Weinberger killed nuclear rocketry

Nuclear-powered rockets could soon transport manned missions to the planets. Robert Zubrin shows how the capability was dismantled.

In late 1957, when the nation, in the aftermath of Sputnik, decided to embark upon a large-scale space program, leading scientists realized that development of a practical space capability would ultimately have to depend on nuclear power. Nuclear fuels contain one million times as much energy, pound for pound, as any theoretically possible chemical fuel, and so it was seen, that while chemical rockets would suffice for early space probes, if space travel, including manned interplanetary and ultimately interstellar travel, was to become cheap and practical, the power of the atom would have to be mobilized.

To meet this need, the new National Aeronautics and Space Administration (NASA) initiated in 1958 two major projects for the development of nuclear-propelled spacecraft. One, called Project Orion, involved the use of small atom bomb explosions to propel a spacecraft. The other, entitled Project Rover, developed the NERVA fission rocket engine which involved the pumping of hydrogen through an atomic pile, where it would be heated and shot out the rocket's rear exhaust nozzle, propelling the spacecraft in somewhat conventional style.

At first glance, the idea of propelling a spacecraft with small atom bomb explosions seems almost incredible. One might think that the craft would be instantly vaporized by the first detonation, thus ending the mission. However, it was discovered at Eniwetok that many steel structures positioned within a few feet of the atomic detonation had experienced only the most superficial damage. The heat of the bomb blast had been more than enough to vaporize them, but because it passed by them so quickly, they were only mildly scalded.

Orion is born

On the basis of this and similar observations, weapons design and effects expert Theodore Taylor picked up on a 1955 idea by Ulam and Everrett of Los Alamos Labs to propel a spacecraft using a succession of small atomic explosions. A crew of about 40 atomic scientists was assembled, including Dr. Friedwardt Winterberg, at the General Atomic Division of General Dynamics, secured a government contract, and Project Orion was born.

The design chosen was of the uncontained nuclear propulsion type. A tiny atom bomb of perhaps 0.01 to 0.1 kilotons would be dropped from the storage area down the central pipe to emerge 100 feet below the pusher plate, where it would be detonated. The bomb shock wave, perhaps reinforced by some additional material thrown in with the bomb such as water or hydrogen, would then impact and rebound off the pusher plate, propelling the rocket forward with an impact that could be suitably cushioned by an array of shock absorbers positioned between the pusher plate and the rest of the structure. Then perhaps one second later, another bomb would be dropped and detonated, furthering the acceleration.

While the explosion beneath Orion would be uncontained, the charge could be shaped so as to project most of the bombs' energies in the appropriate directions. This approach was found preferable to the contained nuclear pulse method, in which the bomb goes off within a thrust chamber, vaporizing some water on the thrust chamber walls and propelling it out as exhaust, since this latter design has very formidable structural demands in terms of the required strength of the thrust chamber. In the Orion design, on the other hand, it was discovered that, with proper shaping and structure, the pusher plate could even be made out of ironwood (which has the advantage of not conducting heat, and ablation of its surface could be substantially avoided by spraying grease on the plate's lower surface between blasts.

An Orion blast-off would of course create radioactive fallout, but it was calculated that the total contamination stemming from a mission would be 1 percent or less than that caused by the bomb dropped on Hiroshima. Since it could be launched from a remote desert site, the danger would be 100 times less than from a small test explosion. A modern Orion design could today make use of the much cleaner varieties of bombs developed since the 1960s, virtually eliminating fallout.

The Orion planners were quite ambitious. While Wernher von Braun projected a massive chemical rocket program to land a man on the moon by 1970, the Orion planners projected a much less costly program which would involve sending manned missions to Mars by 1968 and to the moons of Saturn by 1970. While the Apollo chemical rocket could deliver less than 1 percent of its initial weight as payload to the moon and back, Orion would have been able to deliver 45 percent of its initial weight as payload for a return lunar mission, and 25 percent on a roundtrip to Mars.

