. . . THE HEAVENS AND THE EARTH

A Political History of the Space Age

Walter A. McDougall

1985

Basic Books, Inc., Publishers *New York*

[illegible] the person of Stalin and the regime with the purposeful [illegible] skies. The seeds of spaceflight disappeared into the soil [illegible] technocracy, but by 1941 the soil was sufficiently fertilized—[illegible]man cost, to be sure—for germination to occur. Perhaps [illegible]le then inhibited the growth of rocketry by its contribution to [illegible]break and disastrous defeats of the war. But the course of that [illegible]war, by ridding Russia of the invader and saving the technocratic [illegible]tate, by winning a share of the German technical inheritance for [illegible]oviet engineers, and by blowing in a new international storm in [illegible] long-range rocketry took on surpassing importance, also put the [illegible] drive for spaceflight back on schedule.

CHAPTER 2

Political Rains and First Fruit: The Cold War and Sputnik

A week after the Allied invasion of Normandy, a gothic devilment buzzed its way across the English Channel. It was an unmanned, winged cylinder twenty-seven feet long, powered by a jet engine on top of the fuselage that developed 110 pounds of thrust. This *Vergeltungswaffe-1*—so dubbed by Adolf Hitler—was the ancestor of the cruise missiles of the 1980s. It carried only a ton of explosives and flew low and slowly enough for interception. Its successor, the V-2 (or A-4, as its designers called it) was even less cost-effective since its unit cost was ten times that of V-1. But the V-2 was invulnerable, the first medium-range ballistic missile. By investing the dwindling resources of the Nazi Empire in these technical adventures, which, without atomic warheads, could only stoke the determination of the enemy, Hitler did achieve a vengeance of sorts. He hastened the day when staggering costs and numbing fear accompanied the efforts of his conquerors to refine the V-2's offspring into engines of terrible destruction.

A detailed history of the German rocket program lies beyond our scope. The subject has been well covered elsewhere, and more important for our purposes is the fact that the German program ended abruptly in 1945.[1] The political environment of the birth of the Space Age was the Cold War to come, not the war just ended. To be sure, the German legacy permitted the Soviets to traverse quickly that terrain of practical experience the war had denied them, and it pushed the United States into the rocket field before it might otherwise have entered. But the V-2 represented few theoretical breakthroughs unfamiliar to Soviet rocketeers. Only a pure determinist could designate the V-2 a sine qua non of the origins of the Space Age in our time. What the German engineers did, with their clever fabrication of what seemed even in World War II a "baroque arsenal," was to prod their enemies to the East and West into premature fear and rivalry, and to make themselves and their blueprints the most prized spoil of war.

Of all Stalin's imprints on Soviet and world history, his technological bequest is perhaps the least appreciated. For if the Soviets' determined

drive for nuclear and rocket weapons after the war derived from Cold War competition, it expressed as well the continuous commitment to Soviet technological primacy promised ever since 1917. When, after Stalin's death, Russian rocketry and Soviet technocracy yielded their first fruits in the birth of the Space Age, the world voiced astonishment. However glaring the faults of communism, the might of technocracy stood revealed.

The German Sixth Army, encircled at Stalingrad, surrendered in February 1943, and the Wehrmacht went on the strategic defensive. Casting about for technological fixes to the dilemma of a Blitzkrieg turned war of attrition, Hitler restored top priority to an extraordinary new weapon called the A-4.

The A-4 entered production as the V-2. A British air raid on August 17, 1943, suggested the wisdom of transferring manufacture to the Mittelwerk factory, carved from a slope of the Harz Mountains near Nordhausen in Thuringia. By 1945 nearly 900 V-2s per month emerged from the eerie underground assembly line, manned by slave labor. The production network of the V-2 was also a prototype of the national integration of brain power and materiel characteristic of the technocratic state.[2]

The Rocket Team harbored a hidden agenda, of course: spaceflight—the Gestapo even arrested von Braun in February 1944 on the charge that he was not really interested in the military needs of the Fatherland and planned to flee to England.[3] Indeed, von Braun's team indulged their dreams of larger versions of the V-2 with the potential for orbital flight. Designations A-5 through A-8 were upgraded V-2s, but the A-9 and A-10 were of another order of magnitude. They were to comprise a multistage rocket, the first stage developing 400,000 pounds of thrust, and designed for a range of 3,200 miles. It was the first ICBM on paper, but it was also a spaceship. The A-11 was visualized as a third stage capable of boosting a pilot into earth orbit. Finally, there was the speculative A-12, boasting a first stage with 2.5 million pounds of thrust and capable of orbiting a 60,000-pound payload.[4]

Soviet intelligence seems to have followed German rocket research closely during the war. Defector Tokady testified that the Bureau of New Technology in the Ministry of Aircraft Production collated all data from open and clandestine sources, and when Tokady arrived in occupied Germany in 1945 as aeronautical consultant to the Red Army, he was given complete dossiers on German personnel and facilities.[5] Soviet agents in England must also have reported all they could discover on the V-2, which London's Operation Backfire sought to reverse-engineer from flight data, wreckage, and espionage.[6] Prior Soviet knowledge of German rocketry even suggests that the Kremlin's desire to reach Peenemünde before the Western Allies influenced Red Army operations.

THE A-4

In 1929 the Ordnance Ballistic Section of the German army assigned Walter Dornberger to develop a liquid fuel rocket of longer range than any existing gun, a sobering assignment, given that the Big Berthas of World War I fired projectiles sixty-five miles. Dornberger visited the "rocketport" of the amateur Verein für Raumschiffahrt in Berlin, set young Wernher von Braun to work completing his doctorate, and together they recruited the Rocket Team. Just as in the Soviet Union, the rocketeers did not find state support—the state found them, and at a propitious moment. "The more time I have to think about it," wrote Willy Ley, "the more I have arrived at the conclusion that the VfR progressed as far as any club can progress. . . . Experimentation had reached a state where continuation would have been too expensive for any organization except a millionaires' club."[7]

Von Braun and Dornberger chose for their lonely, spacious test site a sweep of sandy coast on the Usedom Peninsula beyond the mouth of the Peene River. But by the time Peenemünde opened in the fall of 1939, the Wehrmacht was rolling over Poland, and Hitler decided the big rockets would not be needed. Von Braun and Dornberger pressed on, with reduced budgets, toward a prototype of their majestic A-4, the first medium-range ballistic missile, standing 46.1 feet high. It was a single-stage rocket powered by LOX and alcohol, developing a thrust of 56,000 pounds, a payload of 2,200 pounds, and a velocity of 3,500 miles per hour while inertially guided by gyroscopes and leveling pendulums to its target 200 miles distant. The first A-4 flight test finally took place in June 1942. It failed, and so did the next. But the third bird, in October, rose from the Baltic dunes in a stable and gentle arc fifty miles high until it passed out of sight en route to the impact area 119 miles downrange. Dornberger's team watched in exultation—like the Alamogordo physicists three years later, they attended in the delivery room as a new Power was born. But where the elemental blast of the atomic bomb rendered its makers diminished, apprehensive, in a sense imprisoned, the elegant, finned cylinder of the A-4 was a metaphor of liberation, defying gravity as it soared aloft with little hint—after the first moments—of the brute force it contained. An aspiring and creative thing, it had brushed the sleeves of space.

At the Yalta conference in February 1945 Marshal Zhukov was stunned to have his plans for advance on Berlin vetoed by Stalin himself: "You are wasting your time. We must consolidate on the Oder and then turn all possible forces north, to Pomerania, to join with Rokossovsky and smash the enemy's 'Vistula' group."[8] Stalin's motives are unknown, but his order redirected the Soviet advance on a line for Peenemünde. The Soviets also secured, with no apparent opposition, both Peenemünde and Nordhausen in the occupation zones drawn up by the European Advisory Commission.

On May 5, 1945, Major Anatole Vavilov stormed the Baltic test site

with infantry from Rokossovsky's Second White Russian Army. He met no resistance and took no prisoners—the place was deserted and mostly in ruins. As for V-2 production facilities, when the Soviets finally took possession of the Mittelwerk in July they found it stripped of everything but odd scraps and charred units in railway cars outside. Stalin's reaction was predictable: "This is absolutely intolerable. We defeated Nazi armies; we occupied Berlin and Peenemünde, but the Americans got the rocket engineers. What could be more revolting and more inexcusable? How and why was this allowed to happen?"[9]

The answer was that the German Rocket Team and prescient American officers willed it to happen before the Red Army was in a position to prevent it. As early as mid-January 1945 von Braun took responsibility for the safety of his people, who voted unanimously to flee Peenemünde and go in search of the U.S. Army. As one member of the Rocket Team put it: "We despise the French; we are mortally afraid of the Soviets; we do not believe the British can afford us; so that leaves the Americans."[10] And so, in a harrowing exodus through the stricken Reich, von Braun started south in February with 525 people and thirteen years' worth of documentation hunched in boxcars. Reaching Bleicherode in Brunswick, von Braun buried his paper treasure in an abandoned mine shaft some miles to the north. The team then commandeered a train with forged SS orders and made their way through chaos and air raids to Bavaria. On May 2 a small party went to look for Americans, found an unsuspecting private guarding the road, and approached with hands in the air. The bewildered soldier leveled his rifle as one man stepped forward and said in accented English: "My name is Magnus von Braun. My brother invented the V-2. We want to surrender."[11]

Imagine, too, the dumb wonder of the American lieutenant who veered off from the drive into Nordhausen on April 11 and bumped into the Mittelwerk. There, on railway cars leading into the bowels of the earth, were gigantic rockets lined up like imports from Mars. And inside, a gutted mountain, bizarre machinery, slaves like living skeletons: a scene from Flash Gordon. Nearby they found the workers' camp and thousands of corpses stacked here and there as garbage awaiting pickup. If too weak to work, slaves were left to expire—150 per day—human sacrifices on the altar of machines and power, another logical conclusion, like Stalin's *sharagas*, of totalitarian technocracy.[12]

When word reached the American command of the capture of the Mittelwerk, the Ordnance Department decreed Special Mission V-2: get your hands on a hundred operational V-2s ready for transport to a new White Sands Proving Ground in New Mexico. The task was herculean enough, since few fully assembled and undamaged V-2s remained. What was worse, the Red Army was scheduled to occupy the region in a matter of weeks. Troops hastily gathered up one hundred of every part that looked likely, threw them into impounded freight cars, and hauled

everything away into the American zone. In time, after much travail, the ingredients for the hundred V-2s landed on railroad sidings in the New Mexican desert against the day when the von Braun team would arrive to sort them out.

There remained the priceless Peenemünde files, buried in a mine 300 miles to the north. Desperately locating trucks while local miners sweated to reach the cache, the men of Special Mission V-2 disinterred the documents and beat it back to the American zone.[13] Thus, when the Soviets arrived, they found the Nazi dynasty's richest graves already robbed. In July the Americans coordinated their roundup of scientific personnel and offered contracts for work in the United States. After assurances were given that their families would follow, 115 German scientists departed in September for the New World. In this way the Cold War for "intellectual reparations" in the form of Nazi scientists and their secret weapons began before the political Cold War was apparent. At Potsdam in July the Big Three powers agreed to share German scientific facilities, but it was a sham. The Soviets were already carting off entire laboratories, while the German rocketeers, a wind tunnel, and other spoils were en route to the United States. What Winston Churchill called the Wizard War in technical one-upmanship and espionage did not stop on V-E day.[14]

Soviet pursuit of scientific booty seems to have been more premeditated, but less successful.[15] The discovery of a bare Peenemünde kicked off an immediate effort to locate the missing brains. Already in May, Peenemünde veteran Helmut Gröttrup was approached by a member of the Soviet Special Technical Commission in charge of reconstituting the V-2 production line. In August a German engineer told the Americans that "the Russians intend to develop a big rocket with a normal range of 3000 miles and they are needing specialists with knowledge of the theory of flight mechanics and control equipment. . . . The Russians set big prices for getting over to Russian area Professor von Braun and Dr. Steinhoff." They also broadcast over Radio Leipzig to anyone connected with Peenemünde, guaranteeing good wages and personal safety.[16]

All they got were the rank and file of the V-2 program, engineers and minor technicians scattered over the eastern zone. "When I arrived at Peenemünde," wrote Tokady,

> there was hardly a German sufficiently competent to talk about the V-2 and other big stuff. There were many, almost all, claiming to be V-2 experts . . . [but they] talked and talked, and displayed the typical characteristics of a second-rater. . . . not only in Peenemünde, but also in all Soviet-occupied Germany, we found not a single leading V-2 expert.[17]

Only one major designer went over to the Soviet side, Gröttrup. His motives are unclear but appear to have been personal rather than

political. Having worked in the shadows of the great, perhaps he preferred to lead the Soviet-affiliated missile program rather than remain anonymous in the West. By mid-1946 Gröttrup commanded over 5,000 workers, and new V-2s rolled off the line again in September. They were then static-fired at a German test facility under the direction of ... Glushko. At the same time Korolev, now free after seven years in prison, was deep into designs for larger V-2s and proudly concluding that the Soviet rocketeers really had little to learn from the Germans. "What were our impressions of Peenemünde?" recalled Tokady.

