for the human species. That poses the problem of how to take the planet Mars and convert it into a livable planet, transform the atmosphere in order to allow its colonization on a large scale by the human species.

This last challenge involves all the areas of the biological sciences, which are crucial because they illustrate highly coherent forms of organization of energy, and therefore, form a kind of analogy with the kind of coherent, matched, and tuned processes which will have to increasingly dominate our economy in the era of coherent nuclear energy forms.

Dr. Toshibumi Sakata

SDI: the technical possibilities

Dr. Sakata is the director of the Tokai University Research and Information Center.

Later today, we are scheduled to discuss the scientific and technical dimension of SDI, but the attitude toward SDI is more important. I would like to give you my conclusions first, rather than the reasons that led to them.

SDI's flexibility

We should clearly decide, take a stand, take a position on SDI in order to discuss the details. There are diplomatic, political, and defense aspects of SDI and scientific and technical aspects of SDI. But basically, SDI involves military aspects. A lot of discussions are going on about the military aspects of SDI, and there are a lot of ambiguities involved in these discussions. Based on such ambiguous assumptions, various people are giving their opinions, but most of those opinions are laymen's opinions.

The basic elements of SDI are related to military technology and strategic aspects. Unless one is deeply involved in that area, one cannot properly understand the essence of SDI. The basic element of SDI is strategic, but SDI is only an initiative. It is not fully systematized nor solidified as a system. It is still flexible, and it allows a lot of flexible interpretations.

In 1983, President Reagan introduced the initiative. Then it was modified in 1985, and naturally so, because it is still an initiative, not a fixed system, and modification was due. In the initial concept for protection, the background technology of SDI is not really a replacement for conventional technology, because President Reagan modified it as a reinforcement rather than replacement. Of course, a lot of controversies took place in the meantime, because discussion of the initiative was not exhausted.

The strategic aspects require consensus of the American citizens as well as allied nations. If this strategic initiative went ahead without having a consensus of those people, that would carry risk and danger. While SDI is a defense of the United States, it is also a defense of allied nations. If the people of these allied nations think that this has nothing to do with them, it might endanger the whole initiative. Therefore, modification was made from time to time.

Another basic element of SDI is technology. In recent years, strategy changed from a human orientation to technological orientation. Naturally, discussion and study on technical aspects of SDI must be thoroughly carried out. The technology involved in SDI could be discussed from the standpoint of military capabilities, as we have done for two days, since there are a lot of new aspects, or new technologies. But fundamentally, I would say that technologies involved in SDI upgrade conventional technology. As for energy as one of the spinoffs, the history of energy clearly indicates that these x-ray lasers and gamma-ray lasers were developed one after another as an extension of conventional technology, but the possibilities of such technologies were discussed long before.

As for the basic technology, conventional physics and science which are available today are still valid. We haven't stepped aside. It is not a totally new science or new theory. It is an instant output or generation of high energy that is the basic technology, and controlling that high energy is most desirable. As to the material, lightweight and very strong, sturdy material is quite important. And thirdly, information is involved, high-density information should be transmitted in a very small amount of time. If those three aspects of technology are developed, then it is clear that there will be a lot of spinoff effects.

So the technologies of the basic elements of SDI are just an extension of conventional technology. But I can also say that technology cannot develop without having some kind of impact. SDI might have an impact from other aspects and this impact given by SDI could accelerate and advance technical development.

Coming back to the starting point, we have to consider the international balance of power. Probably, SDI is a new strategy which would replace mutually assured destruction. Then, this basic element of strategy should be a threatening power; otherwise it is useless. So, SDI as a strategy should be examined from the aspect of threat. Probably, this word threat may not be appropriate, but in order to be effective strategically, this SDI should have a power, an influence of threat. Otherwise it is useless. Whether or not SDI is strategically effective depends upon technology. On top of the military discussion, we have to study the scientific and technical aspects of SDI to make it a complete system. Naturally, the demand for scientific and technical advancement is a must. So, for those people involved in science and technology, SDI has a significant meaning.

The place of Japan

Another aspect of SDI relates to the role Japan has played in international society. At present, the science and technology developed by Japan has accelerated economic development, but only scientific and technical aspects of Japanese development has been emphasized, wrongly so. Because of our education in science and technology, we could achieve such a high level of technology, and we have contributed to certain portions of science and technology. Technology available in Japan right now is attracting a lot of attention, and those people involved in SDI expect a lot from Japanese technology. However, whether or not Japanese technology would give solutions to the SDI problem is a big question. The role to be played by Japan in the international scene must be studied and analyzed. Japan has to contribute in a new approach to the international society, make appropriate proposals to avoid any misunderstanding. The people of the world often criticize Japan for not contributing to international society, or not making proposals to international society, because in the past, Japanese activities in the international scene were a weak point. We were not given an opportunity to do so, first of all, and then our very unique approach might have caused some of the misunderstanding in the international scene.

So I would express a positive attitude to SDI because the discussion now being held among allied nations seems to evolve around peace. If SDI contributes to the maintenance of peace, then we should contribute to the new development phase of science and technology. But what we have to deal with right now as Japanese is to make a contribution to the international society and make proposals to the international society. And that will give us, the Japanese, a new impact in science and technology.

Now this aspect was rather neglected, so I would like to focus on this important point.

Earth from the standpoint of space

The last point that I would like to emphasize is that the technology discussion which was triggered by SDI has a very significant meaning, and that is why I am positive about SDI. The technical and scientific capability we have has been accumulated in the past history based on scientific knowledge of the Earth. But the planet Earth must be considered in the wider framework of space. In this century, satellites have been launched and we have found many new aspects of science. We may need quite a revolutionary approach to the scientific framework in this century. We have to build up conventional technology, first of all. But advanced technology is not just an extension of conventional technology. We need quite a new technical system of science and technology and this totally new concept of science and technology might be initiated by SDI.

The spinoff effects often proposed are proposed because of possible economic effect. But, as any such proposals are destined to be, there is a big question as to the spinoff effect. The private sector has promoted large-scale research and development, upgraded to the present advanced technology. Unfortunately, military projects are not officially allowed in this country, so top-down type of technical development was not fully carried out in focal areas of technology. But now we are given the choice of SDI, and we have to consider whether or not top-down technology or military technology should be taken up. We cannot expect immediate spinoff effects from military technology. In the space technology in the past, we expected a lot, but it took a long time to have a spinoff effect. We needed time and money to enjoy the spinoff effects of space technology. The same is true with SDI.

Now coming back to science and technology, this SDI will give us a very good opportunity for Japan to create a new scientific system and framework. And this is a very good opportunity for an allied nation of the United States to play its role. So I would like to emphasize that we have to shed a new light on this important issue.

Heinz Horeis

The case for boost-phase defense

Heinz Horeis, with the Fusion Energy Foundation, West Germany, is the managing editor of the German-language Fusion *magazine.*

I want to address the question of whether SDI will represent a real power—whether it will be effective. This question, ever since President Reagan announced the creation of a missile defense in March 1983, has been the subject of a very controversial debate, not only in the United States, but also in Western Europe.

The opponents of SDI, among them some quite well known people, have claimed from the beginning that beam defense is not feasible, that it will not work. There are two widespread and well-known reports which represent this kind of argument: first, the Office of Technology Assessment (OTA) report from 1984 written by Ashton B. Carter from the Massachusetts Institute of Technology; and second, the report put out by the American Union of Concerned Scientists. Both reports, and others which are similar, have one thing in common: The starting point is political. The authors are against beam defense for political reasons and try to construct scientific and technological arguments to prove that SDI is not feasible.

Obviously, however, if you base your evaluation on such prejudice, then you are forced to construct facts, to make false assumptions, and so forth.

The fate of the first OTA report is indicative of this. Scientists at Los Alamos and Lawrence Livermore National laboratories worked through this report last year in detail, and have shown that all of its main arguments against SDI were wrong or based on false assumptions. As a result, a second OTA report was published at the end of last year, which gives only very few scientific and technical arguments. It does not even cite the first report, which shows how much this is discredited by now. Yet, the first OTA report is still spreading and the arguments in there are still spreading, especially in Western Europe.

Why it's feasible

First, let me show the fundamental characteristics which allow us to say that a beam defense will be feasible and effective. By effective, I mean that an overall defense screen to protect whole nations will be possible, not only a so-called point defense. To show this, it is useful to compare beam defense with the concept of conventional missile defense, the so-called ABM defense.

There was the same debate about 15 years ago on the subject of the ABM defense as we have on SDI today. The critics of ABM defense pointed out at that time that an all out defense was impossible because an enemy could easily counter the defense, mainly by just increasing the number of offensive weapons. At that time, this argument was basically right, but, repeated today, it has lost its value.

In the concept of an ABM system designed by the United States at the beginning of the 1970s, there were two types of missiles: the Spartan, which would detect incoming warheads at a distance of around 2,000 kilometers, and the Sprint, a high-acceleration missile to detect warheads after reentry, within the atmosphere.

The problem involved in this kind of defense is obvious. The attacker needs only one missile or one warhead more to overcome the defense.

This is especially true since modern missiles carry many warheads. The Soviet SS-18, for example, carries 10 warheads, so the defense would have to use 10 missiles to defend the threat carried by only one offensive missile. This ratio of 10 to 1 is obviously a very bad deal for the defense.

This situation changes fundamentally with beam weapons, because it is not missiles against missiles, where both the offense and the defense are on the same technological level. Now, the defense is based on a technology which is far superior to that of the offense.

This level has the following characteristics. A laser beam propagates at the speed of light, at 300,000 kilometers per second, compared to a missile, which travels only up to 7,000 kilometers per second. This is orders of magnitude less. While it takes a missile several minutes, and in the case of the ICBM, 30 minutes, to cover a few thousand kilometers, a laser beam needs only a fraction of a second to cover that distance. That means that the battle times for ABM missiles are on the order of minutes, while for lasers they are less than 1 second. Therefore, a laser could fight in the order of hundreds of objects per minute.

If you take these basic parameters—velocity and battle time—you see that beam technology is several orders of magnitude superior to missile technology. This is the fundamental reason that, with beam weapons, the defense will have a clear and decisive advantage over the offense. This basic fact, however, is ignored by the opponents. They say beam defense requires too many systems in space, warheads cannot be destroyed, decoys will make defense impossible, battle management is too complicated—whatever.

In reality, the properties of beam weapons lead to a very crucial and special advantage. With lasers, one can attack missiles in their boost phase, the first phase of missile flight. This is impossible with ABM technologies because missiles are far too slow to reach the boosters before they burn out, and they can, at best, reach them in the midcourse of their flight.

This boost-phase defense has three essential advantages: First, the huge flame of the booster can be easily detected; second, the booster's thin skin, about 2 millimeters, can very easily be destroyed; and third, destroying one booster could destroy 10 warheads and maybe up to 100 decoys. This reduces the stress on the following layers of defense by orders of magnitude. So an effective boost phase defense is crucial for the success of the overall system.

Countermeasures?

The critics have therefore suggested countermeasures to make an efficient boost-phase defense impossible. One suggestion is that the booster could carry a skirt to hide the flame and make detection more difficult. This obviously is ridiculous. Not much better is the proposal that the booster should be equipped with a reflective surface. At first this seems reasonable because the laser beam would then be reflected by the missile skin. If you give it some thought, however, you see that to be effective the surface has to be nearly perfectly clean, and there is absolutely no way to maintain such a clean-room atmosphere after launch. Huge amounts of gases are floating around and the missile has to pass through an atmosphere of dust particles, and so forth.

Another suggestion is to equip the booster with a protective layer, for example, 1 centimeter of lead or other material. In the OTA report, Carter reports that the booster would be hardened by a factor of 20 or even more, which would mean that 20 times as many lasers would be needed in orbit.

Even if this could be done, the offense would have to pay severe penalties for this shielding because additional structural mass on the booster would reduce the payload mass significantly. For the SS-18 such a shielding could cost 60% of the payload. That would mean that instead of 10 warheads, the SS-18 would only carry 4 warheads, which is obviously very advantageous for the defense, not for the offense. But let us assume that the enemy is willing to pay this price. He has spent much money and time hardening his missile to make it more difficult and time consuming for a chemical laser (which Carter based his evaluation on) to burn a hole through the skin of the missile. Then the enemy finds out that the defense now uses a laser with a much shorter wavelength, which can focus much more energy on the target with the same amount of power and can therefore kill a hardened missile as fast as a chemical laser could kill an unhardened missile. The enemy also has to recognize that an x-ray laser is used now that does not burn a hole, but delivers an extremely short and powerful pulse at the target that destroys the structure by a shock wave.