Orion's space explorers would not travel in a tiny capsule like Apollo, but in a craft the size of a 16-story skyscraper. As Taylor later explained: "We had an aversion to weight minimizing. We did not need to recycle urine, for example. We would have just thrown it over the side. We could have taken barber chairs, if we wanted them. Anything could be carried that might be necessary for a big-scale manned expedition anywhere in the solar system."

Enter Freeman Dyson

The most prominent scientist to sign on with the Orion Project was Freeman Dyson, a famous British mathematical physicist, a board member of the antinuclear space colonization group known as "L-5."

Dyson, who was close friends with the British intelligence "communists" Frank and E. P. Thompson, the latter of whom is currently attempting to lead a Europeanwide antinuclear "peace" movement, came over to the U.S.A. after the war, and was brought into the Princeton Institute for Advanced Studies as a protégé of the antinuclear Robert Oppenheimer. With these connections, Dyson's surprising emigration from his high post at Princeton to join Orion has something of the marks of an infiltration deployment.

But, on advice from Oppenheimer and antinuclear fanatic George Kennan, Dyson wrote an article for the Council on Foreign Relations' journal *Foreign Affairs* in 1960, in which he strongly argued against any nuclear test ban treaty, claiming that it would endanger U.S. national security. This had the intended effect of giving Dyson a reputation as a military hard-liner, which became key to his credibility when he was shortly thereafter assigned as one of the top scientific advisers to the newly formed Arms Control and Disarmament Agency (ACDA).

Dyson was uniquely situated to influence events when the crucial moment in the test ban treaty talks came in the summer of 1963. Averell Harriman was in Moscow negotiating the treaty and had come close to signing, except that an impasse had been created by the Soviet insistence that *all* tests be banned, which was contrary to the American position since this would eliminate Orion as well as Project Plowshare, a Livermore program for digging canals and other water projects using small-scale nuclear explosives.

Harriman cabled back to Kennedy, "I think we shall have a treaty if I give way on this one." Kennedy then picked up the phone and called ACDA, where the question on giving way was relayed to Dyson for advice. "Of course we should give way," he replied. This answer was relayed to Kennedy, who cabled it to Harriman and the treaty was signed.

The signing of the test ban treaty in this form effectively killed Orion, though the program was allowed to limp on a few more years under Air Force supervision. Dyson made double sure it also killed Plowshare, a program for peaceful use of nuclear explosions. (If continued, Plowshare would have greatly facilitated the then-contemplated Nawapa water development project for channeling massive amounts of unutilized northern Canadian river waters to irrigate the entire Mountain States region of the U.S.A., Canada, and Mexico, and many similar programs around the world.)

"I went with Wadman to extract from the director [of Plowshare] a written statement saying whether or not his program could continue within the terms of the

Why only nuclear rockets can master space

Rocket performance is ordinarily measured in terms of specific impulse, the length of time one pound of fuel can be made to deliver one pound of thrust. The higher the specific impulse, the greater the capabilities of the rocket. The following are key sample specific impulse values.

Best solid-fuel chemical rockets	Minuteman ICBM	280 seconds
Best liquid-fuel chemical rockets	Saturn booster	450 seconds
NERVA nuclear fission rocket engine	1970 model	850 seconds
Gas-core fission rocket		2,500 seconds
Orion small fission-bomb rocket	1960 design	4,000 seconds
Inertial fusion-propelled rocket	Winterberg design, 1980	100,000 seconds
Maximum possible performance Orion type H-bomb-propelled rocket		250,000 seconds

treaty as signed," Dyson relates. "The director was faced with a dismal choice. If he said yes, he was helping to ratify the treaty. If he said no, and the treaty was ratified in spite of him, his program would probably be closed down. Bureaucratic politics is a dirty game, even when the good guys are winning. We had him neatly skewered, and he knew it. He said yes, and we took his statement back in triumph to ACDA."