> This is an extremely interesting question, and I would like to answer it frankly. We were quite clear on three things: (1) in the field of original ideas and rocket theories, the USSR was not behind Germany; (2) in the field of practical technology of rockets of the V-2 caliber, we were definitely behind the Germans; (3) having seen and studied Peenemünde, we came to the conclusion that there were in the USSR rocket engineers as able and gifted as elsewhere.[18]

Whether the Soviets would have been more impressed had they captured von Braun and his papers is another question.[19] Nevertheless, Gröttrup labored on at Bleicherode until October 1946. Then, late one night, after a drinking party hosted by his Soviet military shepherd, Gröttrup received a hysterical call from his wife. They were all to be rounded up and sent to the Soviet Union at once. Six thousand German technicians, including 200 rocket engineers, and their families, left Germany on twelve hours' notice for a seven-year stint on the steppes.[20]

Paranoid or not, Stalin must have thought his postwar prospects delectable. By spring of 1945 his armies were overrunning Central Europe, the farthest westward thrust of Russian power since Napoleonic days. This century's enemy, Germany, lay beaten and divided. The only check on Soviet policy was the Allied army, but it was already shrinking as U.S. forces shifted to the Pacific. The capitalist powers were also divided among themselves. At Yalta Roosevelt had made no secret of his distaste for British colonialism and was eager to purchase Soviet help against Japan.[21] Indeed, a war that began so badly for the USSR was ending in such a way as to permit the achievement of Stalin's most ambitious war aims.[22]

To be sure, matters could have been even better had the Allied force in Normandy not broken out so swiftly to compete for occupation of Germany. For all his recriminations to Western leaders about their delay in opening the second front, Stalin must have been disappointed at the crossing of the Rhine and "rooted" for the Germans to hold out in the West. (Churchill, for his part, hoped that the Red Army would not reach Berlin and the Danubian Plain.) Still, the revolution had passed its sternest test, broken imperialist encirclement, and reopened the field for Communist expansion for the first time since 1921.

Then, suddenly, by the end of summer, the mood in the Kremlin darkened. The Americans had built and used an atomic bomb.

A mountain of literature exists on the collapse of the wartime alliance and the descent into Cold War. Interpretations range from the stridently anti-Soviet to the stridently anti-American, and the debate, as historian Charles Maier has observed, often seems an extension of the Cold War itself.[23] There are those who see Soviet expansionism after World War II as a case of traditional Russian imperialism and those who attribute it to the global mission of communism. Others hold that imposition of friendly governments on their borders was a defensive reflex by the Soviets and did not indicate implacable hostility or unbounded ambition. Still others explain Soviet behavior with reference to a rapacious Stalin, or to the inner dynamics of the Stalinist state. On the other side are those who blame the United States. To them Stalin was a "traditional" Russian statesman with whom the Americans could have found a *modus vivendi* but for the death of Roosevelt and the irascibility of Truman and his advisers. New Left authors postulate an ideological or commercial imperialism determining American hostility toward the USSR, and argue that the use of the atomic bomb against Japan was a ploy to intimidate the Soviets and force an "American" peace. Finally, there are the historians with a "longer perspective" who consider it almost inevitable that two great states thrust into world leadership, each with its own culture, ideology, interests, and foreign policy traditions, each threatened militarily by the other, should fall into mistrust and rivalry for a time.[24]

In all these views, however, technological change is a dependent variable. The new Superpowers presumably derived political goals, be they obnoxious or benign, from some impulse or another, and then applied military technology to their achievement. This is excusable—in an age of nuclear arms the notion that technological change is an independent variable seems too terrible to entertain. But the opposite hypothesis must at least be considered. For of all the things that made the United States and the USSR distrustful in the moment of victory, perhaps the greatest was the fact that one was not only Communist, but a technocracy, taking for granted its destiny of technological superiority—and the other was not. Regardless of the political climate, the Soviet Union was always in a race, and Stalin had already determined to live in a world with but one nuclear power as briefly as possible.

The USSR supported nuclear research before the war with no less vigor than other countries. V. I. Vernadsky founded the Radium Institute in 1922, Peter Kapitsa and Abram I. Ioffe won international reputations in the 1930s, and the Soviets began Europe's first cyclotron in Leningrad in 1937. When Otto Hahn and Fritz Strassmann discovered nuclear fission in 1938, Soviet scientists quickly explored the theory of chain reaction, including the requirements for explosive conditions in a critical mass of fissionable material. The Presidium of the Academy of Sciences

then ordered construction of a more powerful cyclotron to be completed in 1941 and sought access to uranium deposits in the Belgian Congo. Just prior to the invasion, two of I. V. Kurchatov's students proved the possibility of spontaneous fission, and others explored ways of producing U-235 and heavy water in quantity.[25] But just as the war stimulated German rocketry while stifling Soviet work, so it pumped huge sums of money and talent into the British and American atomic programs while stopping the Soviets in their tracks. Whether or not Stalin was aware of the possibility of a uranium bomb in 1941, for the moment the USSR could do nothing.[26] Scientific institutions were evacuated from European Russia before the German armies, and the Leningrad cyclotron gathered rust.[27]

A twenty-eight-year-old colleague of Kurchatov, G. N. Flyorov, relit the atomic fuse. In a letter to Stalin he noted the secrecy that had fallen over American research: "It is essential not to lose any time in building the uranium bomb."[28] A new laboratory directed by Kurchatov emerged in late 1942. Its mission was to build the bomb. The key factor in the decision, according to historian David Holloway, was Soviet knowledge of German and American work rather than any instinct about the postwar environment. But when Soviet agents pierced Germany in 1945, they hunted nuclear physicists as assiduously as rocket engineers. Most had fled, but Gustav Hertz, like Gröttrup, chose the USSR.[29] Again like Gröttrup, he was to find the Soviet specialists at least as capable as himself.

What did Stalin know or guess about the Manhattan Project and the implications of its possible success? If his spies were accurate, he would have heard that some American scientists placed little hope in the project as late as the turn of 1945 and expected at best a single bomb of half a kiloton (equal to 500 tons of TNT).[30] Such an increment in destruction would hardly change the world or repay the investment. But the Americans got a much bigger boom on July 16, 1945, at Alamogordo. President Truman then chose his moment, at Potsdam, to mention casually "that we have a new weapon of unusual destructive force." Stalin replied that "he was glad to hear of it and hoped we would make 'good use' of it against the Japanese." Truman and Churchill concluded that he had not understood that it was a reference to the atomic bomb.[31]

Stalin's breezy reply makes one wonder if he already knew of the Alamogordo test. But the Soviet spy ring in Canada did not report it until August 9, and British Communist spy Klaus Fuchs not until September.[32] Perhaps other sources relayed the news more quickly, for Marshal Zhukov's memoirs of Potsdam suggest neither ignorance nor underestimation of the bomb:

> On returning to his quarters after this meeting, Stalin, in my presence, told Molotov about the conversation with Truman.
>
> "They're raising the price," said Molotov.
>
> Stalin gave them a loud laugh. "Let them. We'll have a talk with Kurchatov today about speeding up our work."
>
> I realized that they were talking about the creation of the atomic bomb.[33]

But the Potsdam mystery is academic. On August 6, 1945, the fireball over Hiroshima spoke for itself. Communist journals in the West like the *Daily Worker* and *L'Humanité* at first applauded the bomb as a means of hastening Japan's surrender. In a few weeks they changed their line and attacked the American atomic monopoly. Modest Rubinshtein, a leading agitprop expert on technical affairs, reported that "The American reactionary press insists that the United States must keep the method of production of atomic bombs a secret in the expectation of future war." But, he warned, the monopoly would not last for long.[34]

In mid-August the People's Commissar for Munitions received a puzzling summons to the Kremlin. When Kurchatov appeared as well, "at once it became clear to everyone what the conversation would be about": "A single demand of you, comrades," said Stalin. "Provide us with atomic weapons in the shortest possible time. You know that Hiroshima has shaken the whole world. The equilibrium has been destroyed. Provide the bomb—it will remove a great danger from us."[35]

The equilibrium had been destroyed! Such equilibrium as we Westerners detected after the war consisted of the huge Red Army looming over Western Europe, balanced by American air power and the atomic bomb. Did the Soviets view matters differently? Did their new conventional military dominance in Eurasia serve simply to create a "balance" that was immediately upset by the bomb? The American and British ambassadors both sensed such a feeling in Moscow toward the end of 1945. "Suddenly the atomic bomb appeared," wrote Averill Harriman, "and they recognized that it was an offset to the power of the Red Army. This must have revived their old feeling of insecurity."[36] Sir Archibald Clark Kerr:

> There was great exaltation. Russia could be made safe at last. . . . She could stretch out her hand and take most of what she needed and perhaps more. It was an exquisite moment, all the more so because this resounding success under their guidance justified at last their faith in the permanence of their system.
>
> . . . Then plump came the Atomic Bomb. At a blow the balance which had now seemed set was rudely shaken. Russia was balked by the West when everything seemed to be within her grasp. The three hundred divisions were shorn of much of their value.[37]

One does not have to believe that Truman deliberately hoped to intimidate the Soviets to grasp how the Soviets must have seen their objectives threatened and their power diminished. Stalin gave Kurchatov authority to coordinate research, plan factories, and mount expeditions

to prospect for uranium. How long, assuming all-out support, did Kurchatov think it would take to build a bomb? Five years, he predicted.[38]

The USSR exploded an atomic bomb in August 1949, a year "early." Soviet secrecy, pride, distrust of the West, and especially the ideological commitment to technological superiority all militated in favor of a crash program and against international controls on nuclear weapons. Even if one could assume away the rapid degeneration in relations between the Superpowers, it is hard to imagine the Soviets renouncing their drive for the A-bomb, once Hiroshima was history.[39] The Soviet world view made unacceptable any world in which the capitalists possessed superior military technology. It gave them no choice but to press military technology as far and as fast as possible.

What of the Grand Alliance, the one hiatus in the official Leninist line on imperialism and foreign policy, during which British monarchy, American democracy, and Soviet communism fought side by side, and even the Kremlin spoke of the Great Patriotic War against the Teutons? Such nationalism served well during the emergency, but the official Leninist view could not be set aside indefinitely without the dictatorship losing its legitimacy. After the war Soviet theoreticians quickly returned to orthodoxy on the hostility of the capitalists, the inevitability of new wars, the necessity for strict Party leadership, and the role of technological supremacy as a measure of the success, legitimacy, and security of the revolution.

The reversion was evident in the fate of the Soviet Institute of the World Economy and World Politics, charged with describing and interpreting the global changes resulting from the war. Among its findings was the undeniable productive might revealed by the supposedly decadent American economy. The explanation of American dynamism seemed to lie in the growing government intervention that "eliminated monopolies which threatened the war effort" and made the United States "capable of enormous development" even in the postwar period.[40] If capitalism had changed its spots, what should the USSR do in response? Debate on the question began at the time of the first Soviet request for American reconstruction loans (January 3, 1945), and just a few months prior to the commission of a new Five Year Plan. Traditionalists held that monopoly capitalists still dominated Western policy. The postwar period would bring inflation, unemployment, and technical stagnation, all of which could only increase pressures for war, with the USSR now the sole target. But nontraditionalists at the institute, led by Evgeny Varga, thought that state regulation not only restored Western dynamism by mitigating the contradictions of capitalism but also served to mellow Western foreign policy. Varga predicted political moderation from the Americans, argued for East-West cooperation in reconstruction, and hoped for a postwar world not divided into economic blocs.[41]

Cooperate with capitalism or return to autarky? For the first time in a

decade something like open debate broke out on Soviet domestic and foreign policies. Molotov, Mikoyan, and Kaganovich took the traditionalist view. The USSR "must equal the achievements of contemporary world technology. . . . We will have atomic energy, and much else." But several Politburo members disagreed, including Andrei Zhdanov, who stressed consumer industries in the wake of wartime sacrifice.[42] Stalin appeared to choose moderation. His speech on the Five Year Plan counted Britain and the United States among the "peaceloving states," promised rapid reconstruction and a consumer orientation, and sent delegates to the March meetings of the new World Bank and International Monetary Fund. But he also said that war and victory had justified his harsh policies of the 1930s and called on Soviet scientists "not only to overtake but to surpass in the near future the achievement of science beyond the borders of our country." Only this would insure the USSR against "all sorts of accidents."[43] Thus before the Cold War was "declared" and his own diplomats haggled for loans without political strings, Stalin launched the greatest crash military program in the history of the regime.