As you can see, the headaches are on the offensive side. A countermeasure that may help against one system is useless against another system.

Another very often proposed countermeasure is that the Soviet Union would develop and use fast-burn boosters, which would reduce the boost phase to 60 seconds instead of the current phase of about 300 seconds. The SDI opponents claim that this would be very effective, because the time for boost defense is shortened significantly, which is true. Additionally, the booster would, in particular, escape the x-ray laser, because the boost phase would end within the atmosphere and, the opponents say, x-rays cannot penetrate through the atmosphere. So, this laser could not be used.

Let us first assume that the booster with such a fast burn time can be developed. (Although one has to say that even by American standards, the time needed for this development would be something like 10 or 15 years.) Let us look at the price the offense has to pay for this. A fast-burn booster would first be more expensive. Second, it would carry less payload; that means fewer warheads will be deployed. Third, because burn-out is within the atmosphere, it is much more difficult to deploy lightweight decoys; and last, burnout within the upper level of the atmosphere is not necessarily protection against the x-ray laser. As indicated by Professor Winterberg, an x-ray laser with a focusing device would be powerful enough to bore a hole through the atmosphere and hit the booster before burnout.

Costs: defense versus offense

All of the cited countermeasures, therefore, are not as easy as the opponents suggest. They do not make missiles invulnerable. At best, they make defense more difficult. But in any case, a price has to be paid which is in favor of the defense. How high this price may be, I want to show you in quantitative terms.

Take the fast-burn booster as an example. If you want a fast-burn booster, you obviously cannot just take your existing missile and modify it. You have to construct and produce completely new missiles. If you consider the total cost of an ICBM at around $100 million, then this replacement of the whole offensive arsenal would cost on the order of several hundred billions of dollars. This is somewhat on the order of what a defense system might cost, and I believe that even the Soviets would think twice before they undertake such an investment in their offensive forces, since the outcome is very questionable.

And even if they want to do this, let them. They would invest $100 billion and more in an old technology which has no positive spinoff whatever, while we would invest the same amount into a system which has not only military use for defense, but also extremely high economic benefits. The overall outcome again is in favor of the defense.

The inherent superiority of beam technology over missile technology has to manifest itself in the question of costs. That means that defense has to be cheaper than offense, to be effective. I want to give you two examples for this, and it should be clear that the figures that I will mention are only rough guesses that indicate the order of magnitude with which we are dealing.

Let us first take the free-electron laser as an example. As we heard yeaterday, this has turned out to be one of the most promising candidates for a ground-based laser. Such a laser would direct its energy via mirrors in space onto the target. It would have a power of several tens of megawatts on average, it should be of short wavelength, and could attack objects in the whole course of their flight. Very roughly estimated, it could destroy some thousand objects, both boosters and warheads. Five to ten such systems could thereby more or less neutralize the whole Soviet nuclear threat—a threat that represents a value of several hundreds of billions of dollars. Such a ground-based system would cost on the order of $1 billion. And the whole mirror system may cost $10 billion. So, very roughly estimated, one gets a value of 10 to 1 in favor of the defense and this is a margin that one can live with.

Most striking is the case of the x-ray laser. Some time ago, *Physics Today* published an exchange of letters between a scientist named [George] Chapline, who works on the x-ray laser at Lawrence Livermore, and Hans Bethe, one of the leading opponents of the SDI in the United States. Chapline wrote that an x-ray laser satellite would cost around $2 million. It seems to be surprisingly low, but I think that this is more or less right, because an x-ray satellite is a simple and compact device with a weight of only several hundred kilograms. So what could such a system do? For a conservative estimation, I refer to a paper an SDI opponent from the Massachusetts Institute of Technology has written, where he states that an x-ray laser is not feasible for defense. He calculates that a yield of 25 kilotons is necessary to kill one booster that is 1,000 kilometers away. If we have a charge with the yield of 500 kilotons, then the satellite could destroy 20 boosters. These 20 boosters represent a value of $1 or $2 billion. The missile to put the satellite into orbit—and one missile can carry several satellites—would bring the cost per x-ray laser satellite to about several tens of millions of dollars. This gives you a cost ratio of around 100 to 1 in favor of the defense.

This doesn't even take into account that an x-ray laser beam can be focused, as Professor Winterberg mentioned yesterday and as the scientists from Lawrence Livermore have indicated. This would increase the energy-flux density that you can have on the target by a factor of 1 million, and would mean that one satellite could destroy hundreds or even thousands of targets over long ranges. Even I, as a spokesman for beam defense, hesitate to transform this into cost relations, and so I leave this up to you.

To conclude for the case of boost-phase defense, I have tried to show you with a few examples that it is very hard to undermine the feasibility and effectiveness of beam defense. There are many other suggestions brought forward against beam defense which I am not mentioning here; overall, when these criticisms are not totally wrong or arbitrary, they overlook some decisive factor.

Beam defense technologies are fundamentally superior to the offense and this margin gives enough room to deal with countermeasures and other emerging problems without losing this advantage. The burden remains on the side of the offense. And this opens up the way to a technological development that can overcome nuclear weapons and make them obsolete.

Dr. Nobuki Kawashima

The positive and negative influence of SDI on the community in Japan

Dr. Kawashima works at the Institute of Space and Astronautical Science, Tokyo.

Actually, scientists have their problems in SDI. Some are very delicate problems. Today, in my presentation, I would like to share some thoughts with you on one of the unique characteristics of Japan in relation to the SDI project.

Unique Japanese characteristics

The Japanese scientific community, unlike those of different countries, possesses very unique characteristics. And I would like to explain to you what the background is of these unique Japanese characteristics. The first element in explaining the background is the fact that Japan advocates the principle that is against nuclear armament, and also, the Japanese people still have very clear memory of the bad experience in the Second World War. We cannot get rid of the image left by the fact that we invaded the Asian countries in the Second World War. That means that whenever a major issue comes up, the Japanese people tend to think it to be synonymous with invasion or attack or offense. After the Second World War, the Japanese have enjoyed a relatively peaceful time, without having to face the threatening perils leading to the extinguishing of the country. In Japanese society, it is said that scientists should not say anything on topics relating to military issues. Therefore, even in the development of nuclear energy and even in the space development program, there is a consensus in Japanese society that these two areas should never be exploited for military attack or defense purposes.

This notion is particularly prevalent in the scientific community here in Japan. As one example, the leading organization in physics in Japan, called the Scientific Society of Physics, prohibits scientists in the defense agency or defense university from becoming a member of the society, in order to avoid any coloring by defense personnel of the pursuit of purely scientific goals. Also, the publication of papers or the research advanced by these people is prohibited by the society. This is the background we are faced with. Scientists right now are questioning themselves what role they have to play in such an environment here in Japan.

There are numerous spectra of possible scientific spinoffs from SDI. Some of the elements are already known to you. One of the major elements in SDI is the beam weapon, the directed energy weapon, either laser technology or the particle beam weapon or possibly, in the future, the microwave particle beam might be developed along with the SDI research program. All these areas have something to do with development of the SDI program. In the same manner, a kinetic energy weapon which is a pillar of the SDI as well as the rail gun or electron accelerator, will take advantage of super-high-pressure phenomena.Let me repeat, as people said, that there are a number of spinoff effects from SDI research. Therefore, naturally, eminent Japanese scientists in, for example, x-ray astronomy, are engaged in producing an apparently multilayer membrane. This multilayer membrane or coated mirror has been long awaited for other utilizations in astronomical observations.

The other example is laser technology, which is a very important emerging technology using infrared rays. I believe that infrared astronomy will become a very important area. There are a number of examples such as those that I have cited as possible spinoffs, and these are the scientific benefits we might obtain.

The next question, then, is whether Japanese scientists are ready to participate in the program or not. I think that in order to answer this question, we have to qualify the scientific background for SDI.

Attitudes toward SDI

Nuclear fusion energy has been developed as a dream for humankind, but recently, this research on nuclear fusion energy has reached a stalemate. This is exemplified by the reduction of the project for this research in the United States. The same phenomenon is happening in Japan as well. The fact which triggered this stalemate is the rising sense of confidence or the absence of threats of energy problems, because of the lowering of the price of oil or petroleum. So, recently, people even say that there is really no concern over the price of oil any longer.

Space researches have occupied a very prominent role in astronomy: for example, the landing of Apollo on the Moon and the Viking mission to explore whether living organisms exist on Mars. Even this area has started to suffer from backward development.In the United States, it might be easy for scientists to change their emphasis in the research area from space research to the SDI-related space programs. But if that happens in Japan, the payroll or salary in the budget for research are two different things. Therefore, even if the budget is cut in certain areas, the Japanese scientists think that as long as they are paid well, it really doesn't matter for them.

The next question is, what are the current attitudes of the scientists who are in the SDI program? One school of thought, of course, is the opponents of SDI. We have the same situation in the United States and the Society of Physics in Japan. There was a lot of discussion on the pros and cons of SDI here in Japan. As for the rationale of the opponents of SDI, they cite several reasons to object. One cited reason is the fragility of the weapon, of space vehicles. The second reason is difficulty in SDI technology, which is a very popular opinion among the opponents; and the third rationale they cite very strongly is that even if SDI developed a good defense scheme, this scheme will stimulate or be caught by further advanced research on the opposite side. They claim that no perfect defense system was possible in the past, and it will not be possible in the future. These are the reasons the opponents quote to justify their opinions.

The second group of scientists here in Japan shows indifferent attitudes to SDI. The third category of people in Japan I would call very weak. Of course, these people believe that their research would have something to do with SDI, but they fear to say so. So they just keep silent, and even if they know that their research has something to do with SDI, they don't express it. The fourth category of people is those who are very much interested in SDI, but do not have enough courage to say that they are interested in SDI in the scientific community. The scientists who are very vocal on their position on SDI are very few in number, to speak frankly.

Nonetheless, we will recall the original objectives of SDI for them. The first one is to make nuclear weapons impotent and obsolete. I believe that this rationale could hold very firmly here in Japan for those who advocate abandonment of nuclear weapons. And SDI has as an objective to get rid of MAD, mutually assured destruction. Against this concept, the opponents in Japan would say that scientists are being deceived. That is the rationale the opponents would argue. Of course, other people would say that even if we are deceived, even if you know that you are deceived, you can go ahead with your research as long as you benefit from it.

Even in space research and energy research, it is unavoidable, as you might confirm from history, to go with the times, so to say, to go with the prominent trend of the age. Nuclear fusion is one of the major areas in SDI research, and as a major area, nuclear fusion has had a very difficult time. Recently, in the summit meeting between Soviet leader Gorbachov and President Reagan, there was a statement that only research will be made. Some people might feel that that statement is very strange, particularly in these military negotiations on defense. The statement is slanted, in that international cooperation will be undertaken on fusion research, which apparently has something to do with SDI. I am not familiar with why they came up with this statement, but particularly in Japan, I believe that that statement, in due course, will have a very positive effect on the trend of nuclear fusion research here in Japan.

Future prospects

Then, what are the future prospects, what would be the reservations of the Japanese scientists with respect to the SDI program? Please allow me not to express my personal opinion, because I do not think that this is the objective of today's meeting; if I express my opinion, sometimes that would jeopardize some areas.

If we consider the future prospects, the Japanese government will have to decide whether or not to go ahead. If the government of Japan expresses itself very clearly, in due course, whether or not after that time Japanese scientists could express their opinions freely among the society is another question. I have to think that it will not take a very long time to change the attitudes of Japanese scientists. Thereby, they could speak up on this issue.

Ten years ahead, some people say, attitudes might change, if not in the short term. In Japan, the term peace is considered to be in a genuine sense peace itself. But the campaigns of the peace movement are losing the clear definition of the word peace. One editor in a publishing company once said that if the books are titled something with peace, those books would not sell well, particularly among the young people in Japan. There has been a natural increase in the awareness among Japanese young people that we have to defend the country by ourselves. The time will come that the younger generation will have this kind of awareness.