The treaty was ratified, and Plowshare, like Orion, did not survive.

NERVA moves along

But even while Orion was being sent to its grave, the other NASA nuclear program, the development of the NERVA fission rocket engine, not requiring atomic explosions, was making impressive progress. By 1965 it was clear, even to those who had pushed most heavily for a chemical rocket-centered program, that progress in space beyond Apollo would have to depend on nuclear power.

As Wernher von Braun told a 1966 symposium of the New York Academy of Sciences: "The technology now available will enable us to accomplish the manned lunar landing in Project Apollo. . . . For really serious manned exploration of the planets, however, to include manned landings, nuclear or electric propulsion will be required. And I would personally prefer a nuclear stage for a manned fly-by mission to Venus and Mars. And a manned Mars mission, which could be achieved by the mid-eighties, would very definitely require nuclear propulsion.

"The highly successful test firing program of the NERVA I engine lends confidence to the belief that a nuclear rocket stage can be designed."

The basic principle of the NERVA rocket engine, is quite simple. Supercooled hydrogen gas is pumped into the vicinity of a small solid-core nuclear reactor, which heats it to temperatures ranging from 4,000 to 5,000 degrees centigrade. The heated gas expands radically and is fired out the rear exhaust nozzle, with a specific impulse in the range of 800 seconds, about double that of the best possible chemical fuels. Since each pound of fuel creates twice the thrust of chemical fuels, for an equivalent mission, half the fuel weight could be eliminated and replaced with payload.

It was calculated that a NERVA-powered Mars roundtrip mission launched from Earth orbit would require an in-orbit starting weight of from one-half to one-quarter that of a chemically propelled mission, would make the trip in half the time, and would be fully reusable, after orbital refueling, for additional trips to anywhere in the solar system. And since the hydrogen gas used in such a system is only a working fluid (i.e., not a combustant) for an essentially permanently fueled nuclear reactor, it might ultimately be possible to create NERVA-like designs which could be "refueled" with gaseous substances readily available on Mars, the moons of the outer planets, or elsewhere in space.

Averell Harriman: geopolitician

Caspar Weinberger: cost accountant

Furthermore, the NERVA system was subject to considerable improvements. Beyond the solid-core NERVA rocket, whose temperature is limited by the melting point of uranium, lay the possibility of liquid-core or gaseous-core fission reactor rockets. The gas-core reactor, whose development was already absorbing 10 percent of the NERVA budget by 1970, would operate at temperatures of up to 25,000 degrees centigrade, its superheated uranium fuel contained as a plasma by magnetic fields. Such an engine could deliver specific impulses of up to 2,500 seconds and would be able to propel a 60-day roundtrip to Mars, as compared to 450 days for NERVA, or three years (approximately) for chemical rockets. Moreover, the development of gas-core fission reactors for use in space would also have made this tremendous energy source available on earth, with certain spinoff developments in the direction of the mastery of magnetic confinement techniques for controlled fusion and magnetohydrodynamic (MHD) coal processing.

The idea of NERVA had actually been conceived as early as 1955, and begun as a joint project by the Air Force and the Atomic Energy Commission, becoming a joint NASA-AEC project in 1958. Work on the engine was done by Aerojet-General, and the reactors were built by Westinghouse.

Between 1964 and 1970, twelve different models of the NERVA engine were built and tested. The last, the NERVA-XE, exceeded all expectations. The design specification called for producing a specific impulse to let 760 seconds; 850 was achieved, with 900 a possibility. To accomplish any one mission, one hour of total operation would be required; 14 hours were achieved, including 4 hours at full design power of 4,200 megawatts thermal. Work went ahead to build a NERVA engine with a thrust of 75,000 pounds ready to fly in space by 1978. The Mars mission was slated for 1982.