The new Five Year Plan called for an annual R & D budget four times higher than the record figure allotted (but not implemented) in 1941. The 1946 budget set aside 6,300 million rubles, growing to 9,000 million by 1950.[44] The U.S. government, by comparison, spent $3,850 million on R & D during the whole of World War II, of which $2,000 million went into the Manhattan Project. In 1950 the U.S. government allotted $1,083 million. This figure does not include the large sums spent by private industry, while the 9-billion Soviet figure for 1950 was partly a product of inflation. But it is fair to conclude that the Soviet budget for military research was several times greater than the American, and perhaps six times greater as a percentage of gross national product (GNP).[45]

By 1947 whatever ambiguity existed in Stalin's assessment of the international scene disappeared. The Marshall Plan forced him to choose either to integrate the world economy by accepting Western aid and conditions or to cultivate his Eastern European garden and recover in isolation. As in early 1946 the Varga thesis surfaced for discussion, but this time it would be more accurate to say that it provided an occasion for the reinterment of nontraditional views on capitalism.[46] So the old contradictions in Soviet technology policy survived the war years. By definition the USSR had a superior potential for R & D but was still, by historical accident, temporarily behind. Great efforts must be made to catch up, but not through international mechanisms that carried unacceptable risks. Capitalism was still ahead in the technology race, and even more dynamic than before, yet it was still so economically sterile that it must soon launch wars to stave off collapse! Varga had tried to erase this inconsistency from Soviet theory and had also born witness to the fact, as had leading Stalinists in 1945, that "capitalist encirclement"

had been broken. By February 1946 Kaganovich was insisting that it, too, remained.[47]

The attack on Varga signaled the end of the flirtation with international cooperation. Stalin snubbed the Marshall Plan, imposed bilateral trade treaties on the Eastern European states, restored the Communist International (now called Cominform) in September 1947, and agreed with Churchill that the world was divided into two camps. Zhdanov, a bellwether, admonished the USSR to resist imperialism in all its forms and invoked the analogy of Munich and Appeasement three years before Truman did the same.[48] Varga himself held out bravely until the Berlin Crisis of 1948 and formation of the North Atlantic Treaty Organization (NATO) washed away his last handholds. He publically confessed "a whole chain of errors of a reformist tendency" and "departure from a Leninist-Stalinist evaluation of modern imperialism."[49]

Would a more accommodating Western policy have altered the outcome of the Soviet debate? This question lies beyond our scope, but two facts stand out. First, the Soviets could not have entered into meaningful cooperation without relinquishing the myth of conflict between "world camps" and socialist superiority. Second, the Soviets chose to race in new fields of military technology almost at once. Their large standing army might intimidate Eastern Europe, but it was also the drapery to cover a new "window of vulnerability" until they could pull even in technology.[50] By tripling the R & D budget with peacetime crash programs in atomic, aviation, and rocket technology, the Kremlin all but announced its estimate of the dangers of the postwar world and its intention to restore the "balance" upset by the bomb. The diplomatic breakdown that followed seemed only to confirm the wisdom of decisions already made concerning military R & D. Those decisions and others concerning what sort of hardware might impress an adversary skulking in the safety of another hemisphere "kicked" the USSR into the last leg of the pathway to space.

Grigory Tokady was chief of the Aerodynamics Laboratory of the Moscow Military Air Academy and a leading expert in rocketry. As technical adviser to the Soviet occupation army he had the mission of locating data and personnel and otherwise aiding Gröttrup, Glushko, and Korolev to revive the V-2 production line and an affiliated design bureau. What a luscious treat for the Soviet engineers to be turned loose on all that sweet technology after their wartime fast! But the V-2, as the Chief of the Soviet Air Forces confided to Tokady, was not enough. "They were good to frighten England, but should there be an American-Soviet war, they would be useless; what we really need are long range, reliable rockets capable of hitting target areas on the American continent. This is an aim that should dominate the minds and efforts of your rocket

group."[51] So, in October 1946, Gröttrup's Germans and their Soviet patrons departed for the East.

They found in the USSR the foundation of a vast new R & D complex. By the end of 1945 Commissar of Armaments D. F. Ustinov chaired a sixty-man Scientific Council to advise on military rocketry. In June 1946 the new Academy of Artillery Sciences set up a department for rocketry and radar under A. A. Blagonravov. Then in April 1947 Stalin called for Tokady himself to brief him on a project that had turned up several times in captured German files. It was Eugen Sänger's antipodal bomber, a piloted, winged rocket to reach an altitude of 160 miles and "skip" on the top of the atmosphere halfway around the world. Answering the summons, Tokady bounced from one NKVD sentry to another like a ball bearing through a pegboard, and came to rest in the Kremlin office of the deputy prime minister. "You know this book?" asked the minister, holding a translation of the secret proposal that Sänger had peddled without success to Nazi leaders. Tokady knew it well, and soon found himself before the Politburo weapons expert, G. M. Malenkov. Sänger's work was theoretical, said Tokady with professional caution. It was not at all certain that such an engine could be built or metals developed to resist the heat of combustion and reentry. Malenkov insisted that "the flying bomb is an outmoded weapon now. . . . The point is that the V-2 is good for 400 kilometres, and no more. And, after all, we have no intention of making war on Poland. Our vital need is for machines which can fly across oceans!" Were the British and Americans pursuing the Sänger Project? Tokady thought it possible: "If it be true that the Americans are so greatly concerned with rocket weapons that they have transformed Texas into a vast Peenemünde, as is often said, it is hardly possible that they have overlooked Sänger's plan. They have combed German scientific centers pretty thoroughly."[52]

The next day Tokady appeared before the Politburo. The important thing, he concluded, was intensive research, whether or not it resulted in hardware. Stalin paced and puffed on his pipe. "Certainly research is necessary," he replied. "But we still need Sänger planes, and their construction should be our immediate objective." Such planes, added Malenkov, could cross the Atlantic and return in one hop. "So they would," said Stalin, "and their possession would make it easier for us to talk to the gentleman-shopkeeper Harry Truman, and keep him pinned down where we want him. Tokaev, we wish you to exploit Sänger's ideas in every way." The Council of Ministers hastily drafted a decree for a special commission comprising Colonel-General I. A. Serov, Tokady, Academician Mstislav V. Keldysh, M. A. Kishkin from the aviation ministry, and Vasily I. Stalin, an air force major general.[53]

The Sänger Project proved to be premature. But the Politburo's interest in intercontinental delivery systems before they even possessed the atomic bomb was a turning point. By the end of 1947, according to

engineer A. G. Kostikov, "everybody wanted to design a trans-Atlantic rocket."[54]

Postwar conditions for R & D were better than at any time in Soviet history. European Russia had twice been overrun and scorched, 30 or 40 million citizens were dead of purge or war. Yet during these years after 1945 a threefold increase in R & D spending, construction of modern laboratories and proving grounds, and incessant government pressure for results made for frenetic progress. The Academy of Sciences pushed pure and applied research in atomic energy, radar, jet and rocket technology, electronics and semiconductors, calculating devices (computers), and combustion theory. In 1946 the Gosplan established a department for technology to plot not only five-year plans but yearly and evenly quarterly schedules for R & D and installation of new technology. The Council of Ministers resolved to double or triple the salaries of scientific workers, who suddenly found themselves a privileged class.[55] The research *sharaga* lived on—according to one estimate 15 percent of the top Soviet scientists were still in camps[56]—but the infrastructure for a new, expanded assault on the technological frontier was in place.

Rocket test ranges opened at Kapustin Yar, seventy-five miles into the steppes east of Stalingrad, and at Tyuratam, a railhead in remote Kazakhstan. The Gröttrup team worked in isolation on an island in Lake Seilger, 150 miles from Moscow, before their transfer to Kapustin Yar. There they supervised test launches of V-2s, consulted on the short-lived Sänger Project, and designed new rockets. Their R-10, with greater thrust than the V-2 and a detachable warhead, never entered production, and the multistage R-12 intermediate-range ballistic missile (IRBM) called for stage separation that was still beyond current technique. So Gröttrup's R-14, a full-blooded atomic bomb carrier designed to send a 6,600-pound warhead 1,800 miles, was a single-stage, finless monster fueled by the alcohol-LOX brew so favored by Peenemünde veterans and stabilized in flight by a novel system of swiveling nozzles. It was the most advanced design in the world of 1949. The Soviet Scientific-Technical Council whisked away all the plans for the R-12 and the Germans never saw them again. Instead they were put to work on antiaircraft missiles and trained gaggles of postgraduates who in time took over routine design work. Finally, on November 22, 1953 (ten years to the day before the JFK assassination), they received orders to pack for home, as abrupt as the initial summons of seven years before.[57]

The handling of the Gröttrup team is illustrative of Soviet borrowing. Always behind, the Soviets are constantly tempted to tap foreign hardware and talent. Always prone to secrecy, in part to cover their own backwardness, they are discreet and anxious to patriate foreign skills as rapidly as possible. The Gröttrup team was also "second string," and for this, for politics, and for pride, the Soviet engineers made only partial use of them. Historians Frederick Ordway and Mitchell Sharpe conclude

that the Germans contributed in specialized fields (twelve experts in guidance were held back from the 1953 repatriation) and in the "systems engineering" approach to rocket design.[58] Even if Glushko and Korolev had little to learn from the Germans in engineering, the managerial techniques of Peenemünde may have found their way to Tyuratam via the Gröttrup team.

Meanwhile, according to Leonid Vladimirov, the ghosts of the *sharaga* still haunted Korolev at the Tyuratam rocket oasis. His old camp warden, V. N. Chalomei, reportedly stole the credit for Korolev's wartime inventions and tried to get him back after 1946. Tyuratam became a divided fiefdom with Glushko, Korolev, and L. A. Voskresensky in one compound, Mikhail K. Yangel and Chalomei, their bitter rivals, in another.[59] Whether such disunity inhibits or stimulates performance is a question no R & D manager has fully resolved. But Tyuratam produced. By 1949 its Pobeda, or T-1, an all-Soviet upgrade of the V-2 with a range of 550 miles, was in production and supplying the first rocket units of the Red Army.[60] The T-2, an IRBM, was under construction by 1952. Design competition for an all-out ICBM, therefore, must have been underway about this time, and journalist Michael Stoiko reports that Korolev's blueprints for the ICBM that launched Sputnik won approval in 1954,[61] the same year that ICBM development became a top priority in the United States.

In plans for imminent construction of a world-girdling rocket to deliver the newly made atomic bombs, Soviet technological maturity was at hand. But the mid-1950s were also a time of rebirth, or remembering, of what rocketry had once been all about. From Tsiolkovsky to Tsander to Korolev, rockets were about spaceflight. In the early 1930s the Russian technical revolutionaries fell into the hands of a Soviet state whose *raison d'être* was to play forcing house of technological change. From the mid-1930s to the mid-1950s (with the exception of Stalin's Eagles) military might had perforce sole emphasis. But the Soviet expectation of imminent nuclear parity had a side effect. In establishing unprecedented might, it resurrected glory. After a hiatus of two decades, the rocketeers and their patrons in the Kremlin rummaged again in that corner of their imagination that harbored the dream of spaceflight.

When the Soviets sported an atomic bomb, the United States responded, after much debate, with sharply increased defense spending and a program to build a fusion, or thermonuclear, or hydrogen bomb of far greater destructive force. Outbreak of the Korean War in June 1950 hardened American resolve. The Soviets reacted by doubling the Red Army to 5.8 million men by 1955 and, without pausing to admire their atomic bombs, pushed on at once for their huskier offspring. In August 1953 they exploded the first thermonuclear device and tested a deliverable H-bomb in November 1955. The corresponding American dates were November 1952 and May 1956.[62] The H-bomb "race," like the ICBM

race, probably began even before the Americans held their hand-wringing debate.

Stalin's death in March 1953 still seemed to presage a thaw. For the first time since the 1920s the collective wits of the Politburo did not have to square their opinions with Stalin on pain of torture and death. Malenkov, Mikoyan, and others approved a negotiated end to the Korean conflict and claimed that Soviet nuclear capacity enabled true peaceful coexistence.[63] Civilian technology might now become the main arena of competition with capitalism. After 1950, R & D spending did level off. A ceiling on the military budget as well could free up investment in light industry and consumer goods. But such views clashed as always with the mythology of capitalist hostility and socialist superiority. Tentative feints toward consumption, trade, and exchange of ideas with the West exposed their advocates to charges of being "soft on imperialism." Even with Stalin gone, Eastern Europe secured, and the H-bomb in Soviet hands, the Politburo still upheld traditionalist assumptions. Klement Voroshilov reasserted the reality of encirclement; Khrushchev, Bulganin, Molotov, and Kaganovich urged more military spending in light of imperialist belligerence in Korea, the effort to rearm West Germany, and the U.S. buildup. "We cannot assume," said Nikolai Bulganin, "that the imperialists expend enormous material and financial resources only to frighten us."[64] Malenkov repented of his consumerism, military R & D rose as part of overall 15 to 16 percent annual increases from 1953 to 1956, and missile expenditures jumped as Tyuratam moved to prototype production of its giant rockets.