April 23

Panel III: Questions and comments

Mr. Zondervan: I would only like to say a few words, because I'd like to have plenty of time for questions. I would like to make three comments, one on the idea of cost exchange, because that's being used as a fundamental argument against SDI. Then, I would like to give you an example of how cost exchange was used in the past, and led to the 1972 ABM Treaty; and then, I would like to get at something which has underlain the discussion of both yesterday and today. That is the idea of grand strategy or military strategy—the underlying fundamentals of grand strategy.

The cost-exchange problem

First of all, cost exchange: This means taking one weapons system and its cost and comparing it to another weapons system and its cost—given that the first weapon system will be used to destroy or neutralize the second.

There is a fundamental problem embedded in the use of cost exchange, which has basically two aspects to it. First, how many weapons of the one system or how many shots of the one system are required to neutralize the opposing system? Once you have this weapon exchange, you then look at the cost of each shot or of each weapon and come up with the final cost exchange.

Back in the 1960s, the United States was actively pursuing an antiballistic missile system. In the early 1960s, this was called the Sentinel system, and later, in the late 1960s and early 1970s, it was called the Safeguard system. The Safeguard system missiles which were being developed were called Sprint and Spartan.

Approaching 1972 and the ABM Treaty which resulted, the U.S. military, under the circles of Robert McNamara and James Schlesinger, came to the conclusion that an ABM system would cost five times more than an ICBM system. Part of the argument was the fractionating or MIRVing [multiple independent reentry vehicles—MIRV] of the payload of an ICBM. The argument was, that since we have two missile systems here, and since we are using one missile system to try to neutralize another missile system, if you fractionate the payloads of the offensive missile system, that leads to a 5 to 1 advantage for the offense in terms of cost.

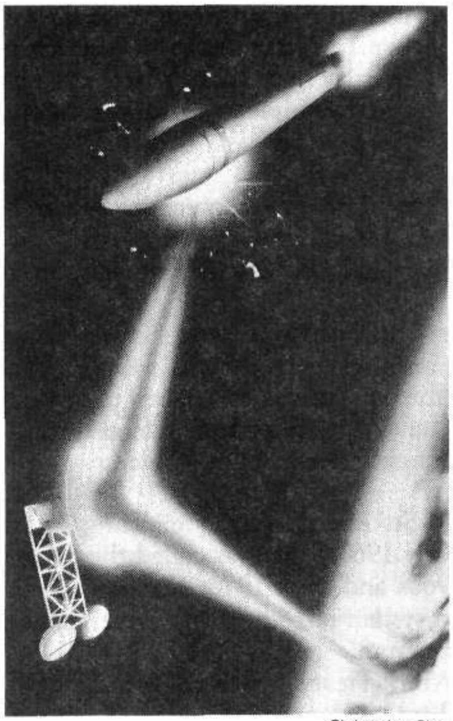
Using cost exchange in this sense was probably correct, because missile systems are a well-established technology. Indeed, it is a basic underlying law of physics that in using a missile to neutralize another missile, the defensive missile always has to have greater performance than the offensive missile. Therefore, necessarily, it must cost more than the offensive missile. This was the underlying argument that led to the banning of antiballistic missile research and deployment of systems in the United States as a consequence of the 1972 treaty.

The Soviets were, of course, also developing an ABM system, the Galosh system, which is currently deployed around Moscow. The United States was given the option of deploying an ABM system, but it decided not to, that it could better use its resources to fractionate the payload of ICBMs, which it proceeded to do. This led to the MIRVing of ICBMs.

Cost exchange and the x-ray laser

The fundamental problem with cost exchange in analyzing systems based on new physical principles—systems which are not well-established in an economy—is that you must be assured of introducing to the cost-exchange model the payback of that new technology into the economy. To my knowledge, there is no economic model in the world, except the LaRouche-Riemann model used by the Fusion Energy Foundation, which even approximates this process.

At best, most macroeconomic models simply take past history and project it into the future based on past costs. This is the fundamental problem with the cost-exchange ratios used today, including the cost exchange with SDI: They do not treat the payback to the economy of the new technologies.



Christopher Sloan

Artist's illustration of a laser beam hitting a missile in its boost phase. In this hybrid system, the laser is based on a mountaintop with a mirror in space.

Let me give one example to underscore what Mr. Horeis said about cost exchange for the defense. In this example, I am going to use the cost-exchange ratio, and show you that, indeed, it is in favor of the defense. Since I said that it is fundamentally wrong to use this ratio—that is, the defense can do better than this would indicate—it would seem to be a very good argument to support defense in general.

One of the most promising near-term deployments for defense against ballistic missiles is the x-ray laser, the pop-up, nuclear-pumped x-ray laser. There has been a major move in the United States to prevent underground nuclear testing of this device. Why is this the case? As I said with the Safeguard and Sentinel systems, the idea here is that you would send up a missile with a nuclear warhead to intercept an incoming reentry vehicle. When the two missiles got close enough, you would detonate the payload on the ABM, which would destroy the RV [reentry vehicle]. So, it would take one ABM to neutralize one reentry vehicle.

Suppose that on the ABM, you do not deploy a warhead, a nuclear bomb which, when detonated, has a highly disorganized release of energy. Suppose you organize that energy as an x-ray laser, a nuclear-pumped x-ray laser. You have seen the rods on the pictures of ABM systems. That is what these do. Suppose that the warhead of this ABM has an x-ray laser with, say, five rods, so that you could organize the energy in a coherent beam in five unique directions. Now suppose you had five reentry vehicles coming in and you deployed this x-ray laser on an ABM for your terminal defense. Obviously, if you can point each one of these five rods at the five reentry vehicles and then detonate your warhead, you have now got a 5 to 1 weapon exchange to the advantage of the defense.

Therefore, if the nuclear bomb powering the x-ray laser is equivalent in cost to the reentry vehicle, which it reasonably could be expected to be because they are the same technology, the same device, you are now at a 5 to 1 cost-exchange advantage in favor of defense to offense. Now, suppose you can make an x-ray laser with more than five rods. Suppose you can have hundreds of rods. Suppose you can have thousands of rods. Obviously, there can be a 100 to 1 or a 1,000 to 1 cost advantage in favor of the defense if this is done. In fact, it may not even be necessary to go after a ballistic missile in its boost phase. If the defense is concentrated on the terminal phase and the midcourse phase, in which there are up to 20 minutes of time to acquire and track and point at reentry vehicles and decoys, and if you just shot everything, it may be that this could well be sufficient and could clearly be advantageous to the defense.

Part of the question here is how many decoys can an ICBM deploy. The maximum number of reentry vehicles in most ICBMs today is 10. If, for example, you suppose that one decoy weighs 100 times less than a reentry vehicle, then if you took off all of the reentry vehicles and put on all decoys, you would have 10 times 100 or 1,000 decoys. Obviously you wouldn't want to do that because then you would not be putting any reentry vehicles onto the enemy territory. But, each ICBM might deploy 500 decoys and some reentry vehicles. Therefore, if you had an x-ray laser with 1,000 rods or 10,000 rods, it would easily be a cost-effective option for the defense and clearly win the cost-exchange ratio.

Military strategy

This brings me to the essence of military strategy. What is actually going on here, with these new physical principles, which have clearly reversed the cost-exchange ratio to the advantage of the defense? Well, the essence of military strategy is this: Given two forces—call them A and B—if force A has a greater capacity to deliver firepower or deliver energy to the opposing force B, and if it can target and retarget its fire and evade the opposing fire with greater capacity than force B, and if force A can also perform these actions more cheaply, such that it is using a lower percentage of its total and material resources than force B, then force A has implicitly absolute military superiority over force B. This is the classical definition or use of the terms firepower, mobility, and cost. If a force has greater firepower, greater mobility, and can deploy its material and human resources at lower cost than its opponent, it has absolute military superiority. I said implicitly, because this presumes that the military command can use this material and resources effectively.

However, if the thinking of a society or the culture of a society is one which leads to superiority in military assets, it follows that a culture and its thinking will also yield a superior utilization of this matériel on a battle field.

This is the essence of grand strategy. The essence of the matter is actually freedom of action, freedom of action in the design, construction, production, and utilization of material resources. This is what is involved in going to the new physical principles embedded in beam-weapon technology. Such a military strategy is consistent with the world outlook of a true republic. It emphasizes the mastery of the laws of the universe and makes the organization of human behavior conform to these laws, which is the paramount concern of the nation-state. It is also consistent with the concept of true freedom, for freedom only emerges when the world is transformed in such a manner that it supports greater numbers of mankind at ever higher material and cultural levels. So, in these respects, SDI is a rational military strategy, a strategy which truly defends a republic. That is the essence of the matter behind SDI.

Question: 100% defense?

Question: I would like to ask what I hope will not be interpreted as an impolite question to Professor Kawashima: You said that scientists in Japan cannot discuss SDI freely. My impression is that scientists in Japan cannot positively discuss SDI freely, but can quite easily negatively discuss SDI freely. Would you please comment on that?

Professor Kawashima: This is a very peculiar feature of Japanese society. I think that it is a lingering after-effect of World War II. As I mentioned in my talk, since the last world war, we have not encountered any crises for our nation. So, even a discussion that our own country should be defended by ourselves doesn't happen. It is true that anti-SDI talk can be done freely. That is true.

Question: I have a question for Colonel Vaughn, if I may. [Inaudible]

Colonel Vaughn: I'm very sorry the translation was not coming through well. I'll put it in my words: I believe what you are saying is that if we can make a statement that we are going, not for 90%, but for 100% reliability in the future, then that is a very rosy picture for the world. The concept over the years has been, that we could go for 100% defense for a certain location; that is, a point defense. We knew there were errors in that, because an enemy always has the advantage of trying to overpower the defense. If he knows that you have a capability of firing so many missiles per minute or per second, he can always add one more and have one more get through. That's been our problem with air defense in the past. We must always try to out-think the enemy by concentrating our air defense forces so as to be able to succeed in stopping the raid—whether it is missiles, planes, or whatever.

Now in this case, I would be wrong—I think any scientist would be wrong—to guarantee a system 100%. But what we start thinking about is that if you approach 85% or 90%, then we can make the defense so effective that anyone that starts a war or starts a nuclear attack knows that only a certain percentage of his missiles can get through—and he cannot knock you out. There will be a second, retaliatory attack. He would get hurt.

So, there's a payoff there; in other words, a trade-off. The Russians or any other country—maybe a Third World country that we don't even envision today—would have the problem of trying to figure out what level of damage it can do. Can it cripple you? The Russians have actually made the statement in their planning that they lost 25 million Russians in World War II. Their planners have accepted 25 million casualties, killed, at the very beginning of a nuclear exchange. They have accepted 25 million. We feel that we can accept 20% casualties in the first 30 days and live and win, but we did not accept this. Those casualties were just unacceptable in our thinking. The Russians have never turned from that. They have said: 25 to 30 million—we lost them in World War II, we can lose them again in World War III. That's where their philosophy from the very beginning has been different from ours.

But now, if there is a possibility that they can start with a first strike, pick the date and the hour and the minute, and try to fire that magic number to overpower our defense, then the problem comes: How many missiles can they get in? Can we take down such a number so that we keep our casualties under a certain figure? When I say casualties, I'm now talking about missiles and retaliatory forces. If we still have the capability of hurting them afterward, and there's an unknown, a question always there in their minds that they could be damaged beyond a certain point by our retaliation—there is your trade-off. With that, you go to the meetings in Geneva and start thinking about actually saying yes, we will have peace. We will not go beyond this point.

So, we feel that we do not have to have 100% perfect defense. That's wrong, in other words. You can never really say that you have 100%. There is a figure below that that we look at and both sides study. They may take another one, but that's immaterial. We are going to push that effectiveness as high as we can.

As we approach this with our scientific communities behind us in Russia, Japan, the United States, Europe, it's really the dream of the world that we are approaching. This is the dream of a space command—it could be a joint command, if they've got their defense and we have ours. They're going to stop everything that comes up and we're going to stop everything that comes up. We're working together.

This exchange of data can be done. We've already exchanged data between their cosmonaut command and our astronaut command through NORAD. We exchange weather data. You may not realize it, but we get the weather report from the Russians just as accurately as we give it to them. I used to always have to know at the beginning of my tour of duty at NORAD, what is the weather over each area in Russia. Is it favorable for a nuclear attack? Would it be favorable for us if we had to launch retaliation? What would be the fall-out, the fall-out patterns? Where is the jet stream at this minute? This is what we must know 24 hours a day. We give them the information and they give it to us. The weather satellites do it for them. Does that partially answer your question?