Enter Cap 'the Knife' Weinberger

America today would almost certainly be entering an age of nuclear-powered interplanetary space exploration and colonization if not for the hatchet job done on NERVA by Caspar Weinberger and George Shultz from 1971 to 1973. Despite the fact that $1.3 billion had already been spent on NERVA and only $750 million remained to be spent over a decade to complete the project, these two gentlemen, as the directors of the Office of Management and the Budget (OMB) initiated a series of budget cuts against the project that within three years wiped it out completely.

NERVA had been funded in 1970 with a budget of $88 million. To proceed as planned, the project needed a 1971 appropriation of $100 million. The OMB, with Shultz as director and Weinberger as deputy, proposed $30 million.

Senators and congressmen on the appropriate committees were outraged. The $80 million cut from NERVA would entail the laying off of two-thirds to three-quarters of the scientists involved in the program at Aerojet-General, Westinghouse, and Los Alamos, and entirely shut down the project test facility at Jackass Flats, Nevada. It would be impossible to ever assemble these teams again, a fact well known to NASA Administrator George Low, who nevertheless told the Senate Space Committee fatalistically that he thought the program would survive the cuts. "If I thought these economy measures meant the end of NERVA, I would of course never support them," Low said.

The Senators were amazed. Said Clinton Anderson, chairman of the Space Committee: "I know of no advanced technology program which has been more successful than the nuclear rocket propulsion program, and I do not understand the recommendation of the fiscal 1971 budget submission to reduce the level of the effort to a mere holding action. In fact, I would have difficulty understanding any reduction in this important program."

The Senate restored $30 million allowing NERVA to barely survive with a $60 million budget, but it was clear that unless there was a change in the wind soon, the program would not have long to live.

The OMB's budget-cutting policy was defended publicly to the aerospace community by Assistant Secretary of the Treasury for Economic Policy Murray Weidenbaum, a free-enterprise ideologue who later joined the antiprogress Heritage Foundation, and is now President Reagan's chairman of the Council of Economic Advisers.

Weidenbaum told *Astronautics and Aeronautics* magazine in March 1971, "I am amazed when scientists say that we must embark upon a major technological project on faith. . . . In technology, the prime consideration is the cost/benefit analysis of what technology is essential and important to the country at this particular time."

The next year, with Weinberger as OMB director, NERVA was cut down to a hopeless $19 million. The reason Weinberger gave: this would make NERVA "more manageable."

The following year Weinberger cut NERVA funds to zero. Outraged, Sen. Howard Cannon (D-Nev.) asked if this cut would make NERVA "still more manageable." "The ground rules have changed since then," NASA administrator Fletcher replied for the OMB. NERVA was finished.

Getting NASA back on track

Today, America finds itself confronted by the same sets of enemies who shut down Orion and NERVA. The liberal wing of the Democratic Party is striving to shut down nuclear power development altogether. Weinberger, now at the Defense Department, is putting a hold on the absolutely necessary development of a space-based laser or particle beam antiballistic missile system, while he tolerates the destruction of basic scientific capability. Meanwhile his junior replica at OMB, David Stockman, guts the budgets for NASA, for fusion research, for MHD, and for other high-technology areas. Stockman says there will be plenty of time to fund NASA and fusion adequately in later years; meanwhile, the program teams are being dismantled. He sounds eerily similar to Weinberger in 1972.

In 1966 the NASA budget amounted to 4.5 percent of the national budget. Had that percentage been maintained, NASA would have a $30 billion budget today, instead of its current $6 billion. In the middle to late 1960s people at NASA were analyzing designs for gas-core fission, and fusion-powered rockets. If NASA had been allowed to maintain its funding, and even 10 percent of its total budget deployed into these areas, we would today possess the ability to release unlimited energy through fusion and gas-core fission, for use both in space and on earth. Instead
weight of $35 a barrel oil prices, energy would be virtually free. And millions now starving in the Third World because of high energy prices would be eating.