So the arms race was not about to end. What of Stalin's other bequests, the rule of terror and the Cold War? Nikita Khrushchev dealt with them before the Twentieth Party Congress in February 1956. There he lectured to an astonished audience at a special midnight session "on the cult of personality and its consequences." He recounted the terrors, tortures, and errors of Stalinist rule, the leader's blunders prior to the Nazi invasion, his collapse in the critical months following, his responsibility for agricultural and diplomatic disasters, and, above all, his attacks on the procedures and loyal personnel of the Communist Party. Stalinism became an official aberration, not a natural expression of doctrine, and Soviet historiography and political vocabulary metamorphosed overnight.[65]

Subsequent events revealed more continuity than Khrushchev's broadside suggested. The wave of de-Stalinization did little to "liberalize" the Soviet bloc. Intramural Party terror and wholesale judicial murder subsided, but the police state lived on, while outbreaks occasioned by de-Stalinization in East Germany, Poland, and Hungary triggered new repression. Khrushchev proceeded to foster his own personality cult, and his airing of Stalin's mistakes did not prevent blunders of his own that brought his own downfall eight years later. The element of continuity most pertinent to us was Khrushchev's adoption of the technocratic myth

and his personal identification with Soviet heroism and futurism. Like Stalin, he struggled to establish his legitimacy against Politburo members with better claims to the succession. Like Stalin, he did so in part by styling himself the personal patron of high technology and the theorist most in touch with the historical laws of his age.

The power struggle after Stalin's death focused on military policy. Khrushchev sided with the majority in the 1953 plan that favored bigger conventional forces, and he courted war hero and supreme commander Georgi K. Zhukov. This alliance helped to save him in June 1957 when Malenkov, Molotov, and Kaganovich conspired to oust him from power. But Khrushchev's military plans, as events proved, did not include old Stalinist generals. Having used Zhukov against his political rivals, Khrushchev would use Stalin's maturing missiles against Zhukov to establish both his own monopoly of power and a new age in military strategy.[66]

The dawn of the missile age, which illuminated the 1956 Party Congress, made the whole world appear differently to those, like Khrushchev, with eyes to see. The postwar Soviet agenda had included consolidation of Eastern Europe and a headlong drive for nuclear parity. The Berlin anomaly still rankled the Kremlin, but otherwise the fulfillment of this agenda was in sight. What lay ahead in Soviet foreign policy? Where were the new opportunities in the coming age of mutual nuclear deterrence? Khrushchev's answers to these questions, also delivered to the Twentieth Party Congress, fundamentally revised Leninist dogma on foreign policy. For an age was upon them when the Soviets could put to rest the old fears of capitalist encirclement and bargain with their adversaries as equals. That equality in turn freed the USSR to compete in other ways, economic and political, and in regions beyond its own cordon. And the USSR was free to do so just as the neutralist "Third World" was coming into existence. This compelling chain of logic, beginning with missiles, seemed to prove that worldwide initiative was finally passing to the socialist camp.

Khrushchev's report to the Party Congress boasted of spectacular postwar recovery, achieved with "complete self-sufficiency"—that is, no Marshall Plan handouts—while the capitalist world, though growing, could never abolish its endemic overproduction, unemployment, and inflation. In foreign policy, Khrushchev denounced the "so-called 'Cold War' launched against the countries of the socialist camp" as well as the bloody war that "was launched" in Korea. The inspirers of the Cold War, he explained, alleged that their military blocs were for protection against the "Communist threat," but this was "plain hypocrisy. . . . Now the slogan of 'anti-Communism' is again being used as a smokescreen to hide the pretensions of a particular power to world domination." Thanks to courageous efforts by Communist parties, working-class leaders, and antimilitarist movements in the West, influential circles were beginning

to "sober up" and "admit that the socialist camp is invincible." Why? Because thanks to Soviet weapons breakthroughs, the atomic arm of the West was now useless. But another challenge had also arisen to imperialism: the "national liberation struggle of the colonial peoples." The disintegration of the empires was the "universal historic event of the postwar period" and was significant to the USSR, for the peoples of former colonies would not be truly free until they achieved economic autonomy, which meant an association with the socialist camp. Of course, new imperialist rivalries were evident: South Vietnam, for instance, was "passing from the hands of the French to those of the USA," and the Cold War itself was a means of instigating war hysteria and thus justifying imperialist expansion.

Despite these provocations, boasted Khrushchev, the USSR was dedicated to the principles of peaceful coexistence, including mutual respect for territorial integrity and sovereignty, nonaggression, noninterference in domestic affairs, equality and mutual advantage, and economic cooperation. "Of what purpose is war to us?" he asked in conclusion. ". . . Our faith in the victory of Communism is based on the fact that the socialist way of production has decisive advantages over the capitalist." True, Marxist doctrine spoke of the inevitability of war, but that was worked out in a period when imperialism was all-embracing and the socialist forces weak. "But at the present time the situation has changed fundamentally. The world camp of socialism has arisen and become a powerful force. . . . We must still exercise the greatest vigilance. . . . But there is no fatal inevitability of wars."

War between capitalism and socialism no longer inevitable! Did this mean stalemate, the arresting of the revolution? No, for "in connection with the radical changes in the world arena, new prospects are also opening up with regard to the transition of countries and nations to socialism." The Party's tasks were to pursue "peaceful co-existence, strengthen inter-communist ties, and tighten bonds of friendship with the new nations, improve relations with the West, but keep a vigilant eye, and preserve Soviet defense at the level of modern military technique and science."[67]

At the Twentieth Congress Khrushchev perceived a new Cold War. His address was a kind of Communist *Rerum Novarum* for foreign policy. The Cold War would continue, but the material environment reversed the correlation of forces. Soviet nuclear and missile power wiped out at a blow the vulnerability of the socialist camp, encirclement by the imperialists, and the inevitability of war. Competition would shift to other spheres: economic productivity, scientific progress, and influence in the underdeveloped nations, whose struggles for national liberation were the second arrow in the socialist quiver. (Indeed, as soon as October 1956 the new correlation of forces would become manifest in the Anglo-French retreat from Suez following a Soviet threat of "rocket attacks.")

In all these ways the coming dawn of the space and missile age meant a new and better world for the Soviet Union and for its new leader: a deterrent to imperialist war; an amulet of attraction for the elites in the postcolonial world; a technological revolution with which Khrushchev could personally identify; a justification for moving against the conservative, Stalinist military leadership; an indicator of Soviet superiority in science and technology. For all these reasons the prospect of the USSR leading the world in the peaceful as well as military uses of rocketry beckoned irresistibly. New frontiers were opening up for Soviet power, and the Twentieth Party Congress passed the baton to a new post-Stalinist leader in touch with the times. Times of accelerating change—but also continuity perceptible in a technocratic, totalitarian state whose legitimacy and international appeal rested on its material promise of a glorious future, hence on regular palpable indicators that that future was still in healthy gestation.

After his swearing-in as President, Harry Truman was stunned to learn of the nature and progress of the Manhattan Project. Roosevelt had kept him in the dark. Similarly, when Khrushchev and his colleagues were briefed on rocket development after Stalin's death, they were flabbergasted. "Korolev came to the Politburo," wrote Khrushchev in his memoirs,

> to report on his work. I don't want to exaggerate, but I'd say we gawked at what he showed us as if we were sheep seeing a new gate for the first time. When he showed us one of his rockets, we thought it looked like nothing but a huge, cigar-shaped tube, and we didn't believe it would fly. Korolev took us on a tour of the launching pad and tried to explain to us how a rocket worked. We were like peasants in a marketplace. . . . We had absolute confidence in Comrade Korolev. When he expounded his ideas, you could see passion burning in his eyes, and his reports were always models of clarity. He had unlimited energy and determination, and he was a brilliant organizer.[68]

In the year following Stalin's death the ICBM was apparently approved, and high-level indications of interest in spaceflight reappeared after twenty years. The president of the Academy of Sciences, A. N. Nesmeianov, announced to the World Peace Council that "Science has reached a state at which it is feasible to send a stratoplane to the moon, to create an artificial satellite of the earth."[69] Several articles appeared in 1954 concerning interplanetary communications, an aeroclub began a cosmonautics division, a biography of Tsiolkovsky was commissioned, and a Tsiolkovsky prize was instituted to honor work in rocketry. Such indications of mild public interest were no more than occurred in the United States, but in the USSR they signaled official interest as well. More telling was the Soviet response to recommendations by the organizers of the International Geophysical Year (IGY) that attempts be made to place

artificial satellites in orbit about the earth. The Soviet Academy of Sciences named a blue-ribbon Commission for Interplanetary Communications (ICIC) chaired by Academician Leonid I. Sedov. Its stated purpose was this:

> The problem of realizing interplanetary communications is undoubtedly one of the most important tasks among those which mankind has to solve on the way to conquering nature. The successful solution of this task will become possible only as a result of the active participation of many scientific and technological collectives. It is precisely for the unification and guidance of those collective efforts of research workers that the permanent ICIC has been established. . . . One of the immediate tasks of the ICIC is to organize work concerned with building an automatic laboratory for scientific research in space. . . .[70]

Moscow radio reported that a team of scientists had been formed to build the satellite. Another academician declared satellites a possibility in June 1955 and believed tackling the problems of spaceflight to be extremely urgent. On July 30, 1955—a day after a similar American announcement—the Kremlin revealed that the USSR planned to launch satellites during the IGY. Sedov predicted one in two years. Reentry problems were under study as well, he said, and a multistage rocket would be used in the first attempt.[71]

Soviet officials, therefore, while avoiding premature boasting, did not hide their intentions. It was just that few took them seriously. Meanwhile, in remote and secret isolation, Korolev pieced together the world's first ICBM. In mid-1953 the Ministry for Medium Machine Building was established—a dummy name for the missile plants (whose political liaison included a rising Party official named Leonid Brezhnev)—and in June 1955 a new test range arose at Tyuratam (where the new Party secretary for Kazakhstan, Brezhnev again, took an interest).[72] Throughout 1955 and 1956 Sedov, Blagonravov, and others predicted the coming of the Space Age. Soviet scientists captivated the First International Conference on Rockets and Guided Missiles in 1956 with tales of high-altitude experiments and dogs launched sixty-eight miles high at g-forces five times normal. There was no doubt, they said, that human rocket flight was possible.[73]

The IGY began on July 1, 1957. Soviet predictions of a satellite became a weekly occurrence as Korolev put his giant rocket to the test. The metallurgists had never succeeded in finding an alloy to withstand the heat produced by very large rocket engines, so Korolev's solution was a "cluster of clusters"—twenty separate engines in a central core and four great skirts, developing 1.1 million pounds of thrust on kerosene and LOX. Presumably built to carry the primitive two-ton atomic bombs of the early 1950s on the 4,000-mile run to the United States, the R-7 was all bulk, short and splayed like a mechanical Cossack in billowing pantaloons, only three times as high as thick, and only twice as tall as a

V-2. The first R-7 (*semyorka*, or "ol' number seven" to the rocketeers) exploded on ignition in the late spring of 1957. When more failures followed, Korolev's team came under criticism—his rival Chalomei sowing discord. But on August 3 the Soviet ICBM roared off the pad and flew 100 degrees of longitude to the east, into the Pacific Ocean near the Kamchatka Peninsula. After a second success, Moscow announced to the world on August 27, 1957, its possession of a proven ICBM. According to Korolev, it was only then that final approval of a satellite attempt descended from the capital.[74] On September 17, the centennial of Tsiolkovsky's birth, the government promised the world that a satellite was coming soon. On the first of October, it announced the radio frequency on which the satellite would broadcast.

Three evenings later space scientists from various IGY countries talked shop and sipped vodka at the Soviet Embassy in Washington. The hosts disingenuously resisted casual probes from their American colleagues as to the date of their first attempt.[75] A Russian emigré even teased his ex-countrymen: "Poor Tsiolkovsky is turning in his grave. His hundredth birthday has passed without even one Russian satellite in orbit. Under the Tsar we would have had several of them long before now and would have celebrated the anniversary with a flight to the moon." One Soviet guest took offense. Before he returned to Moscow two days hence, he said, the emigré would eat his words.[76]

A hemisphere away Korolev, who had slept little for weeks, fidgeted in his concrete bunker, built by slave labor, at Tyuratam. All evening there had been delays in the countdown, frustration, and suspense—the aggravations that have taught us spectators why engineers and test pilots must be so maddeningly equable. Now, in the darkest, chilliest hour of night, the measured pace of seconds, no longer corresponding much to human heartbeats, finally signaled the moment of ignition. Soviet historian Evgeny Riabchikov recounts:

> The clear tones of a bugle were heard above the noise of the machines on the pad. Blinding flames swirled about, and a deep rolling thunder was heard. The silvery rocket was instantly enveloped in clouds of vapor. Its glittering, shapely body seemed to quiver and slowly rise up from the launch pad. A raging flame burst forth and its candle dispelled the darkness of night on the steppe. So fierce was the glare that silhouettes of the work towers, machines, and people were clearly outlined. . . .
>
> "She's off! Our baby is off!" People embraced, kissed, waved their arms excitedly, and sang. Someone began to dance, while all the others kept shouting, "She's off! Our baby is off!"