The Soviet aim: a first strike

Mr. Horeis: I just want to complement this, because the same questions or the same problems, so to speak, are posed in the report that I mentioned, the Office of Technology Assessment report. The author, Ashton B. Carter of MIT, says: Okay, missile defense may work, may be effective, and so forth, but then he says, of these 10,000 warheads, at least several hundred will get through. So, the system will not be perfect. These several hundred warheads would cause enough damage in the United States to make the whole missile defense system worthless.

This would be true if the Soviets aimed at getting several hundred warheads through—but this is not the question. It is a totally irrelevant question. The intention of the Soviets is not to destroy some cities in the United States. The intention of the Soviets is to win a nuclear war. Winning a nuclear war means that they have to destroy as far as possible the military capacities of the United States without being damaged. As for destroying the military capacities of the United States, and mainly, the U.S. strategic arsenal, you need a first strike. This is what the Soviets are aiming at. This is what their arsenal is built for, and that is their strategy.

But, they want a first strike of which the success can be calculated. They want to know that this is successful and this will have the results of more or less destroying the American arsenal. This changes totally if you have missile defense. It is not so much a question of how reliable it is, whether it destroy 50%, 60%, 70% of the missiles. The point is that the existence of even a first-generation missile defense will already make a first strike incalculable, because the Soviets are not adventurous. They know what they want. They wouldn't make a first strike, if they didn't know that that would get them what they want. So even an imperfect missile defense would prevent nuclear war, because there is no chance anymore to be sure of winning it, and winning is what the Soviets want. That's the main strategic point behind this.

Question: I would like to ask Mr. Kawashima and Mr. Parpart: About one year ago, it was said that SDI, as Mr. Kawashima has mentioned, is a conspiracy of scientists involved in nuclear fusion. Maybe that is an exaggeration. However, will the SDI accelerate the feasibility of nuclear fusion? This is the first question. My second question is: If it accelerates nuclear fusion, as Japan is scarce in natural resources, is SDI suitable for the Japanese to go with?

Science and defense

Dr. Kawashima: Today, I'm not going to express my own opinion. To that question, I think that what generally is believed is that when the SDI progresses, fusion research will profit. For Japanese fusion people, for people who are doing fusion research, they are saying that, well, fusion research itself is very important, and they don't think that they need any support from SDI. I think that in the present situation, that is what they are claiming. In any case, I think that, first of all, when we do scientific research, it is very important that that research have a great and primary significance for science itself. For SDI, defense is enough. I think that this is the general understanding of scientists in Japan now.

enough. I think that this is the general understanding of scientists in Japan now.

Mr. Parpart: I think that if we actually look at the matter historically, it is simply an historical fact that the same people who have been thinking about, for example, laser fusion, are the people who were best prepared to think about and work on SDI. At least in the United States and the Soviet Union, that is simply an historical fact.

It is not a question of whether it is desirable or not. It is first of all a question of, is it a fact? In the case of the United States, the people involved in fusion research at Lawrence Livermore Laboratory or at Los Alamos Laboratory or at Sandia Laboratory are also the people who occupy the principal research positions in the SDI program. The same thing is true in the Soviet Union. The top laser researcher in the Soviet Union is Professor Basov of the Lebedev Institute. Basov is also a major-general in the Soviet Armed Forces. I think it is inconceivable that the person who won the Nobel Prize for inventing the laser, namely, Mr. Basov, would not have thought about both the applications for fusion development and the applications for ballistic missile defense.

In this regard, there is little distinction between the United States and the Soviet Union. The present scientific director of SDI is Gerold Yonas, who, until two years ago, was the director of the ion beam fusion program at Sandia Laboratory, which is probably the best candidate for commercial inertial fusion. I can tell you, simply from recent discussions with Mr. Yonas, that he is still just as excited about using his PBFA program on fusion at Sandia as he is about the opportunities for using his scientific knowledge to defend his country. I do not see a contradiction between advancing the scientific ideas of humanity and, at the same time, being engaged in defending the basic principles of our human existence.

So to my mind, and please permit me to comment on this, while it is historically understandable that such a divergence exists in Japan, still, philosophically it is difficult for me to accept that. I can understand it, but I cannot agree. I think any nation that is proud of itself, of its heritage, of its culture, should put its best scientific minds to work on advancing its culture and its scientific creativity, and for that very same reason of pride, should be willing to use those minds to defend itself against any potential adversary.

It is very difficult for me to construct a contradiction between those two principles. To sum up, it is an historical reality that fusion research and SDI research are scientifically essentially identical. It is to my mind a moral principle that they should be so.

April 23

Panel IV: Proposals for a new global strategy

Of Communists and British imperialists

Webster Tarpley

The State Department plot against SDI and the Free World

Mr. Tarpley is a contributing editor of Executive Intelligence Review *magazine and a candidate for the U.S. Senate from New York, U.S.A.*

The much-discussed opposition to the Strategic Defense Initiative inside the United States itself is the product of a very small circle, led by McGeorge Bundy, Robert McNamara, George Kennan, and Gerard Smith—the so-called American gang of four.

I would like to explain this opposition within a discussion of what I see as a crisis of American foreign policy today.

In my own frank discussions with responsible national leaders from all over the world, the most common observations that I have heard have concerned the destructive, and self-destructive, features of U.S. foreign policy. Adjectives that I've heard in this context include: murderous, suicidal, and insane. Foreign friends of the United States have pointed to the tendency of the State Department to punish friends and to reward enemies.

This problem was the subject of comments by the President of Egypt, President Mubarak, who compared United States treatment of Syria with Washington's policy toward his own country, Egypt. Mubarak stated that if a country honestly seeks to be a loyal friend and ally of the United States, that country will be destabilized, will be made the object of embargoes, boycotts, economic warfare by the State Department, and its leaders will be made subject to assassination and the threat of coup.

Indeed, Egypt has been made subject to all of this. But, Mubarak added, if a country like Syria, or Iran, or the Soviet Union itself, hurls defiance at the United States, insults the American flag, destroys American property, kills American citizens, and engages in acts of war against

U.S. armed forces, then that country will be courted and propitiated by the State Department with generous offers.

The recent cases of the Shah of Iran and President Marcos lend credence to Mubarak's remarks.

How then is this American foreign policy made, and what ends does it serve?

Foreign policy is, of course, executed by the State Department, which Gen. Douglas MacArthur, in his time, called "a nest of Communists and British imperialists."

Today, one can indeed observe the presence of groups of British, Soviet, Israeli, and other networks in the State Department, along with the fanatical followers of the Club of Rome, and even, I'm afraid, Satanic cults. Atop this Babylonian edifice there sits the Secretary of State, very often the single most powerful individual in Washington, D.C.

An esoteric theory of government

To explain this inordinate power, which clearly violates the most basic provisions of the U.S. Constitution, the State Department has developed an esoteric theory of government. According to this, the President of the United States is and ought to be a purely ceremonial figure, a figurehead, like the Presidents of Italy or the Federal Republic of Germany today, or the Fourth French Republic. The President's main job, according to this, is to provide warmth and comfort to the masses on the occasion of great national events, usually disasters. Real power, according to the State Department, must be vested in a prime minister—and that is the Secretary of State.

This tendency of the State Department to become a prime ministry is mentioned in General MacArthur's speeches of the early 1950s. If you examine who has been a Secretary of State in the postwar period, if you look at such Secretaries of State as General Marshall, Dean Acheson, John Foster Dulles, Dean Rusk, Henry Kissinger—he gets an asterisk because he's the classic example—Cyrus Vance, Haig, Shultz, you can convince yourself, rather easily, that these are men who have partially or totally dominated the Presidents whom they ostensibly were serving.

Oligarchical families

However, the State Department is no *deus ex machina*; it is the servant of well-defined institutions, specifically, the Eastern Liberal Establishment—a series of banks, merchant banks, insurance and reinsurance firms, all controlled by a group of oligarchical families, operating in coordination with other banking families in Great Britain, Switzerland, continental Europe, and elsewhere; connected also to the oligarchical families of the Soviet Union and the countries of the Warsaw Pact, through a framework of "Trust" arrangements typified by the Yalta Accords.

So, the State Department serves Wall Street. A typical example: One Armacost in the State Department directs the destabilization of the Philippines, another Armacost at the Bank of American collects the loans from the Philippines. The State Department marches to the tune of David Rockefeller, Walter Wriston, and other bankers.

Now, a higher level of control is represented by oligarchical and patrician families. I mention them because they are the enemies of SDI.

It is an open secret that the United States today does not truly function as a democratic and constitutional republic, but must rather be seen as an almost consolidated oligarchical dictatorship, in which brainwashing by the mass media plays a preeminent role. This is the regime of certain families of New York, Boston, Philadelphia, Baltimore, and so forth. If you ask an average American citizen which families rule, he may respond with: the Rockefellers, the Harrimans, and the Kennedys. But I assure you that these are merely three stewards of a power of the Eastern Liberal Establishment, but they are not really the inner core of this patrician elite.

The families are those, especially around Boston, who entered into subordinate arrangements, of junior partnership, with the British East India Company by about 1700. These are the Lowells, the Cabots, the Lodges, the Saltonstalls, Forbeses, Perkins, Higginsons, Russells, Peabodys, and the like.

Very important for our discussion today is that these families, with their relation with the British East India Company, came into contact with Asia and the Orient at a very early time. China and India were the decisive areas of British East India Company operations. And the heart of the so-called British China trade was nothing but opium. This opium was transported by the fabled Yankee Clippers, the sailing ships owned by these families.

The pedigrees and fortunes of the ruling class of patrician aristocrats of the United States are built on illegal drugs, with all the human suffering and degradation that this implies. The main area of their original activity was China.

Yalta and New Yalta

The policy of these families can be seen in the case of Yalta. At Teheran and Yalta, not only was Germany sold out, and Poland sold out, but in the final meeting, the final tête-à-tête at Yalta between Stalin and the dying President Roosevelt, Roosevelt accepted Stalin's demands for the southern part of Sakhalin Island, the Kuril Islands, and the recognition of a preeminent Soviet sphere in Manchuria, in the imperialist tradition, with Russian rights in Darien, Port Arthur, and in the managment of the Manchurian railroads, plus a confirmation of Russian hegemony over Outer Mongolia.

All of this was backed up by Roosevelt's promise to force all of these provisions down the throat of Generalissimo Chiang kai-Shek and his Kuomintang, including by the United States waging war on Chiang. Since Roosevelt had explicitly promised China that he would never grant such privileges to the Soviets, his betrayal of his own ally was complete. And it is worth adding that competent, professional U.S. military opinion, above all that of General MacArthur, was strongly opposed to any Russian entry into the war in the Pacific.

But, as bad as the original Yalta was, there is something worse. That is the "New Yalta," now the operative strategic doctrine of the State Department, these families, and the Washington bureaucracy. The New Yalta, as expounded semiprivately by such publicists as Zbigniew Brzezinski, states that 40 years after the original Yalta, the lines of demarcation drawn on the globe in 1945 are no longer tenable, because of the greatly increased strategic power of the Soviet Union, and the greatly diminished power of the United States. The answer to this, according to Brzezinski and his masters, is to draw new lines of demarcation, this time assigning to the Soviets preeminent interest in and superiority over Western Europe, the Mediterranean Basin, Northern Africa, the Middle East, and as much of southern Asia as the Soviets can dominate. China, according to this plan, would become largely but not totally a part of the Soviet orbit.

Japan, according to this plan, will be subjected to irresistible pressure to become a Soviet pawn for the purpose of containing China.

While this goes on, the United States would shrink to merely a Western Hemispheric power.

Kissinger's '25% solution'

These same ideas have been purveyed by Henry Kissinger, another spokesman of the Eastern Establishment families. In Kissinger's notorious speech to the Bohemian Grove meeting in summer 1982, he argued his case before an audience that included the outgoing and incoming secretaries of state, Haig and Shultz, plus the then-Federal Chancellor of West Germany, Helmut Schmidt. Kissinger's case was that the United States is now fated to lose about three-quarters of its average postwar power and influence, and will thus dwindle to approximately 25% of its average postwar power. This is the origin of the so-called Kissinger "25% solution." According to Kissinger, the role of the true statesman is to recognize that this American collapse is inevitable, and to manage it in an orderly decline.

Precisely because the Strategic Defense Initiative would stop and reverse this decline, the State Department opposes SDI.

At one point or another in any discussion of the State Department and its policies, the question of the what, and the how, tends to be eclipsed by the question of why. Why does the State Department do these things? What do they gain? What is their interest?

The mistake often made in this context is to project on the subject under consideration the common-sense idea of interest which is agreeable to the man-in-the-street. The State Department, however, is ideological, and not practical. The whole image of the U.S. ruling elite today, is that of a group that is more and more divorced from reality, away from the real world, more and more an *ancien régime,* incapable of responding to real events transpiring about it. The families in particular have ruined their progeny through their own policies, and the generation of patricians born since the Second World War has been devastated by drugs, halucinogens, homosexuality, and green/zero-growth ideology.

The State Department in Asia

Turning to the State Department role in Asia since the Second World War: In China, I think it is clear in retrospect, up until 1949, the State Department policy was to destroy Chiang kai-Shek and his Kuomintang, and bring Mao to power. This was the line of the so-called China foreign-service officers of George Marshall, Dean Acheson, and Averell Harriman.

In the case of Japan, during the American occupation, the State Department attempted to permanently wreck your country. It was largely the influence of Gen. Douglas MacArthur that allowed Japan to be protected. In particular, the State Department wished to impose upon you a regime of permanent limited sovereignty, including the division of your country into occupation zones, including a Soviet zone; the permanent wrecking of the Japanese economy through an Asian version of the Morgenthau Plan; and an interference in your vital institutions, including even the imperial dynasty.

It was largely through MacArthur's commitment to stop those policies that they were not successfully implemented. But the danger in Japan was great, and if you want to see how great the danger was, look at West Germany today: You will see a country in which many of those policies were carried out, because there the power of the State Department was total, and there was no MacArthur on the scene.

In the case of the Korean War, General MacArthur was ousted from his commands 35 years ago this month. Millions of Americans protested that. General MacArthur proposed to fight for victory and to end the Korean War. The State Department, with Acheson, Harriman, Marshall, and the rest, imposed a limited war and an endless slaughter of Americans, Koreans, and indeed, Chinese, in the name of respect for the Yalta Accords.

In the case of Vietnam, in 1963, the State Department, acting through Ambassador Henry Cabot Lodge, McGeorge Bundy, and Ambassador Harriman, connived to murder President Diem and his brother, which was the end of stability in South Vietnam and the beginning of the Vietnam debacle.

The Republic of Korea and the free Chinese government on Taiwan are now on the hit list for State Department destabilization.

In the light of these events, and in the light of similar events in Iran and several other countries, it should not be too difficult to see the significance of the recent State Department coup in the Philippines. The purpose of the machinations of U.S. Ambassador Bosworth in Manila, is precisely to liquidate the United States presence at Clark Field and Subic Bay, as a prelude to a total U.S. disengagement from all of Asia, or, to a scuttling of all Asia, as General MacArthur would have said.

President Marcos was weakened over a period of time by the austerity dictates of the International Monetary Fund. The State Department arranged to have the latifundist Benigno Aquino sent back to Manila, and assassinated, in order to provide a martyr to galvanize subsequent events. U.S. intelligence assets Ramos and Enrile were already plotting a coup one year ago, as our magazine, *Executive Intelligence Review,* documented in August last year. Alabama Senator Jeremiah Denton has referred in public to U.S. intelligence plans that included the option of assassination of President Marcos. It is clear that U.S. forces were poised to strike Filipino military units loyal to Marcos.

In short, the imbecilic State Department meddlers, mad dogs in diplomats' striped pants, have engineered yet another strategic windfall for the Soviet Union, whose base at Cam Ranh Bay will soon wholly dominate the strategic water course that is the South China Sea.

To stress again, this is the intention of the State Department. They are implementing the Kissinger-Nixon Guam Doctrine of July 1969, according to which Asia is to be sold out to Soviet aggression. They are acting to correct American "over-extension in Asia," in the phrase of Ambassador William Sullivan, who was one of the masterminds in the overthrow of the Shah of Iran and who played a central role in the toppling of President Marcos.

The LaRouche factor

The conduct of the State Department is a clear fact. What to do about it? The Americans who protested the firing of General MacArthur in 1951, or those who voted for Goldwater in 1964, or for Governor Wallace in 1968 and 1972, and who have been voting for Ronald Reagan in increasing numbers in every election since 1968, were, in their own estimation, casting votes to protest the arrogance, the insanity, and the mismanagement of the Eastern Liberal Establishment families.

The tragedy of Ronald Reagan may turn out to be, in retrospect, that he lacked the strength to deliver on his promise that Henry Kissinger would never be allowed back into the White House.

But now, at the eleventh hour, as the United States and the entire Free World approach the point of no return on the way to ultimate disaster, there is a sign of hope. The American political scene is once again in rapid movement. The results of the Illinois primary, with victories of four LaRouche citizen-candidate Democrats, have created the greatest political sensation in the United States since the days of Franklin D. Roosevelt. As a consequence, the uncontestable front-runner for the

Democratic nomination for the presidency in 1988 is now Lyndon LaRouche.

In the year 1986, LaRouche citizen-candidates are running for the Senate in 15 states, for the governorship in 8 states, and for the House of Representatives in 165 election districts. In the first week of May, there may be more victories that will add to the shock effect of the Illinois vote.

Into the hands of these LaRouche candidates, this year and in 1988, are confided the last best hopes of a tormented world for seeing the State Department policy of cowardice and treachery replaced by an American policy, of which General MacArthur, were he alive today, would be proud.

I would, therefore, in conclusion, recommend the closest attention, by all nations and peoples around the world who love freedom, to the progress of the LaRouche citizen-candidates of the Democratic Party, and to Mr. LaRouche's bid for the White House in 1988. For, on this, the fate of the SDI will depend. Thank you.

Takeo Sasagawa

Peace, technology, and international society

Takeo Sasagawa is a professor at Tokai University, Tokyo.

It is a real opportunity for us to hear the statement by the candidate for the United States Senate, and I would like to make some proposals. First, that moving from mutually assured destruction to mutually assured survival is a commitment made by the United States. That is what I understood here in the presentations from yesterday and today. The transition from this mutually assured destruction to mutually assured survival will not have a military impact on society as a whole. We consider SDI to be participation by the President of the United States in a nonnuclear activity, and it is worthwhile to listen to the principle of the SDI, or basic philosophy behind this SDI.

A tool for peace

During press interviews with Presidents Johnson and Ford, I was very impressed by their statements that while they were in office, it was their greatest relief that they did not push the button that would start nuclear war. The thing that impressed me most was that their faces were very blank when they said that. And I think that what President Reagan is concerned with is the same. We can't push the button that will lead to a nuclear war. The individuals in command of the Soviet Union and the United States have the power to press the buttons, but we should consider their responsibility. And when those two are in the process of deploying the SDI, we understand and we learn that there are more things to be done. It will take much time to solve all the pending questions.

As Japanese citizens, we should proceed down the stable road to that peace. We enjoy peace under mutually assured destruction, which is rather a crazy doctrine, and we have doubt whether this kind of peace will last forever. When we consider the interests of Japan, we see that Japan lacks natural resources and a market, so Japan's survival is based on the peace of the world.

So, we hope that the process of SDI will lead to peace, and we should understand SDI not as a spinoff of technology, but as one of the tools for the peace of the world.

Secretary of Defense Weinberger mentioned that the transformation from mutally assured destruction to mutually assured survival will be continuous and will be conducted step by step, so there is no reason for the Japanese people to worry about the transformation. It is the further strengthening of the deterrence power. With regard to reduction of offensive weapons, such as ICBMs, negotiations between the United States and the Soviet Union will continue, which will assure the peace of the world.

Should Japan participate?

The Japanese Diet is now deliberating participation in SDI, but we should make some declaration of the standpoint of Japan itself, and afterwards decide whether or not to participate in SDI. If we are to participate, we also must decide what way to participate in SDI. It is rather easy to say that we would like to participate, but the implication is quite great. This is the first time that Japan will be involved in strategy on a worldwide basis, so it is not just interest in spinoffs, but the phenomenon which will involve Japan in the worldwide strategic scene. And what is the role and what is the contribution of Japan?

As Mr. Momoi mentioned yesterday, the letter *s* means sensor and surveillance, *d* stands for detection, and *i* stands for intelligence or information.

I agree with Mr. Momoi that sensor and surveillance should be the important factor for Japan. I would like to further mention that detection and intelligence or information, command and control, communications lines, and intelligence should be the target of the research and development in Japan. So, Japanese high technology or advanced technology will make it possible for us to develop information and intelligence as well as detection.

Japan is involved indirectly in the implementation of nuclear strategies. If Japan has technology on surveillance and detection, and if we cooperate in that regard, it becomes clearer to the Japanese people what world strategy as a whole is.

In satellite monitoring, Japanese technology is well ahead of other countries. And by having the satellite information, we could have some surveillance of the hot spots in Asia, and also could prevent wars and other disputes, as well as locate submarines.

Reactivating the economy

Is there any technology or breakthrough via the SDI? Yesterday, it was mentioned that there is a spinoff from research and development of the SDI, and there should be some chain reaction; we can't deny that. But I would like to take some historical perspective on this matter.

There is a 50-year cycle of ups and downs of the economy of the world. The first industrial revolution started in the 1760s and 1770s, and at present, a false industrial revolution is occurring. So, there were four ups and downs during the last 200 years. In the 1980s, there should be new breakthroughs for technology and for economy. Of course, there are many driving factors that move the economy, such as recession, war and armaments, and also resources and new materials experience innovations. And as we have heard this morning, energy itself is experiencing innovations. So there are many factors influencing the economic cycle.

But innovations both in materials and energy are the most important factors to drive the economy. New SDI materials and new energy (such as the laser beam), increase rather significantly these two new factors.

In the past, we had a major war every 50 years. However, we did not experience a global war for a long time. Since we do not have war, it is necessary to reduce the interest rate and to activate domestic consumption, because we have money supply problems. At the next summit in Tokyo, this kind of innovation in high technology should be a major topic. It will be essential to reactivate the world economy, and this should be a very important theme or topic at the summit.

We have discussed the laser beam this morning, and how it will lead to fusion, especially in terms of commercial inertial fusion. If SDI progesses, this kind of fusion will progress. The atomic reactor utilizes magnetic fusion rather than inertial fusion, but research and development is leveling out at present on the world scene. Inertial fusion has great potential for the future when we consider the situation of magnetic fusion. Maybe in the 21st century, we'll be relieved of the threat of a nuclear war; and maybe we will be relieved of the deficit of energy in the future, if we succeed in these kinds of new technologies.

Matching society and technology

But there is a problem. Is it all right to have progress only in terms of technology? But this is a very big problem, so I can't take very much time to discuss this matter. Is there any international society and economic development which will catch up with the technology or breakthrough? This is a problem which we have to face.

As to the atomic reactor, there is an organization called the INTOR, international tokamak reactor. This is a conception—it is not an actual organization. The conception is to organize INTOR with the cooperation of the United States, the Soviet Union, and Japan. This is only technological cooperation, but when we have this kind of new technology or new materials, is it possible to share this technology on an international basis? It is possible that if we are very wise, it may be possible that in the future we will be free of any concern for raw materials and concern for energy. We have to consider these developments in the context of the SDI development.

I don't have any conclusion of my own, but if laser fusion energy is monopolized by the Soviet Union, it will be trouble for the world. The State Department of the United States is not wise, as Mr. Tarpley mentioned, so the monopoly by the United States will do harm to world peace. So, it will do harm to monopolize this technology.

If we can have this very advanced technology by SDI, and we can have very advanced energy, we have to have an international political situation and economic system which will match up and catch up with the technological development. I think that today, the audience for SDI is mostly the engineers and those who are involved in the technology area, so we have to consider the society and the economy which will match up with the technology.

These are the three points of which I would like to ask your consideration

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Panel IV: Questions and comments

Mr. Sakata: I would like to leave something behind, that you can recall after the meeting is adjourned.