The rocket disappeared. Everyone rushed to the radio receivers. The satellite's first signals, from the moment of its separation from the booster, were recorded on tape for its anxious family below: ". . . beep, beep, beep. . . ."[77]

At the IGY gathering in Washington, a Soviet embassy official called Walter Sullivan to the telephone. It was the *New York Times* Washington bureau. Sullivan scratched a message and handed it to Lloyd V. Berkner, who clapped his hands and called for silence. "Radio Moscow has just reported that the Russians have placed a satellite in orbit 900 km. above the earth."[78]

Premier Khrushchev had just returned to Moscow from his dacha in the Crimea. "When the satellite was launched," he recalled, "they phoned me that the rocket had taken the right course and that the satellite was already revolving around the earth. I congratulated the entire group of engineers and technicians on this outstanding achievement and calmly went to bed."[79] It was left to the official announcement the next day to set the tone for seven years of propaganda from a triumphant Soviet, and increasingly Khrushchevian, technocracy: "Artificial earth satellites will pave the way for space travel, and it seems that the present generation will witness how the freed and conscious labor of the people of the new socialist society turns even the most daring of mankind's dreams into reality."[80] In the weeks and months to come, Khrushchev and lesser spokesmen would point to the first Sputnik, "companion" or "fellow traveler," as proof of the Soviet ability to deliver hydrogen bombs at will, proof of the inevitability of Soviet scientific and technological leadership, proof of the superiority of communism as a model for backward nations, proof of the dynamic leadership of the Soviet premier. At the fortieth anniversary of the revolution in November 1957, Khrushchev predicted that the Soviet Union would surpass the United States in per-capita economic output in fifteen years.

Russian rocketry and revolution embraced again. Only this time the revolutionary flames leaped the oceans, found crackling timber in the United States, and then spread around the world on the strength of the promise not of Marxist dialectic but of Leninist technocracy. It is not too fanciful to suggest that the fires of "ol' number seven" were themselves kindled by the bombs astride the carriage of Tsar Alexander II.

Conclusion

How had the Soviets come so far so fast? How was it that human penetration of space arrived as "early" as 1957? The fact that the first satellites were the feats of a closed, totalitarian society obscures most of the details even as it illuminates the whole. The drive for spaceflight was in the nature of the Soviet beast just as the urge to explore, discover, and overcome nature is part of the nature of man. Communism is strong because it expresses a part, but only a part, of human reality. But the totalitarian nature of the regime means that we have no documents by which to trace the technical progress of the engineers or the industrial capacity supporting R & D. Some facts are known, however, and some inferences can be drawn.

First, spaceflight was not premature. The Soviets showed an unexpected capability in guidance technology and an impressively large rocket. But shooting a satellite into a rough orbital trajectory is not the same as pinpointing an ICBM to its target or positioning a communications satellite; and any garden variety multistage rocket or a big, simple single-stage rocket is sufficient to accelerate a small orb to orbital velocity. The rocket teams in both Superpowers protested that they could have launched a satellite years earlier if left to do so without military or political interference.[1] But the genius of the engineers was only a necessary, not a sufficient, condition. The characteristics of the Soviet regime and the advent of nuclear weapons provided the nourishment and climate sufficient for the space technological revolution to occur. Those characteristics included an ideology of foreign relations that ensured distrust and competition whatever the diplomatic settlement after World War II. They included a self-definition that compelled Soviet leadership to exert maximum effort to equal and surpass the technological achievements of the capitalist states, and a concentration on science and R & D unique in the world. They included a materialistic progressivism that linked the legitimacy of the Party and of its leader to their capacity for inventing the future and conquering nature. In these ways the Soviet Union was especially suited to open the age of spaceflight.

What of the barriers to science and technology in the USSR? Did not the same totalitarianism that glorified technology also stifle its progress? This is demonstrably the case in numerous areas of applied science. The

symbology of American politics had left Eisenhower behind. Teller and Gavin, Lyndon Johnson or Henry Luce of *Life* magazine—their words no longer sounded like those of some future decade. Rather Eisenhower's suddenly sounded like those of a past.

CHAPTER 7

The Birth of NASA

Whatever his insistence on restricted federal spending, Eisenhower could not refuse to respond to the Sputniks. It might not be true that American science was slipping. (It was surely not true, as retired President Truman claimed, that the Russians led in "this satellite proposition" because of the "character assassinations of Oppenheimer and others.")[1] It might not be true that American education was inferior, or that high-school physics had anything to do with Vanguard's flop. It might not be true that the U.S. military posture was inferior, that the Pentagon spread money around in wasteful rivalry, or conversely did not spread enough money around, as in the single satellite program. Indeed, all the charges made in the wake of Sputnik may have been false, contradictory, or beside the point. Nevertheless, the new symbolic value of space, science, and education demanded action.

For the charges did spring from an apt intuition. A new age was dawning, in which organized brainpower for military and civilian science and technology was the dearest national asset. Eisenhower, however, rejected the demands of generals and congressional "hawks" for a crash buildup and opted instead for sufficiency. But "sufficiency" implied mutual deterrence, and that only meant that the Cold War would be expanded beyond nuclear weapons and espionage into a competition of entire systems, each claiming to be better at inventing the future. Hence Sputnik posed an insoluble dilemma for Eisenhower's United States: either it must race headlong for strategic superiority, compromising fiscal integrity and militarizing much of the private sector, or it must accept strategic parity, in which case *all* aspects of national endeavor, including conventional weaponry, economic growth, "social justice," and the hearts and minds of Third World peoples became yardsticks of Cold War competition. Either way Sputnik invited another American lurch toward technocracy. The Eisenhower response that addressed the Sputnik challenge head-on, but that also expressed his ambivalence to the new age, was the National Aeronautics and Space Administration (NASA), another federal agency devoted to the conduct of a specific technological revolution.

The 1958 State of the Union message was an echo of Khrushchev's 1956 foreign policy speech, and spelled out the new and subtle challenges to an audience still obsessed with the satellite problem (when do *we* get one?). "Honest men differ," Eisenhower began, "in their appraisal of America's material and intellectual strength. . . ." But, Sputniks notwithstanding, the American people "could make no more tragic mistake than merely to concentrate on military strength." Hence the paradox: the Soviet rockets actually blunted, rather than sharpened, the military component of the Cold War. Communist imperialism was still the threat, said Ike.

> But what makes the Soviet threat unique in history is its all-inclusiveness. Every human activity is pressed into service as a weapon of expansion. Trade, economic development, military power, arts, science, education, the whole world of ideas—all are harnessed to this same chariot of expansion.
>
> The Soviets are, in short, waging total cold war.[2]

American progress in strategic technology was extremely rapid, the President insisted, especially the navy's Polaris. But Communist regimes, frustrated in attempts to expand by force, were concentrating as well on an economic offensive, especially in developing countries, that could defeat the free world regardless of its military strength. Eisenhower confessed his failure to anticipate the psychological impact of the first satellite and warned against a repetition of this failure in the economic field. Hence aid, trade, and mutual security efforts were even more important than strategic arms, and the United States' major Cold War asset was its economic health, sustained by "tremendous potential resources" in education, science, research, and, not least, "the ideas and principles by which we live."[3]

So Eisenhower issued no call to arms. Rather he recognized the changed nature of the Cold War and the new themes and symbolism of the Space Age (all of which would find sharper and unrestrained expression in the inaugural address of the next President). But Ike still hoped to meet the demands of total Cold War with limited government. He called in his speech for (1) defense reorganization for unity in strategic planning and R & D; (2) acceleration of R & D; (3), (4), and (5) mutual aid, trade, and scientific cooperation with allies; (6) investment of a billion dollars over four years (a fivefold increase) in teaching and scholarships in fields vital to national security, and a doubling of research funds for the NSF; (7) supplemental appropriations for defense of $1.3 billion and another $4 billion for missiles, science, and R & D in FY 1959. But these increases would come from expected revenues and not unbalance the budget.

In the eyes of the President this was a decisive but prudent response, sufficient to show the world that "the future belongs, not to the concept

of the regimented, atheistic state, but to the people. . . ."[4] The first post-Sputnik budget, "adhering to those principles of governmental and fiscal soundness that have always guided this administration," amounted to a rise of only 1.5 percent over the previous year. Defense spending was still lower than in FY 1954. In his budget message, Eisenhower felt obliged to justify even this small increase by the need "to keep pace with the rapid strides in science and technology."[5] The dual nature of the administration's domestic response to Sputnik revealed itself in its four main initiatives: science and R & D, federal aid to education, defense reorganization, and the space program. In each case, the proposed changes were explicitly designed to be temporary in duration, limited in scope, or self-mitigating in execution: a nod, but not a bow, in the direction of technocracy. Let us see how this was so.

The federal role in R & D, as has been seen, was a headache dating back to World War II. Its complexities and contradictions were such that almost all federal funding of research fell, *faute de mieux,* to the AEC and the military. Throughout the 1950s, however, professors and administrators calling for direct government aid grew louder, more numerous, and less sensitive to dangers of politicization. The federal scientific community, such as it was prior to Sputnik, backed its colleagues in academe. Eisenhower declared in 1954 that the NSF should henceforth be responsible for all federally funded basic research, while other agencies stuck to applied research related to their missions.[6] But the effect of this executive order was to reduce DoD and AEC support for pure science, while the NSF lacked the funds to take up the slack! Alan Waterman protested, styling his appeal to the White House as a program for "Maintenance of Technological Superiority." In July 1957, before Sputnik, I. I. Rabi and the ODM Science Committee reported to the White House that "the welfare of the U.S., incomparably more than at any other time in its history, is dependent on new scientific knowledge for the welfare of its people, for the advancement of its economy, and for its military strength. . . . Research is a requisite for survival." Rabi pleaded for military and AEC support of basic research, since the military itself now pushed against the frontiers of knowledge. To be sure, government could encourage private investment in R & D, perhaps through tax policy, but the time had passed when national needs could be met from private sources.

> The U.S. has reached a "point of no return" in Federally supported research. Our American society, our standards of health and living, our modern defense, all require large scale research. . . . [We] cannot take the risk of falling behind in our military technology which would almost certainly occur if the DoD depended on other agencies to plan and sponsor research. . . . *There is a need for a strong and wise protagonist of basic research in the DoD in the interest of maintaining our military superiority.*[7]

Here was a remarkable reversal! After 1945, scientists advised Truman that even military-related research ought to be directed and funded by a *civilian* agency; in 1957, scientists advised Eisenhower that even civilian basic research ought to be sponsored by the *military*! In August a classified Cabinet paper generated by the NSF and the BoB seconded the motion. After Sputnik the ODM scientists had little difficulty persuading the President to appoint a Presidential Assistant for Science and Technology and to release far greater sums for basic research through both the NSF and the DoD: $55 million for NSF grants (up from $38 million in FY 1958) and $53 million for science education (up from $17 million). Compared to the banquet of the 1960s, these sums were only hors d'oeuvres, but they quickened appetites in an age when a mass spectrometer costing $60,000 was rudimentary equipment, a serious chemistry lab went for $750,000, and a cyclotron or radio telescope many millions. Nor did Ike give a blank check to the military; he had enough trouble trying to rein them in on *applied* research. But these first increases proved to be a lever for many educational and research groups with "national" goals to pursue. In 1958 the vice president convened a panel on federal support for *social* science on the premise of countering Soviet psychological warfare and even drug-induced behavioral control, while in and out of government the proponents of job training, social welfare, mental health programs, and so on set new goals for the "national agenda" and comprised a vast academic/bureaucratic lobby demanding federal financing of the quest for new knowledge.

The great leap into federal support of local education, the National Defense Education Act of 1958, was another paradigm designed as a stopgap. And again Sputnik acted as catalyst in a volatile mixture that had bubbled up since World War II, when the GI Bill legitimized federal aid to education. Various sorts of reformers cashed in on the Cold War alarm to sell the notion that government money was a panacea for a variety of deficiencies.