One comment on the criticism of SDI. Thus far, there has been no other single project which has been so controversial as the SDI project. When the SDI project was first proposed, it struck people very abruptly. All of a sudden, the suggestion was made. That's how many people felt about it.

A polarized world

After the Second World War, the United States implemented a number of policies. In retrospect, when we recall these policies, combined with the pioneering spirit with which the American people were endowed, and their mentality, the U.S. postures were reflected in the kind of policies they have taken on various issues after the Second World War. Sometimes in world policy matters, the country might have made some mistakes, and a few years later, they have reflected on their mistakes.

We have successfully been in a peaceful age. I think many people must have benefited from this peaceful time. Take the example of the problem of the State Department as a previous speaker indicated. I believe that there is some discrepancy between how things are judged in the State Department and by the man on the street. There are two superpowers, the U.S.S.R., on the one hand, and the United States, on the other. These superpowers, so to say, established nuclear umbrellas, respectively, and that is why the world has been polarized between two spheres.

This polarization of the world, could have been attributed to the fact that it was done just for the self-confidence and complacency of the two nations. Of course, there has been a lot of background discussion on why that phenomenon took place. Sometimes, to make judgments is a very dangerous thing; so, not being cool-headed and calm, sometimes people fail to make the correct judgment. I believe that how the Japanese people perceived the past 45 years has been different from what the two superpowers must have conceived and perceived in the past 45 years. The world changed so drastically after the war. I believe that people should have accepted certain opinions based on rational judgment and some people should have made more rational judgments by being cool-headed and very objective.

As Professor Kawashima mentioned, it is deplorable that sometimes people fail to make an objective, rational judgment, and we have to suffer from the after-effects of the erroneous judgment. At least from the scientific point of view, I believe that history testifies that the rational theory should be expressed, fairly and freely, as a rational theory. This cannot be done frequently in today's world, which is quite deplorable. In general, as time passes, people forget the bad things and try to recall only the good things in the past. And peoples' notion, people in their mentality, try to forget something bitter in the mind and try to keep the comfortable things in it. I believe that bitter experience gives you something to reflect on, but the negative effects are forged in one's mind, and you will suffer from that trauma for a long time.

This is how the Japanese people perceive, or what I call the theory nurtured by the Japanese people, although it might not be applicable to the world scene. I believe the SDI ideas puzzled the Japanese nation. People don't know what to do and how to do it, what judgment to pass.

Because the Japanese people are not really well conversant with the defense issue and the fusion issue, people try to get a lot of information to lead us to the right judgment. How we should direct ourselves in the right direction is something we have lacked in the past.

In official forums, there has been no substantial discussion on the SDI issue since the announcement of SDI in 1983. This is partly due to the U.S. lack of effort. The United States has done some enlightening or educational dissemination of information. Of course, the United States has a great advantage over us in the sense that the society is open, so that the proponents and opponents can debate rather fiercely in open forums in the United States. This is a merit, and this doesn't happen in Japan.

When proponents and opponents exchange opinions in open forums, as somebody put it, people are free to make a negative statement, but not free to make a positive statement on the SDI. So, no matter how repetitive the discussions in Japan, I believe people easily tend to make negative statements, but not really come down to the roots or the basic principle of SDI projects.

There were some serious conditions imposed upon us after the Second World War. We have changed some policies affecting the relationship between the United States and Japan. When exports emerged as a problem in the United States, for example, each state formulated some bill in order to deal with the trade issues against Japan. Particularly the Muskie bill actually puts a constraint and curtailment on Japanese automobiles due to the Clear Air Act to control exhaust, the gas from the automobile. After that, Japan became visibly involved in order to clear away that act so that automobile exports could be continued without harm.

Equal partnership

I would say the United States and Japan have demonstrated their wisdom, so to say, joined a wisdom race to see which could win. And I believe that the United States has posed several challenges or tasks to Japan and Japan has tried to solve those challenges. Japan would like to achieve equal partnership with the United States, which Japan has not ended up with in the past. Again, I believe that SDI is another task or challenge the United States has imposed upon the Japanese people.

Japan and the United States have never played cards, and the Japanese people don't play cards. Japan can't play poker. The Japanese people are not really very good at hiding their emotions or hiding their cards from their counterparts. I believe that the Japanese people have again tried to be frank and think about this SDI program rather seriously.

Sometimes, although we use a common language, in our tactics, the meaning of the word could be different. When you speak of attack or defense, we are of a mentality to think of Japanese martial arts, as opposed to the ballgame, which is very popular in the United States. The rules of the game in the United States and the Japanese martial arts are different. Sometimes Japanese fail to understand what the rules of the game are in the American ballgame. In other words, there is a discrepancy in the comprehensions of the rules of the game of the two.

Even the terminology "strategy" could be interpreted in a different way in the different countries. The Japanese people, I believe, do not really deeply comprehend strategic issues. But I think we should, unless in so doing, we can't be the equal partner of the United States. In the SDI, the issue is on the concept level, it is an initiative. So, there is much room left for reconsideration. I believe that Japan could express opinions as suggestions or modifications to the initiative or the concept of the project. I believe that Japan should never be passive, but be active in making suggestions or opinions on this concept.

We discussed a lot yesterday and today. I believe that a lot of what we have discussed has been nothing new. All of the information that we have obtained this time has already been published in books in the past, so, so far, nothing new. I thought that this discussion actually has been rather old hat, or already familiar pieces of information to us. I think it is high time that we asked what is SDI and what is the basic principle and how should we cope with it. These are the kinds of subjects I would have liked to see in this forum.

As Professor Sasagawa indicated, he refers to Momoi's terminology, small-letter sdi, the ISMA, International Satellite Monitoring Agency, proposed by Giscard d'Estaing to the United Nations in 1973. Actually, this ISMA proposal was crushed due to the dynamics of the superpowers. ISMA is a gear to provide a balance function on a global basis. This proposal was quite interesting, although it was canceled. The other proposal called DSMA, District Satellite Monitoring Agency, also existed. In 1972 in Copenhagen, we made a small proposal by saying that we should launch some international surveillance satellites to provide a good monitoring of events over the globe.

A surveillance function

The number of satellites launched into orbit exceeds 3,000, well over 100 satellites each year. Some satellites went up and came back to the ground after one week, some satellites operate in orbit for a long term. People started to find that we can't be without satellite utilization. And 80% of total satellites are for military purposes. Almost two-thirds of the satellites were launched by the U.S.S.R., and about 1,000 were launched by the United States; the remaining, more than 100 satellites, were launched by other countries. So, the U.S.S.R. comes first in terms of the number of satellites (setting aside the quality of the satellites), second, the United States, third, Japan, and fourth, France.

This fact is important. Japan should have something more to do, some responsibility to pursue on the basis of this fact. One possible element that Japan could undertake is to offer a surveillance function over the conflict areas of the world. So it might as well be part of the SDI role Japan could propose, on the basis of the unique capability of the Japanese people, or the unique position of Japan in this utilization of space, the utilization of satellites.

One point I don't really understand is the fact that conflicts between the superpowers have lasted for a long time, but no war has taken place between the two countries. Japan fought with both of them. The other two powers are playing games and no one rules the games of the two nations. Japan one time fought against the U.S.S.R. and one time fought against the U.S.A. I believe that there should be a bilateral treaty between the U.S.S.R. and the U.S.A.

Aside from this bilateral treaty, the European countries have launched a Eureka project against the SDI project. President Mitterrand of France announced early that Eureka would be a different program, but Japan alone didn't know how to behave and did not really respond with a clearcut policy.

Scientific and technological areas have developed to be an important tool for mankind. If the tools are utilized in the wrong way, it will lead to the collapse of the total population. If science and technology could be very important in serving as a tool to balance power, then for that purpose, I believe that we should exert our efforts.

In this context, the Japanese role is self-evident; the contribution of Japan becomes self-apparent. It is dangerous to argue here in Japan that we need a defensive superiority to offense, therefore sounding too military. That's really dangerous thinking in Japan without first having a discussion on the basic principle of SDI. Japan should take rather a global standpoint to reconsider this project.

I would like to propose on this occassion that Japan should make a new proposal in this defense issue. Second, Japan should encourage people to discuss the pros and cons of the SDI project in a more open way. We should be bound by timely pressure, as I understand it, because the environment-technology issue has to be resolved. We feel that we are at the eleventh hour, we are forced into a corner to make a decision in such an environment, but never can afford a cool-headed objective decision. I just talk rather randomly, but so I would like to conclude my presentation.

Mr. Parpart: When I was a graduate student in mathematics at Princeton University, our favorite game was the game of golf. So, I would like to challenge Professor Sakata to a game. And perhaps this might clarify some of our mutual thinking on these matters.

LaRouche's greetings to the conference

Professor Sakata: Before we open the floor for questions and answers, we would like to hear the message of Mr. Lyndon LaRouche, whose statement will now be read by Mr. George Gregory.

Mr. Gregory: Mr. LaRouche has conveyed a message to this panel this afternoon which is most appropriate, on the subject of the revolutionary impact of SDI on the growth of the world economy.

His message contains a number of highly specific and technical points, so I propose to compress his message somewhat and to make it available to those participants who may want to examine it in more detail.

Mr. LaRouche's message: Twenty-four years ago, Soviet Marshall V. D. Sokolovskii wrote his shrewd insight into the flaws of the U.S. ballistic missile defense program then being developed. He foresaw that high-speed interceptor rockets and related kinds of so-called kinetic-energy weapons could never provide an effective defense against offensive ballistic missiles. He foresaw that only by using what he described then as advanced physical principles, such as laser weapons, could defense obtain the superiorities in firepower and mobility needed to supersaturate a strategic thermonuclear offense.

It is a matter of physics principles and therefore, also valid for the United States, that a strategic defense based upon what are called new physical principles, will have at least a 10 to 1 superiority in firepower, mobility, and cost over a ballistic missile offense.

Many techniques for deploying beam weapons have been discussed, including the techniques of strategic defense which my associates and I first proposed in 1982. During my discussions with French military officials in 1982, those officials asked me if it were not true that what I was really proposing was not any single set of defensive systems, but rather that I was projecting very high rates of technological attrition in defensive systems over the decade ahead. I responded that the French military's assessment of my proposal was correct. As rapidly as one set of defensive weapon systems is deployed, work will begin to develop effective countermeasures against such systems. To overcome those countermeasures, improved defensive systems must be deployed.

The most critical feature of my 1982 proposal for a U.S. strategic defense initiative was my assessment of the economic feasibility of sustaining the costs of such a defense policy. A few, but not most of the military features of my proposal, were original to me. The Soviets have been committed to their own version of SDI since 1962. So, if we pursue SDI we can therefore concentrate on the economic benefits to our economies.

The starting point of my economic analysis is not unfamiliar to Japan. My standpoint is broadly identical to that of such exponents of the American system of political economy as Alexander Hamilton, the Careys, and Friedrich List. My opponents among economists therefore label me either a mercantilist or a neomercantilist. The basis for my own contributions to economic science is the principles of physical economy first developed by Leibniz. My only original contribution to economic science is my use of the work of Bernhard Riemann to solve the problem of correlating measurable advances in technology with resulting rates of increase in the productivity of labor. It was this contribution which has been at the center of my proposals for the U.S. Strategic Defense Initiative.

It is this connection between the new technologies of SDI and increase of productivity in the economy generally to which I turn your attention now. In brief, the functional connection between technological progress and productivity is demonstrated by comparing the potential population of so-called primitive societies, of about 10 million individuals at most, with the present population approaching 5 billions. This increase is due entirely to those kinds of modifications in human behavior which the past 500-years' history associates with scientific and technological progress.

We can sum up the results of economic science by stating that the possibility of increasing the potential population density of humanity depends upon conducting technological progress in an energy-intensive, capital-intensive mode. This means that the amount of usable energy per capita and per square kilometer must be increased. It also means that the portion of work allotted to capital imrpovements in land and work places must increase as a percentage of total work. For example, without development of infrastructure and without increasing rates of capital investment per operative, no nation is capable of sustaining technological progress in agriculture and industry.

By economic science, we mean economic science as originally defined by Leibniz. Instead of simply economic science, we might use the term used to describe the teaching of Leibniz's economic science in German universities during the 18th and early 19th century, physical economy. It may be recalled that Leibniz's founding of economic science was begun with his study of the principle of heat-powered machinery. These principles were introduced to the American economic system by Benjamin Franklin.