By the late 1940s the reigning philosophy of American schools, John Dewey's "Progressive Education," came under attack. Built on a "new humanism" that stressed "life adjustment" rather than "the three Rs," Progressive Education encouraged two pernicious mentalities, according to later critics: "The almost frightening belief in education as a sovereign remedy for all our social problems" (James Killian) and "The naive egalitarianism which urged in the name of democracy the same amount and kind of education for all individuals. . . ." (Education Policy Commission, 1956).[8] The 1949 bestseller *And Madly Teach* excoriated an educational philosophy that discriminated against brighter students and enlarged the areas over which "the authority of the social whole is supreme." In this view, progressive education taught relativism and egalitarianism, thus undermining the moral confidence of young people and rewarding "grey conformity." But as the 1950s advanced, social

"progressives" insisted that public education was not equal enough, given discrimination against children from poorer school districts and racial minorities, while Cold War pragmatists stressed that since education was the United States' first line of defense, excellence should be set apart and cultivated. Opposite emphases, but the same solution: more federal direction and subsidy. Admiral Hyman Rickover frankly urged Americans to imitate Russian education: the Cold War, he believed, was a race between "opposite systems of management," not ideologies. Von Braun denounced "life adjustment" curricula, considered egalitarian education a contradiction in terms, and ridiculed the notion that an intellectual elite was incompatible with democracy.[9] After Sputnik, these many threads intertwined as social liberals and Cold Warriors found common ground.

Eisenhower himself sponsored brick-and-mortar bills from 1955 to 1957 to help states cope with the baby boom, but attempts to channel federal dollars into curricula, teaching, and equipment repeatedly failed. Confusion among the reformers, resistance on principle to governmental meddling in the classroom, and thorny issues raised by parochial schools and desegregation all contributed to deadlock. Some Southerners advocated federal support but feared forced integration, while Catholics were loath to pay for programs from which their schools would be summarily excluded. But after Sputnik educational lobbies and their bureaucratic allies unabashedly exploited the panic and denounced U.S. schools as second rate. A National Education Association lobbyist admitted that "the [education] bill's best hope is that the Russians will shoot off something else,"[10] and the three Rs of educational legislation came to be known as "Race, Rome, and Russians."

The conflict of views was clearest, perhaps, in the pronouncements of the current and former presidents of Harvard University. Nathan Pusey said bluntly that Sputnik required a vast increase in the share of the national product devoted to education. But former prexy James Conant cautioned Eisenhower against crash programs that could damage schools, confuse school boards, and undermine confidence in what was generally an outstanding school system. "Those now in college will before long be living in the age of intercontinental ballistic missiles," said Conant. "What will be needed then is not more engineers and scientists, but a people who will not panic and political leaders of wisdom, courage, and devotion . . . not more Einsteins, but more Washingtons and Madisons."[11]

Eisenhower sided with Conant and, working closely with Killian and Health, Education and Welfare (HEW) official Eliot Richardson, designed a bill that served his rearguard view against the pretensions of technocracy. He granted the need for more scientists and engineers, but resisted the notions that this need was permanent and that technology alone could solve military and social problems. His program for aid to students in science, engineering, and foreign languages was meant explicitly to be temporary and not to imply control of local education by the bureaucracy.

"The federal role," Eisenhower insisted, "is to assist—not to control or supplant—[local] efforts." The program was to run for seven years only.[12]

Richardson joined with congressional leaders, especially Alabama Democrats Carl Elliot and Senator Lister Hill, to steer the bill "between the Scylla of race and the Charybdis of religion."[13] In the end, twenty-three Southerners and twenty-four Republicans who had previously opposed education bills shifted to support this carefully worded National Defense Education Act (NDEA), a bellwether bill of the young Space Age. For despite presidential warnings, the act still pointed in the direction more liberal Congresses would take. A Democratic rider on the bill earmarked $60 million in vocational grants for students *not* going to college. After all, if some youngsters were to be privileged on account of their scientific bent, did not equity demand that those less gifted or otherwise inclined also receive help? This may have seemed fair, but once federal responsibility for private opportunity was established, and the principle of equity applied, there was no stopping point at which government could resist claims upon the public purse. Each extension or increase of federal aid to one or another collectivity, defined by specialty, financial station, region, race, sex, or whatever, proportionally increased federal power over the recipient institutions. This was Eisenhower's premonition, hence his NDEA, another vanguard action forced by the Cold War, was drafted as a rearguard attempt to contain the domestic drift toward centralization.

The third Eisenhower initiative was reorganization of the DoD. Ever since the 1947 legislation was whittled down to win naval and congressional sufferance, civilian officials hungered for further reform. Sputnik and the Johnson hearings provided the opportunity. Even the testimony of disgruntled generals, admirals, and industrial contractors, each touting his own efforts and complaining of everyone else's, only strengthened Eisenhower's hand in his effort to push through DoD reorganization. The State of the Union message made it a major goal of 1958, the new defense secretary endorsed it, and the administration named blue-ribbon panels (including Rockefeller and the three most recent chairmen of the JCS) to design it.[14]

The bill sent to Congress in April invoked the technological revolution to explain the need for change. Thermonuclear weapons, missiles, and atomic submarines increased the destructiveness of war, reduced warning time, eliminated breathing space after the onset of hostilities, and placed a premium on efficient R & D. Hence Eisenhower asked Congress to unify operational commands and place them directly under the Secretary of Defense, enhance the power of the Secretary and enlarge his staff, allocate all military funds directly to the Secretary and not to the services, and centralize all R & D functions under a Director of Defense Research and Engineering (DDR & E). In addition, the JCS must cease to be a committee of rivals, but must act as a single corporate body with an integrated staff capable of directing all the armed forces of the United States in peace and in war.[15]

The bill drew stubborn resistance from quarters attached sentimentally or selfishly to the autonomous services: veterans' organizations, service advocates in Congress, contractors, and the navy. But a White House public relations campaign recruited distinguished advocates in the public and private sectors and dispelled the specter of "military dictatorships" that opponents claimed to see in centralization. "There will be," said the President, "no single chief of staff, no Prussian General Staff, no czar, no forty billion dollar blank check, no swallowing up of the traditional services, no undermining of the constitutional powers of Congress." Rather, the reorganization would meet the needs of the nation by streamlining operations and R & D in an expensive, technically dynamic age.[16]

With minor amendments the administration bill became law on August 6. At first glance it seems another innovation forced on Eisenhower by the outcry over Sputnik. In fact, it was as much another example of Ike's campaign to help civilian leadership hold the line on R & D and keep technology policy subservient to national strategy and economic prudence. Its significance was evident in the fracas over the defense budget for FY 1960, as the Cabinet squarely faced the problem of adjusting American strategy to the coming age of mutual deterrence. Was massive retaliation still valid, now that the USSR had an ICBM? Even Foster Dulles had his doubts: Europeans worried whether the United States would use its nuclear arsenal in case of Soviet conventional attack. Perhaps tactical nuclear weapons might suffice. But Secretary of Defense McElroy feared that tactical nuclear warfare would escalate. Generals Nathan Twining and Taylor and Admiral Burke all liked the flexibility offered by tactical weapons but observed that an inventory of small yield warheads did not yet exist. Deputy Secretary Quarles stuck with massive retaliation: the nuclear age was inevitably one of deterrence, not war-fighting. But what if deterrence failed? asked Navy Secretary Thomas Gates. In that case, said Twining, nuclear attacks would be directed at military targets, not population centers. But that in turn required more numerous and sophisticated delivery systems than a simple "city-busting" strategy.[17]

Here were the leaden questions of the missile age. The United States had to maintain a sufficient and technically current deterrent. But since the Soviets would, too, tactical weapons became important for the defense of Europe. Since crossing the nuclear threshold risked escalation, conventional forces must be beefed up to avoid that option. And if Khrushchev intended to foment brushfire wars in the decolonizing world, then counterinsurgency forces must be purchased as well. Thus there was a great temptation to increase one's options with an across-the-board buildup of military force. But buying the maximum of flexibility,

like extending aid to more and more social groups, was ultimately ruinous.

There were two ways of budgeting for defense. One was to ask each service to declare its needs, urging restraint of course. When this was done, the total would come to something like $100 billion—everyone asked for everything. The second way was to impose a ceiling, $44 billion in FY 1960, allocate a share to each service, and let each set its own priorities. The latter method, initiated by Truman and revived by Ike after Korea, was arbitrary and annually assaulted. As soon as the budget was released the aggrieved services rallied every congressman, contractor, and columnist in their camp to protest the budget and strategy that produced it.[18] But with the Secretary of Defense and JCS enjoying centralized direction and control of all funds, the ceiling system could be reinforced and made less arbitrary. The Pentagon reform was a tool, therefore, of efficiency and economy, which helped the United States to adjust to the missile age and helped Eisenhower rein in the services.

In all these areas—science, education, and defense—the President hoped to restrain the growth of government even as he expanded federal activity into domestic arenas relevant to total Cold War. The most revolutionary issue of all, however, was space exploration. It had so many unique elements, organizational anomalies, and conflicting political implications that the administration's best efforts could not untie its tangles, but only reduce them to a few, tight knots. It was also the issue most closely connected with the new symbolism of politics and technology, and potentially the most expensive.

By the mid-1950s the venerable NACA was slumping. It was the best equipped aeronautical research organization in the world, but institutional conservatism and financial strictures rendered its very future dubious. Jet aircraft were becoming routine, the future lay in spaceflight, but since 1947 NACA's role in rocket research had been circumscribed by the military. To be sure, the NACA participated in the "X-series" of rocket planes that were carried to high altitudes above the California desert then shot upward on their own rockets to record heights. The Bell X-1 first broke the sound barrier in this way in 1947 and soared fourteen miles high. The planned X-15 would eventually reach fifty miles above the earth, the fringes of space. Nevertheless, as late as 1955 only a small portion of the committee's budget went for space-related research, and Chairman Jerome Hunsaker gladly relinquished "the Buck Rogers jobs" to the USAF and JPL. According to JPL luminary Theodor von Kármán, the NACA was "skeptical, conservative, and reticent."[19]

From its peak in World War II, the NACA budget shrank steadily until, in 1954, it received only half of what it asked for. This institutional weakness was due in part to Eisenhower's cost cutting, but NACA also

lacked powerful allies. It channeled only 2 percent of its funds to private contractors, while the military services were pleased to assume tasks in which the committee showed no interest. NACA was an adjunct, not a rival, of the Pentagon and industry. As such it performed well, but if the USAF or army or NRL came to monopolize the next great stage of flight technology, NACA might lose its lease on life. This prospect inspired young NACA engineers, mostly from Edwards AFB and Langley Research Center, to organize a "frontier faction" and agitate for future-oriented programs. Meanwhile, the traditionalist Hunsaker was replaced by Jimmy Doolittle, who not only embraced "Buck Rogers" but commanded respect in Congress, industry, and the military. By October 1957, one-fifth of all NACA work was space-related.[20]

After Sputnik, the timid NACA leaders still held back, however, until internal protest (punctuated by the "young Turks dinner" of December 18) and talk of new space agencies forced them to choose between pushing NACA forward or floundering in the backwash of the Sputnik tide. By mid-January, NACA director Hugh L. Dryden, Doolittle, and chief counsel Paul Dembling had in hand a coherent space program based on NACA in cooperation with the DoD, NSF, NAS, universities, and industry. David challenged the Goliaths for the limitless and potentially richest fiefdom of all—outer space.[21]

In a liberal society government grows by accretion. A foreign threat or new political symbolism can bestow prerogatives on the state that it must exercise if it is to maintain its international status and domestic legitimacy. But once these are acknowledged, struggle ensues within government for control of the new tasks and the budgets and power they confer. Sometimes existing agencies win out, sometimes new ones—such as the AEC—are created. The victorious organization, finding its place in a pluralistic system, can then forge alliances inside and outside of government and sustain itself into the far future, outlasting even the threat or symbolism that first gave it life. Space was likely to be just such a "big ticket" enterprise, and Eisenhower accordingly pursued an apparatus for space R & D that was subservient to the White House, isolated from its most powerful claimants, but still adequate to discharge legitimate space missions for science and defense.

The management of public tasks, therefore, is both a function of policy and an influence on it. Who does something, and how, go far to determine what gets done. Was space technology a military problem rightfully devolving on the DoD? If so, how could space science receive the attention it deserved? If space was awarded to a civilian agency, how would legitimate military functions be performed? Was space inevitably tied to Cold War competition, or could it spawn global cooperation? If competition prevailed, the space program must be national and secret; if cooperation, then international and open. The same questions tormented Truman and the Congress at the time of the Atomic Energy Act: civil or

military control, secret or open; stress on science or weaponry; in-house research by government or contracted research by universities and industry; control of patents by the state or encouragement of private development; international cooperation, regulation, or laissez-faire competition? Atomic energy policy retained these tensions. The main business of the civilian AEC was still warheads for the military; the main research was done at Los Alamos and Livermore, not Westinghouse; the International Atomic Energy Agency and the Atoms for Peace program fell far short of their promise. Could space be handled differently? Or were the nuclear arrangements the best that could be had? The dawn of the Space Age did differ from that of atomic energy in one happy way: the first satellites were peaceful contributions to the IGY, not weapons of war. Perhaps U.S. policy could help to prevent the extension of the Cold War into the serenity of space and head off a literally limitless technology race that would inevitably make the Space Age an age of technocracy for the United States and all the world.

Such reasoning made elevation of the innocuous NACA an attractive answer to the question of what to do about outer space. But competition was strong. As early as December 1957, Medaris and von Braun submitted a fifteen-year space program based on development of heavy boosters by the ABMA. It forecast lunar reconnaissance and two-man satellites by 1962, manned lunar circumnavigation by 1963, and a fifty-man moon base by 1971.[22] The army's ABMA/JPL team gave it the best in-house capacity for the space job—and space, after all, was just "high ground," the taking of which was the army's job.

The USAF meanwhile anxiously monitored the army-navy race to launch the first U.S. satellite and hoped to persuade Washington that space was its rightful domain.[23] USAF public relations specialists promptly invented the term "aerospace" to suggest that air and space were a continuum. The X-15 program meant that the USAF was already working toward manned spaceflight; it possessed the biggest boosters then under development, the Titan and Atlas; and it would soon test the Agena spacecraft for WS-117L. But the navy was also in the game. The NRL inaugurated American satellite research in 1945; it managed the official U.S. satellite project, Vanguard; it, too, had missions in space: satellites for navigation, weather, and fleet communications. And when science fiction wrote of space travel, it always spoke of voyages in *ships*.

The Johnson hearings gave voice to all sides, and each service had its tribunes on the Hill, but senators, too, were perplexed about what to do with space. Johnson's seventeen recommendations only mentioned improved control of space-related work "within the DoD or through the establishment of an independent agency." Backed by special pleaders, "each political participant sought to convince the administration of its own special capability in space by calling loudly for recognition of its skills and resources. It was a veritable 'Anvil Chorus.' "[24] Candidates

"Whew! At First I Thought It Was Sent Up by One of the Other Services"

From *Herblock's Special for Today* (Simon and Schuster, 1958). Originally appeared in the *Washington Post*, November 21, 1957.

included the three services, an independent, unified DoD office, the AEC, the NACA, the NAS and NSF in cooperation with any of the above, a brand-new space agency, or a Cabinet-level Department of Science. The last was an updating of the Kilgore notion, which smacked of socialism to some but was a pet project of Senator Mike Mansfield (D., Mont.).[25]

The military claim to space, on the basis of mission, priority, and capability, was too strong to ignore, while satellite programs currently underway needed at least a temporary home. So in mid-January 1958

EXPLORER 1

Army-navy competition for the honor of launching the first U.S. satellite built to an excruciating climax throughout January 1958. A political cartoonist caught the mood by depicting a Soviet rocket whizzing above a military base, with the brass below gasping in relief, "Whew! For a minute I thought it was launched by one of the other services!"[26] The presumptive reward of victory in the race was an inside track to future space missions. While the ABMA hurriedly prepared a Jupiter-C for launch on the 29th, the navy combed another Vanguard for bugs before its next chance on the 18th. But the NRL pushed the date back to the 23rd, then to the 26th because of rain and technical problems. Finally, a second-stage engine was deemed faulty, and Vanguard missed its chance entirely.

The ABMA, possessed of a thoroughly tested booster and experience at the Cape, geared up in very little time. General Medaris insisted on scanty publicity; he wanted no repetition of the Vanguard debacle in case the worst should happen. High winds in the jet stream stopped the countdown for twenty-four, then forty-eight hours. January 31 would be the army's last hope before Vanguard got another crack. Medaris resumed the countdown. At 10:48 P.M. the Jupiter ignited. The first U.S. spacecraft, like Sputnik four months before, rose like a Roman candle in the dark, lighting up the swamps of the Banana River instead of Asian steppes, free from the humbling competition of God's own sunshine. The guidance system functioned; the upper stages fired. Now there was nothing to do but wait, for perhaps an hour or more, for news from the tracking stations. Medaris fought with the press and his own nerves, Army Secretary Brucker complained from Washington of shortages of coffee and cigarettes. Like Korolev and his comrades, they all acted like expectant fathers. Finally someone shoved a slip of paper into the general's hand: "Goldstone has the bird."[27] *Explorer 1* was in orbit.

Hagerty phoned Eisenhower, who was standing by at the Augusta National Golf Club. "That's wonderful," said Ike. "I surely feel a lot better now." The country felt better, too. But Ike's next thought was characteristic: "Let's not make too great a hullabaloo over this."[28]

Explorer 1 weighed in at 10½ pounds and established a lasting American superiority in miniaturized electronics. The two micrometeoroid detectors, a Geiger counter, and telemetry returned more, and more useful, data than the giant Soviet Sputniks—and discovered the Van Allen radiation belts girdling the earth.

Jupiter and Vanguard each failed in February attempts, but the navy evened the score when the diminutive *Vanguard 1* reached orbit on March 17. Its Geiger counter sent back more data on the Van Allen belts, and its proton-precession magnetometer established beyond the doubt the geologists' suspicions that the earth is pear-shaped. If the Sputniks argued persuasively for the political/military importance of the space technological revolution, the American "moons" proved it to be a scientific leap of unparalleled promise.

Secretary McElroy created the Advanced Research Projects Agency (ARPA) within the DoD, headed by GE executive Roy Johnson and physicist Herbert York. ARPA would run U.S. space programs on an interim basis by authority of the Secretary.

After the welcome relief provided by *Explorer 1*, Killian appointed a PSAC panel to study the space problem, while the bustle and rhetoric on Capitol Hill gave the impression that the administration was indecisive. But Congress, too, had to endure a period of education before reaching conclusions. Senator Clinton Anderson's plea for help from the president of DuPont is indicative. A patron of atomic energy from New Mexico, he was introducing a bill to give the space mission to the AEC:

> I had a professor in math—calculus, I think—who said I could solve most problems in math if I could state them correctly. If I could state my current problem to you, I would probably have it half-solved. My trouble is that I can't.
>
> I went to see LBJ and pointed out that this problem was likely to be tossed into the lap of Congress. . . . I want the military to have the fullest opportunity to push satellites into outer space and to explore outer space for every military reason which now occurs to them.
>
> But if that is the only thing we do, then the Russians, who are very adept at propaganda, will say that the President's program for peaceful uses of outer space is hypocrisy. . . .
>
> I have not tried to foreclose the possibility that the conquest of outer space may be left to a completely separate civilian agency. . . . It may be NACA or NSF should take charge. In my bill I assigned it to the AEC. . . .
>
> Now you can see what considerations of this kind do to an individual whose business life has been devoted to running a little insurance company in a small Western city. . . .[29]

In those same hectic days after *Explorer 1* the Congress organized itself for the Space Age. In so doing, it paid tribute to its extraordinary symbolism. There had not been a new standing committee in the House since 1946, yet the reconvened Congress moved quickly to create committees for space. An aide to Overton Brooks (D., La.) recalled:

> We were staying at the *George Cinq* [Paris] and we came out of the hotel and bought an American language newspaper . . . and here on the front page is the headline—Russia had orbited a satellite. Well, Brooks about jumped out of his skin. He could talk of nothing else. As a matter of fact, we came home two days early. He said, "The first thing I'm going to do when Congress goes back into session is to drop in a bill to form a special committee because we have to catch up with them or surpass them."

Speaker Sam Rayburn agreed, and the committee formed under John W. McCormack (D., Mass.) in early March. But as usual Johnson was first out of the gate. The Senate named its Special Committee on Science and

Astronautics on February 6, with LBJ as chairman and a membership composed of other committee chairmen.[30]

A new congressional committee is no light undertaking. It invariably sparks jealous jurisdictional struggles. The prestigious membership of the space committees was also a testimony to the importance vested in space. Oversight committees for a federal activity guarantee visibility and support, since committees do not generally want to see their federal charges lose budgetary power and importance. Hence the space program, wherever it came to reside, was assured in advance of a strong political alliance. In addition, the special committees gave impetus to a civilian solution, for purely military space activities would remain under the aegis of the armed services committees.

What might Congress do to influence space policy? Here again Anderson's musings give a clue to congressional thinking. His long experience on the Joint Committee on Atomic Energy, Anderson lectured his colleagues, had taught him that "Committee members cannot compete with scientists on their own ground. So we stay in our field—the objective." What ought to be the objectives of a U.S. space program—propaganda, military power, science? "We should not," he continued, "encourage an all-out effort in all three fields. Let one man go and let the two others work as fast as they can." His own pet project was a nuclear rocket, but if immediate propaganda results were deemed the first priority, then the Congress should "turn von Braun loose" on his million-pound-thrust chemical rocket.[31] That, in turn, would suggest a civilian space agency independent of the AEC and the military. Such were the interconnections of politics, organization, and technology.

The PSAC, reporting in just two busy weeks, identified two distinct objectives in space: exploration and control. The PSAC discounted most of the Buck Rogers notions, but granted the military importance of surveillance, meteorology, and communications. Such uses, however, raised questions of international law such as where outer space began, how to allocate radio frequencies, the legality of overflight, and the regulation of space vehicles, since within the ten years orbital space might become a "celestial junkyard." "The problems involved are tremendous and the programs which must be undertaken will be lengthy and costly." All this suggested to the panel the wisdom of a civilian agency. But to be effective, it must have access to the necessary brainpower, which meant freedom from civil service pay scales and restrictions, freedom to draw on all talent inside and outside of government, and broad contractual powers in the private sector. The various civilian options all had their drawbacks. A new space agency would take time to organize and require extensive legislation and facilities. The AEC could be easily expanded, but at the expense of interference with its current function. NACA had the experience in flight technology, but its governing committee was cumbersome and it had only partial relief from

civil service and contractual rules. The new ARPA could take on the whole job without retooling, but that would seem to make spaceflight solely a military enterprise. The United States had lost the prestige of being first; at least it should project an open, peaceful program in contrast to Soviet secrecy. The preliminary PSAC report, therefore, tended to favor the eventual creation of a new Space Exploration Agency by legislation.[32]

Even as the PSAC staff drafted these preliminary thoughts, the heavyweights were moving to a decision. Vice-chairman of the PSAC, James Fisk, and retired General James McCormack, a vice-president of MIT, favored the NACA. The Bureau of the Budget, always hesitant to create new agencies, also favored expansion of the NACA. Gradually, a consensus emerged. McElroy and Quarles, impressed by the history of NACA/DoD cooperaton, came on board. So did Rockefeller, who stressed the importance of a peaceful space program in world opinion, Don K. Price, an advocate for civilian science, and Milton Eisenhower, President of Johns Hopkins University and Ike's brother. The PSAC then concluded that, apart from reconnaissance satellites, the major goals of spaceflight in the near term were scientific and political. "The psychological impact of the Russian satellites suggests that the U.S. cannot afford to have a dangerous rival outdo it in a field which has so firmly caught, and is likely to continue to hold, the imagination of all mankind." An American space organization should leave military satellites in the Pentagon, but otherwise be lodged in an open, civilian agency. NACA was the preferred choice by dint of its experience, facilities, and, not least, "its long history of close and cordial cooperation with the military departments."[33]

As currently constituted, however, NACA was too small. The rocket and space engineers were all in the ABMA, NRL, USAF Ballistic Missile Division, JPL, and the aerospace firms. NACA's basic laws must be amended to tap these sources, to provide for a single director appointed by the President, to free it from civil service, to retain an in-house capacity but permit contracts with private industry, and to provide for coordination with the DoD.[34]

On March 5, Eisenhower approved a final memorandum ordering the BoB to draft a space bill based on NACA before Congress recessed for Easter. Three weeks later the draft was done and, as Senator Johnson sneered, "whizzed through the Pentagon on a motorcycle." Nevertheless, the BoB, ARPA, State, and even NACA's Doolittle had their chance to complain.[35] By and large, they rallied to the administration, but the proposed space agency was already stepping on toes and eliciting yelps that presaged the interagency skirmishes NASA would spark in years to come.