There are four principal factors correlating with increase of productive powers of labor. First, the amount of production of capital goods must increase relative to production of household goods. Second, the amount of usable energy supplied must increase, both per capita and per square kilometer. Third, the modal energy density cross-section and the relative coherence of energy supplies must be increased; fourth, technology, as Leibniz defined it, must be advanced.

We are at the verge of the greatest technological revolution in mankind's history. This revolution will be based on greatly increasing the volumes of usable energy, both per capita and per square kilometer, with emphasis in leaps in the levels of high energy density cross section, with increasing emphasis on the electrohydrodynamics of the plasma process, and the role of coherent forms of electromagnetic pulses in production, and on new qualities of robotics by means of which operators will be enabled to control production of such high energy-density characteristics.

Perhaps the best way of demonstrating the impact of SDI technologies on the economy is by considering the application of these technologies to the colonization of the Moon and Mars. The establishment of artificial habitat environments on Mars and the need for continuously powered flight by flotillas at one gravity between Earth orbit and Mars orbit, require the technologies of controlled thermonuclear fusion, of coherent electromagnetic pulses of very high energy density, self-focusing effects, and of optical biophysics. It will also require dedicated types of parallel processing computers, in the megaflop range. We shall be greatly advantaged to have analog-digital hybrids of the quality indicated. If our planet undertakes such a colonization program seriously, we could begin colonization of Mars during the third decade of the coming century.

Such a target has already been recommended by a U.S. commission. Obviously, if it is feasible to establish colonies on Mars, it is a much easier task to apply the same technologies to such tasks as developing rich agroindustrial complexes in the middle of the great deserts of Earth. It is even cheaper to revolutionize the design of new qualities of cities in the more agreeable climates of Earth. With these technologies, the Earth's food supplies can be produced far more cheaply, more abundantly, by energy-intensive industrial process methods aided by application of optical biophysics.

The connection between the technologies of an SDI system and space colonization technologies is so immediate that the research and development of one is nearly identical with that for the other. Therefore, the central practical question to be confronted by governments and industries in connection with SDI, is the question of assuring ourselves that this desired kind of spillover of technology into the civilian domain does occur. Technology is transmitted into production chiefly through improvements in the technology of capital goods produced. The greater the rate of advancement of technology in capital goods, and the greater the rate of investment in capital goods per capita, the greater the rate of increased productivity generally.

Thus, the buildup of the capital-goods sector for SDI and space development is the most efficient mechanism by which such technologies are transmitted directly into the civilian domain. It is merely necessary to build these new capacities on a scale significantly greater than that required for SDI and space requirements, and to cause the excess capacity to spill over rapidly into capital goods for civilian production. To ensure that this desired success occurs, we must adopt the policy of increasing greatly, the percentages of employment devoted to scientific and engineering occupations, while increasing significantly the percentage of national output devoted to capital-goods production and infrastructure building.

A target of not less than 10% of national labor for employment in relevant science and engineering occupations and a doubling of present percentages of national incomes allotted to capital goods and infrastructure would be a good choice of targets for the coming 10 years.

We must shift employment away from emphasis on nonscientific services and redundant administrative and selling functions, moving these percentages of the labor force into either science and engineering or capital-goods production. This requires, obviously, adjustments in education policies, and also in policies governing priorities in preferential tax rates and in flows of credit.

On condition that we inspire our populations to associate personal achievement with contributions in these directions, and that we educate our populations to cope with the new technologies I have indicated, we shall accomplish the desired victory of strategic defense over thermonuclear offense and we shall solve the principal nonmilitary strategic problems of our planet.

If we adopt the proper policies, the creative powers of many millions of scientists and individual operatives will do the rest for us.

Kinetic vs. directed energy weapons

Question: I would like to address the question to the experts on American military issues as well as to General D'Allonnes. I have carefully listened to General D'Allonnes and that lecture impressed me to such an extent that I feel like I belong to the project team in SDI. I don't mean that I don't have any argumentation against it. By Japanese participation in SDI, what benefits can the United States gain? What does the U.S. government expect of Japan by Japanese participation in SDI strategically? This was my first question. Second, what strategic role do you think that Japan can accomplish in joining SDI?

I believe that a partial answer must have been made by General D'Allonnes, but there is a distinctive difference between France and Japan. First, we are not nuclear-armed; second, we are not a member of the NATO nations. I believe that it is an exaggeration to judge that the age of MAD, mutually assured destruction, is over. At least for a transitional period, we have to live with MAD, in coexistence with MAS. I believe that, for a transitional period, we have to have MAD. So, I question what would be the strategy which will combine MAD and SDI. I think this stragtegy will be particularly required by the Western Allies as well as by Japan.

In the SDI concept, beam weapons were emphasized in various variations. But, even more so in Japan, kinetic energy weapons (KEW) could be one of the promising areas, or the area Japanese people might be interested in. So I feel that Japan should devote much of her efforts to kinetic energy weapons.

Some American people said that a beam weapon was not cost effective. Therefore, a kinetic weapon is much better because it could attack 80% of the ICBMs. I do not necessarily agree with that opinion, but I personally feel that three pillars—beam weapons, kinetic energy weapons, and ASAT[antisatellite]—would be required. But for the time being, I think it is smart to pay due attention to kinetic energy weapons as General D'Allonnes has just indicated in Japanese defense.

Japan is not only strong in economy and technology, but Japan is located very strategically in geopolitics. Unlike France, the SLBMs located in the Sea of Okhotsk account for 30% of the SLBMs the U.S.S.R. owns. In aircraft, the Sea of Okhotsk is one of the primary areas the U.S.S.R. is placing emphasis on. So, in SDI, I believe that it will be more effective if we can launch some defense weapons against SLBMs or aircraft. Of course, we have committed ourselves to a nonnuclear policy, no armament of nuclear weapons, but I believe that in the overall framework of the U.S. SDI strategy, they should be a major area to which Japan could make a contribution.

Right now, NORAD is not really responsible for Japanese defense, but it is strong enough to make MAD effective. Perhaps Japan could send some representatives to work for NORAD, or Japan itself could perform some similar function in SDI as NORAD does. Japan could do something indirect in SDI. I believe that it will be better off if Japan commits itself to be engaged in SDI. I think that Japan should do that. I believe that the answers to my questions could infringe upon some confidentiality, but not to a great extent, and here I would like to welcome the answers. Then, may I invite the American specialists to answer the questions?

Mr. Parpart: I would like to try to answer three aspects of your question. First, why does the United States want Japan to participate in SDI? I cannot speak for the United States government, but I think I can offer some reasonable opinion.

It is not simply or even primarily, I think, a technical matter. Yes, it is true that technologically Japan could contribute a great deal. As Professor Sakata indicated earlier, especially in the area of battle management and so forth, there exist Japanese technologies which would help in developing SDI faster if we could collaborate with Japan than if we could not. Some people have estimated that collaboration between Japan and the United States could shorten the research phase by about two years.

This is important, but I think that it is not decisive. I think that the more important issue is that under the present military doctrines, essentially both Western Europe, as General D'Allonnes said, and Japan, in fact, cannot be effectively defended. It is true that we have the doctrine of deterrence and we have the treaties between Japan and the United States and between the NATO countries and the United States, and we have the so-called nuclear-umbrella concept. But it is a very, very strange umbrella, if you think about it. It is an umbrella that does not have any roof and it does not protect against rain or anything else very well. It is simply a promise that if Japan were to be attacked, then the President of the United States would launch a massive counterstrike. Now, let us suppose that we did that. Still, Japan would no longer exist, the Soviet Union might not exist and the United States would not exist. So, it is a very strange umbrella.

Basically, what SDI does, for the first time in fact, is hold the possibility of actual defense. And by holding the possibility of actual defense, it removes, in addition to that, the possibility of military nuclear blackmail. That is to say, it is not just a military question, it is a political, strategic question.

The actual balance of military forces in the Pacific today is such that even without nuclear weapons, the Soviet Union in Northeast Asia enjoys a superiority which is similar to that in Europe. I believe that only in the context of SDI can any effective long-term defense be considered. So, SDI gives us, for the first time, the realistic possibility of putting our alliances not on promises, but on actual defensive systems which will reaffirm the alliance in the Pacific and the alliance in the Atlantic. That is to my mind the most important point.

From the Japanese standpoint, if I may try to think this from your side, I believe, as also Mr. Sakata said yesterday, that for Japanese firms simply to work as subcontractors in SDI is not a particularly good role. If I were a Japanese, I would not want that role. I would want to collaborate only on the condition that I also have a say in the determination of strategy which underlies the system. And if you are simply subcontractors, you will not have such say, just as subcontractors in any other matter do not have say over the execution of the project. Therefore, I think, both from your standpoint and from the American standpoint, we would have a much more honest and fruitful collaboration if Japan made a strategic decision based on its own interest rather than simply a commercial decision in the interest of a few potential subcontractors.

And regarding the question of kinetic energy weapons (KEW) versus directed energy weapons, the ultimate advantage of SDI over offensive nuclear weapons lies in the fact that offensive nuclear weapons are deployed and delivered by chemical propellants. SDI projectiles are propelled with the speed of light, that is to say, four orders of magnitude faster. That is the most important aspect to be understood. KEW, even under optimum conditions, still employs the same physical principles as the offensive weapons. And therefore, from the standpoint of cost advantage and everything else, it does not ultimately work, in my opinion. There was a study in the United States recently on battle management. And the conclusion was that if SDI were based on KEW, battle management would become almost impossible. I think that is probably true. It is only with powerful laser and particle beam devices that we can overcome the disadvantage of having to potentially shoot at a very, very large number of offensive objects.

Also, KEW would have no interesting technological spinoffs, because it is an old, very well-known and simple-minded technology. As I said to somebody recently, even smart rocks are still just rocks. And that is something that we should really keep in mind.

But again, my basic answer to you is that we should consider these matters strategically first. If Japan feels that it is in its interest to collaborate strategically, then you should. If you feel that it is not in your interest to collaborate strategically, you should not. Commercial matters should only be considered after that fundamental decision has been made. That would be my way of looking at it. Of course, you would have your own.

The transitional period

Mr. Tarpley: I would like to answer another part of your question. First, I would just stress again this question of the directed energy weapons. If there is a problem that has emerged in the management and architecture of the SDI in the United States, it is spending and wasting too much money on the kinetic energy weapons. About half or more is now going for those kinetic energy weapons, and there is already a kind of crisis building up in the SDI because of the way that money is being spent. The directed energy weapons are the only ones that have the inherent advantages of mobility and firepower that make them effective.

In terms of the transitional period, there is a transitional period and we have to think about how to get through the next two to three to four years in the face of the Soviet buildup, in the face of the Ogarkov Doctrine. In the study *Global Showdown,* we address this problem. We talked among other things about a posture of strategic forces called launch-on-warning, the ability to respond almost instantaneously to a Soviet attack once it is clear that an attack is in progress. And, of course, tell the Soviets in advance that this is the case, so that they will think better of it and please not launch that kind of attack.

We talked about the necessity of building 1,000 MX missiles almost immediately, using assembly-line methods, to try to counteract this tremendous Soviet superiority in that department, and give them a few more targets to shoot at.

There is also the question of transitional methods toward beam defense. In particular, we did a study of the trajectories of ICBMs launched from Central Asia. If they are going toward the United States, it turns out, very interestingly, that most of these warheads come together over two points on the globe. One point is over Soviet territory, and another point is over southern Greenland. It would therefore be very effective—and this could be done tomorrow—to saturate those windows, those points on the globe, with very high radiation neutron bombs, exploding one of them per 30 seconds or per minute for a period of 10, 15, 20 minutes. This would have the effect of wiping out or at least neutralizing the Soviet warheads that would come flying through.

The Soviets should be told that, and they should be warned that, therefore, their attack will not succeed; so, they should please cease and desist from any such intention.

I think the general type of architecture toward which we have to attend is a closed gate. There is no moment at which the decision to activate these systems could possibly be made. The system must be left on all the time. It can be turned off if the Soviets want to launch a peaceful satellite. This system could be turned off momentarily to let a peaceful satellite go through. Otherwise, they should be aware that anything they launch will be wiped out almost automatically, and therefore, we have a very, very stable system.

So, I think that there is such a transitional period, but that we can get out of that transitional period faster if we put the money and the effort into the directed energy weapons, because those are the ones with the future.

I have to deplore in this connection the influence of a group of people called the High Frontier Project, of General Danny Graham, who really is responsible for wasting all of this money on a bunch of dead-end technologies.

Q: I would like to ask a comment from General D'Allonnes to the same question.

General D'Allonnes: I don't have very much to add to what was said by Dr. Parpart and the scientists. I think exactly as he, that the difference is the speed. I think equally that the defense of Europe with beam weapons is necessary for two principal reasons. First is a military reason, which I have already explained, and the second reason is a political reason. The military reason is an enormous superiority on the Soviet side; the political reason is that the European countries are not a single nation. With the directed energy weapons, each nation can decide in advance whether they are going to participate in the defense, and then it would be automatic.

I would like to add a little remark, if you permit. I profit from your question by adding just one more word. They reproach us, saying that we want to militarize space, but if we destroy the military weapons in space, we are demilitarizing space.

Q: What's the role of Japan then?

General D'Allonnes: Thank you, you give me great honor to ask my opinion, because I am ignorant of this question. But, I understand from these two days, that Japan could have a role that is extraordinalrily great in this affair. I think that if you permit a suggestion, I think you should ask the question next week, during the Tokyo summit, of [French Premier Jacques] Chirac. He will answer you better than I.

A different kind of KEW

Dr. Winterberg: I would like to make a few comments regarding the question of kinetic energy and related problems. First of all, I do not necessarily think that these conclusions are 100% accurate. I should point out, however, that despite my criticism of the stand against kinetic energy weapons, I share the view expressed against the relatively slow kind of kinetic energy weapons.

As you may remember, in my talk I pointed out that there is, for example, the possibility of accelerating a beam of microparticles. These are particles which may have the size of a micron. We might accelerate them, electrostatically, to a velocity of, let's say, 1,000 kilometers per second. Such beams of microparticles are something like, some hybrid, between pure particle beams and kinetic energy weapons. They would destroy due to kinetic energy upon impact with the target. Of course, you could also say a photon beam is a kinetic energy weapon in the sense that photons, of course, upon impact with the target, convert their kinetic energy into heat.

But I would like to point out that the other alternative, to put nuclear weapons in space for x-ray lasers, probably will be very difficult to realize from the political point of view, in as much as one can, of course, also put offensive nuclear weapons into space. How should we defend ourselves against those?

But the development of, for example, microparticle beam technology is still very much in its infancy. This may be something for the Japanese scientists to get involved in. It is much more exciting to go into a field that is not yet highly developed.

Such microparticle beams are of extreme interest in connection with controlled fusion. Like laser beams, they propagate practically in straight lines. They are not subject to magnetic fields like charged particle beams. So from that more general point of view, I would not necessarily rule out kinetic energy weapons. As I pointed out, if you have, for example, a velocity of 1,000 kilometers per second, and the missiles move at, let me say, less than 10 kilometers per second, you still have enough effectiveness—in that case, two orders of magnitude larger velocity, which is fully sufficient to achieve the goal which is required for a successful SDI.

The Soviet attaché's statement

Mr. Synonov: I want not to ask a question, but to give some remarks.

I thank Mr. Parpart for informing the audience about my disagreement with his very bright, but incorrect detail, that the innovator of the laser, Mr. Basov, is a general. But it is not the only one and not maybe the most important distortion and error of fact connected with him.

Now, the problem of the SDI and the policy of the U.S.S.R. I am sorry, I did not introduce myself: I am Synonov, attaché for science and technology of the U.S.S.R. embassy.

It is not only one fact where the audience heard distortion, and are missing some very important things about SDI weapons and U.S.S.R. policy. I hope the audience will excuse me that I speak with an accent, but you can understand that English is not my native tongue.

There was much talk this year about the Soviet nuclear strategic threat. It was used in the latest decision of our government for developing our economy. Any of you can read the documents and understand this distortion. When it is convenient for American propaganda, it talks about the very poor performance of our economy, science, and technology. But when it is necessary to get support of American people or world opinion for the next military program American officials spoke about, [they talk of] our superiority in that or other technology. I see from some questions of some Japanese participants of this meeting, that they understood this twist.

I want to quote one article from yesterday's *Japan Times:* It was about American Congressman Ed Markey's statement. He said that exaggerated claims about the Soviet threat do not encourage Russian constraint. Right about budget time, we always hear that the Russians could be pulling ahead of us in some new military technology. At the end of the third panel, nobody here said a word about a very important point, such as the existing ABM Treaty? How does the SDI program suit the ABM Treaty? Or when it was convenient for the United States, the U.S.A. signed the treaty about antimissile defense systems and when it is not, forget it.

Mr. Parpart also said that it is a weak point of our economic system, we don't use military technology in our economy. It was in a way, admitting that our system and our economy are not interested in developing weapons or arms race. From the other side, Mr. Parpart said a very interesting thing, even close to the Marxist point of view, that the American economy could not develop well without huge military programs and spendings. Is it good from the moral point of view? I spoke about moral because here I have heard much about moral and immoral things. The United States may develop its economy only in connection with an arms race and military weaponry?

Somebody—I remember, Mr. Zondervan—and now in the letter of Mr. LaRouche, for purposes of demonstrating that it was the Soviet Union who started developing of antimissile laser weapon, used a quotation from a book by Mr. Sokolovskii published in 1962. Mr. Zondervan might even use the other book by our famous writer, Alexei Tolstoi, published as far back as 1927, called *Our Leader,* about can beam space weapon be engineered. But it is necessary to say that the book by our Marshal Sokolovskii was published in 1962, so much before the signing of this ABM treaty.

And the SDI program started in the year you say, not on the empty place admitted also here. Our figures give a different picture of who started research in the military use of space. It was necessary to say also that it was our proposal in 1981 to sign the treaty not to deploy weapons in space, and it was the United States who refused to negotiate this treaty. And the same: They also refused to sign the treaty not to use nuclear weapons first, and the latest, our proposal to destroy nuclear weapons up to the end of this century.

From our point of view, the purpose of the SDI is to break the existing military balance in the world. According to Mr. Reagan, he once said, that he is to increase in vast scale military expenditure in the world and to destroy our economy in this way. At the same time, he didn't say it, but it is to give the military industrial complex, about which power warned Mr. Eisenhower, huge opportunity in profits. Using the image of General D'Allonnes about cake, I want to say that this cake is not for children; this is cake for the military-industrial complex, and it is now developing into not only a military-industrial, but a military-industrial-scientific complex. And the real threat is not the Soviet arms race, but also there is a big threat that science becomes more and more militaristic. And the United States wants to organize scientists for some program for sophisticated technology. Okay, why not develop this same difficult but peaceful problem, fusion energy. That's all, thank you.

The reply

Mr. Parpart: I would like to briefly respond to two of your principal points, if you permit me. When President Reagan announced the SDI on March 23, 1983, he said, and this was reiterated by Secretary Weinberger, that the United States invites the Soviet Union to immediately exchange scientific information, to have Soviet and U.S. scientists jointly look into the feasibility of the system, and if necessary, to jointly deploy such a system for our mutual benefit. This proposal was reiterated at the Erice conference in Sicily, Italy in 1984 by Dr. Edward Teller. George Keyworth, the former science advisor to President Reagan, has made the same point on many, many different occasions. We have at no point in the United States received a direct or specific answer. All we have received is denunciation from the Soviet leadership and disinformation from Soviet scientists. I would like to again reiterate, and I believe that the entire U.S. scientific community is committed to this, that this offer for ultimate collaboration and sharing of these technologies, as far as I know, stands today and awaits your answer.

As for fusion collaboration, at the Geneva summit this was proposed by the United States, specifically in a letter by Secretary of State Shultz. And, as you know, we have had collaboration in the fusion program between the United States and the Soviet Union since the 1960s, when the Soviet invention of the tokamak program actually convinced the United States that fusion was a feasible force for energy production. But you must permit me to say that I find your discussion about the nature of the U.S. versus Soviet military spending somewhat disingenuous. The Soviet Union spends, both in percentage terms of GNP as well as in absolute terms, by any estimate that we have, considerably more on military systems than the United States. And these points can be debated, but I think some of the well-known published figures on actually existing weapon systems today cannot be dismissed.

Finally, a word about the ABM Treaty. The ABM Treaty contains, as you very well know, a very specific clause saying that it does not cover systems based on new scientific principles that might be developed in the future. The protocols to the ABM Treaty, which were attached when the treaty was deposited at the United Nations, make it clear that this clause concerning new scientific principles was insisted upon by the Soviet side when the treaty was signed, and not by the U.S.A., which doesn't surprise me very much, because the principal negotiator on the U.S. side was a man who knows nothing about science, namely, Mr. Kissinger.

What I would say, as clearly as I can, is that we have discussed the nature of what we regard as the Soviet threat, and we believe that the best possibility for disarmament lies in our jointly developing these systems and deploying them at a certain future point. It is under those conditions that the first step we should take, even before that, is the reduction and elimination of intermediate-range ballistic missiles which are the most unstable part, if you will, of the overall missile deployments on both sides. And this is the negotiating position of the United States.

So, those are a few, and I hope clear, points which at some point or other I believe your government must answer.

Question: I would like to ask the Japanese side a question about the possible Japanese participation in SDI. Specifically, we heard two different opinions from the American side about how important the Japanese role is. One said that the success of SDI depends on the participation, and the other said that it would perhaps imply that it would only delay the start of SDI a few years. I would like to ask the Japanese side, how important is the Japanese participation? If the Japanese do not participate, what exactly will the Americans lose, or the Star Wars lose. And along with that, one quick question: Is the Japanese side reluctant at all because they may be worried about losing their technology, if their technology is given to the United States that it may not come back, because it has some kind of a secret technology?

Will the Japanese participate?

Mr. Sasagawa: There are two aspects, political and economic. I don't know myself what kind of decision will be made at the cabinet meeting which is being held today, but in order to give the political evidence, I think that Japan should participate. But because of the political situation, probably after the Tokyo summit or after the election of the Upper House, we may make a decision whether or not we should participate. But this is just a domestic internal reason, and we have to keep up to our commitment as an international ally. As Professor Sakata said, SDI is still at the stage of an initiative. We don't know for sure what kind of specific program the U.S.A. has at this point in time.

But so far as the economic aspect is concerned, last year, the Department of Defense asked Japan to introduce microwave technology, that is, an investigation was asked for by DOD last year. And I talked with people with MITRE and there is much hope placed on this, in communication or electronics, the technology available in Japan is the source of a lot of expectations. Did I answer your question?

Mr. Goda: The kind of question raised induces the kind of answer which I am going to give. I am Goda from the Defense Research Institute. I think, roughly speaking, we can answer you positively. Being a defense ally, we should participate. But of course, it depends on the content, it depends on the timing, and being an ally, naturally we should participate in SDI.

Mr. Sakata: The discussion is already exhausted in this area. Japan can contribute in technology, rather than economy, especially manufacturing technology. But I don't agree with this. The panel discussion revealed that there are a lot of aspects of SDI which are not made clear yet. There is an historical significance for Japan to make proposals and ideas as a representative of Oriental countries. So far, there are Occidental arguments and opposers are Occidental themselves. But if Japan participates, for the coming several generations and coming several centuries, the destiny of mankind will be determined. So, the tradition of Japan will be very significant as a contribution of Oriental wisdom.

Mr. Parpart: As organizers of this conference, on behalf of the Fusion Energy Foundation and the Schiller Institute I would like to thank you all very much for attending this seminar. I would like to thank you very much for your patience with a long, and hopefully not-too-exhausting session. I hope that we've been able to provide some useful information and I hope that we have been able to at least make some contribution to furthering the public discussion in Japan, which I believe is extremely necessary. In the United States, we are in an ongoing discussion process, the different sides oppose each other with great force and vehemence and the argument will not be over soon. But we very strongly believe that by involving as many people as possible in the argument, we can, at least in some cases, benefit from greater wisdom. And I think perhaps in Japan as well, if the debate were broadened, widened, it would make it easier for your own political leaders to make a decision which they have the confidence the Japanese people can support. So I hope we could make a contribution in this direction of public discussion and information. Thank you very much for your attendance.