The PSAC moved to support the maturing space act through the release of its essay, "Introduction to Outer Space." It was, to Killian's delight, a best seller.[36] In it the PSAC explained the four reasons why

space technology was important, urgent, and inevitable: (1) man's compelling urge to explore; (2) military security; (3) national prestige; and (4) science. It went on to instruct the public on why satellites "stay up," rocket thrust and staging, what satellites can do in orbit, and the potential for exploration of the moon and Mars. It noted the military value of reconnaissance satellites but denied the efficacy of such things as satellite bombs and moon bases. Finally, it offered a vague timetable for space exploration, beginning with satellites and moon fly-bys, leading "later" to manned flight and "still later" to manned landings on the moon. But the cost, noted PSAC, would not be small. Scientists and the general public must somehow decide if "the results possibly justify the cost" even though scientific research "has never been amenable to rigorous cost accounting in advance."[37]

The administration bill, the National Aeronautics and Space Act of 1958, entered Congress as S. 3609 in early April. The preamble argued that "the general welfare and security" required adequate provision for aeronautical and astronautical activities, and that they should be the responsibility of a civilian agency except where associated with weapons systems, military operations, and defense. The purposes of space activities were the expansion of human knowledge, improvement of aircraft and space vehicles, development of craft to carry instruments and living organisms through space, preservation of the United States as a leader in space science and applications, cooperation with other nations, and optimal utilization of American scientific and engineering resources. The bill established an independent office of government, the National Aeronautics and Space Agency, under a single director. Its Space Board would subsume the old NACA governing board and consist of seventeen members (nine from outside government).[38] The bill met PSAC guidelines and accounted for the various, sometimes conflicting, considerations of space policy. As such, it sketched a controversial structure that satisfied no one fully and placed a stamp of ambiguity on the enterprise that has never been erased. By splitting responsibility between the new NASA and DoD, the bill chartered two parallel space programs, one open, scientific, and devoted to research, the other closed and devoted to military applications. It was also a significant step toward state-directed mobilization of science and technology, but only to ensure that the United States remain *a* leader, not *the* leader in space. It did not commit the nation to an all-out race. It mentioned several goals for space R & D—science, prestige, and so on—but left open the priorities among them. Perhaps a fuzzy mandate was inevitable or even preferable in the unknown matter of spaceflight. But it ensured that the struggle over space policy began, not ended, with the space act.

Congress now had something to chew on. Indeed, the space act attracted more interest on the Hill than anything since atomic energy. While the space committees held hearings, Senator Johnson maneuvered

behind the scenes and tidied up the messier provisions of the bill. Researcher Eilene Galloway ably seconded Senator Johnson and House Majority Leader McCormack in these months with penetrating memos on the issues, the most intractable being the division of responsibility between civilian and military agencies.[39] Johnson himself buttressed the Pentagon's claim to a share of space, but publically identified the United States—and himself—with the peaceful uses of space. "There are three kinds of records that can be made," wrote his staff. "(1) record of the U.S. as a leader in *international* space activity; (2) record of the Congress; (3) record of the Democrats since they control the Congress." LBJ was advised that he had received the most favorable publicity when speaking of the international aspects of outer space. Stressing this aspect in the fight over the space act would create an "opportunity for inspired leadership."[40]

Throughout April, congressional deliberations came to focus on these military-civilian and national-international problems. The administration downplayed military potential, yet the Congress learned from General Schriever and others that the military side of space technology, like pitching in baseball, was 75 to 90 percent of the game. The proposed bill was vague on the division of labor, while the language on the House side seemed to give NASA all responsibility for R & D. The USAF denounced this version and succeeded in rallying NACA, which had no desire to become a fourth armed service, to its position.[41]

After thousands of pages of testimony, the congressional melée resolved itself to one between the House Committee, which stressed civilian control against the presumptuous generals, and the Senate, which played up international cooperation but was anxious to protect the military space role. The House bill called for a liaison committee (modeled on the atomic energy act) to "feed" useful space technology to the Pentagon. The Senate drafted an article creating a National Aeronautics and Space Council composed of Cabinet officers and chaired by the vice president to plan space strategy. But Eisenhower believed such a mechanism endowed space with an unwarranted importance, while the House feared such a high-powered council would subordinate space policy to strategy and diplomacy and shut out the scientists. What institutional arrangement could prevent NASA from co-opting military functions, yet prevent the Pentagon from "swallowing" NASA?[42]

A Senate committee staff memo explained the military-civilian confusion by the fact that "some people are trying to divide things which cannot be divided. . . ." Scientists want to engage in scientific research. "The fact that one scientist wears a uniform while his co-worker wears a civilian suit does not mean that the uniformed scientist is an incipient Napoleon. . . ." Civilian control was a red herring—in a democracy all policy is guided by the elected representatives of the people. "The main reason why we must have a civilian agency," the memo suggested, "is

because of the necessity of negotiating with other nations and the United Nations from some nonmilitary posture."[43] This truth sank in when Johnson and the House leaders sat down to draft a compromise version of the space act. McCormack confided to industrialist Victor Emanuel that "you know 60 percent of it is military, but I am sure the President . . . and the Department of State want to stress in language the civilian approach rather than the military approach for reasons I am sure you can guess." McCormack thought "he did a great deal when he put in the Bill that the [space] agency should cooperate with the military, instead of the military should cooperate with the agency." Management consultant Donald Wilkins admitted that it was "unanimously apparent to the knowledgeable members of the Space Committee, the Atomic Energy Joint Committee, the Foreign Affairs Committee, and the Leadership of both parties in the House that for the next decade it is extremely likely that the dominant agency of the U.S. Government [in space] will be the Department of Defense."[44]

How should such statements be interpreted? Eisenhower knew how vital spy satellites might be, but he purposely played down the general military importance of space in the near term. Johnson did the same. The House leadership was strongly opposed to military control of the space program. Both houses were preparing resolutions endorsing "space for peace" and "the benefit of all mankind." Yet even staunch civilians admitted under their breath the genetic dominance of the military in their new baby. There is no telling which of several explanations apply to any individual, but all the following have their place. First, there was confusion about what militarization of space entailed. Some had in mind ICBMs as well as spacecraft. Others thought of militarization in terms of "ray guns" and "orbital bombs," not passive satellites. Still others grasped that almost all space technology could be put to military as well as civilian use with no way of sorting it out. To ban the Pentagon from using space without an agreement with Moscow would amount to unilateral disarmament. Second, there was widespread concern, born of idealism and propaganda both, that the United States show the world an open space program. Third, perhaps most important, was the growing realization that separation of military and civilian activities was increasingly artificial in an age of scientific warfare and total Cold War. Even scientific programs, under a civilian agency, were tools of competition in so far as an image of technical dynamism was as important as actual weapons. The space program was a paramilitary operation in the Cold War, no matter who ran it. All aspects of national activity were becoming increasingly politicized, if not militarized.

The House passed its version of the space act on June 2; the Senate followed two weeks later. Among the novelties in the House bill was an upgrading of the proposed agency to an administration and its director to an administrator. This was "a mighty promotion in Washington

SPUTNIK III

On May 15, 1958, Korolev's big booster launched one and one-half tons into orbit. The payload included a geophysical laboratory but no animals. At a Soviet-Arab friendship meeting in the Kremlin, Khrushchev told his visitors that the United States would need "very many satellites the size of oranges in order to catch up with the Soviet Union." His country, it seemed, had outstripped the United States in science and technology.[45]

Although the Soviets still dominated the weightlifting category, the numerical score was even. Von Braun launched a second Explorer, the third American satellite, on the twenty-sixth of March.

bureaucratic terms."[46] Another was an article on patent policy borrowed from the atomic energy act. It gave the government sole rights to all inventions derived from NASA-sponsored research. The patent problem, as always, placed in jeopardy the incentives to American industry to help mobilize the nation's talent for the space effort and, ultimately, the principle of free enterprise. If NASA opted for the arsenal system of R & D, the army model recently vindicated by the ABMA satellites, a state monopoly of patents would pose no problem—but it would also make the government the senior partner in the performance as well as funding of R & D. If NASA opted for the contract system of R & D, the USAF model, a measure of private enterprise would remain—but the monopoly of patents would discourage private firms from wholehearted participation. Nor was private assignment of inventions financed by the state good capitalism. The Congress had to decide, therefore, whether the United States would tend toward an outright statist technocracy or a mixed contractor-state technocracy in which the private sector performed public chores.

On July 7 Eisenhower invited LBJ to the White House. The President disapproved of the Senate's space council idea, but Johnson would not sacrifice this assurance that space got the attention it deserved. Instead, he sought to satisfy Eisenhower by making the President himself the National Aeronautics and Space Council (NASC) chairman. Then he could do with it whatever he liked. "Yes, that might do it," said Ike.[47] The House-Senate conference then hammered out a common version. Both the Civil-Military Liaison Committee favored by the House and the space council favored by the Senate survived. The issue of patents, however, reached a deadlock when the House decided to place all NASA-derived inventions in the public domain for anyone's use. The makings of a horse trade emerged when both houses took steps to create permanent, standing space committees. There was talk of a joint committee such as that for atomic energy, but congressmen feared it would be dominated by the prestigious senators. And so, in Johnson's office,

"where two larger than life paintings of him and Lady Bird dominated the room," Johnson surrendered on the joint committee (which he may not have wanted anyway) and McCormack yielded on patents. "That's the sign of a big man," said LBJ.[48] The patents section, longest in the act, conferred on the government all rights to inventions made in NASA programs, but gave the administrator the freedom to waive such rights at his discretion.

The conference bill passed both houses the next day and Eisenhower signed it two weeks later. On October 1, 1958, the NACA would disappear and reemerge as the National Aeronautics and Space Administration (NASA). And when the 1959 Congress reconvened, it would have two new standing committees, the Senate Committee on Aeronautical and Space Sciences and the House Committee on Science and Astronautics. They inherited the chores of trying to sort out, in conjunction with the administration, the unsortable issues of civil-military relations, cooperation versus competition with other nations, the appropriate spending levels for space R & D, and the role of the space program in determining the future relationship between the state and the creation of new knowledge in a capitalist democracy. In subsequent years veterans of PSAC and of the Congress both claimed the civilian space agency as their baby. Both played indispensable roles, as befit the American system. But why either was so eager to take credit for the space act is less clear. It was an extraordinary piece of legislation fashioned in very little time. But it sewed as many snarls as stitches in the fabric of American government.

In response to Sputnik and the national outcry that followed, Eisenhower took initiatives with which he was not wholly comfortable. He accelerated military R & D, approved unprecedented peacetime funding of civilian science, moved the federal government to fund and direct education, and created a new agency dedicated to state-financed and -directed R & D in a critical and "civilian" branch of technology. That he took these steps with misgiving rather than confidence is indicated by his prior attempt to remove the military from basic research, his watch over military spending, his reform measures to tighten control over military R & D, his insistence that the education act was not a precedent, and his decision to make space, as far as possible, a civilian mission under White House control. This is not to minimize the vanguard aspects of his initiatives. Still, Ike hoped to adjust to the apparent demands of the space and missile era, and of total Cold War, without giving over the government to a technocratic faith that he himself rejected. In any case, organization was only a third of the battle. If Eisenhower's delicate balance of vanguard activity checked by rearguard philosophy was to succeed, prudent management would have to be reinforced with unmistakable policy directives and stringent budgeting. Instead, Ike would learn how difficult it is to preserve one's equilibrium and sense of direction in the topsy-turvy canopy of outer space.

CHAPTER 8

A Space Strategy for the United States

Strategy is a form of economy, a function of scarcity: unlimited resources render strategy unnecessary. But according to Eisenhower, American resources were decidedly limited, not because the United States was poor but because it was rich through private enterprise. For the government to sequester too large a share of the national wealth meant to kill the goose that laid the golden eggs. Truman's government was too big, which was why Eisenhower relied more completely on high-technology nuclear deterrents. But high tech might no longer be a cheap option if, as Sputnik suggested, the United States must mobilize more and more to stay ahead of the Soviet technocracy. How could the United States escape this dilemma? What sort of strategy in space best served American national interest?

Space posed two of the overarching international problems of the twentieth century: how to contain expensive arms races despite bitter competition and distrust, and how to manage the use of nonterritorial regions like the sea, air, Antarctica, or outer space, within the system of sovereign, territorial states? The answers to both seemed to lie in treaties—for arms control and international law to fill the legal vacuum in outer space—and neither was really new. Missiles and military spacecraft merely extended the arms race dating from the atomic bomb, while legal questions raised by spaceflight merely extended the quarrel over verification of arms control, especially through "Open Skies." But space also presented some novelties, including the definition of where "air" ended and "space" began.

Scholars had anticipated the problems posed by satellites, and after Sputnik a spate of articles and books appeared on space law. Journalists and congressmen seized on such exercises, either through idealistic urge or the titillation attending questions such as "who owns the moon?" To the administration, abstract theorizing was sterile. For strategy must serve values, and practical steps, while promoting ideals, cannot be a function of them. That is, one cannot establish harmony and a united humanity

simply by wishing them into existence, or eradicate armaments or greed simply by renouncing them oneself. In the tentative atmosphere after Sputnik, two earnest hopes conflicted in the West: hope that the United States might respond with even greater vigor to counter Soviet space power; hope that space could be made off-limits to weaponry altogether. Eisenhower had to allow for all possibilities by speaking of idealism and acting with realism. The dual space program and the space policy derived from it in the first years of the Space Age reflected this complexity. Hence U.S. space strategy aimed at the establishment of a legal regime in space that complemented the American propaganda line of openness and cooperation in space and held out hope of agreements to "put a lid on the arms race," and at the same time preserved American freedom to pursue such military missions in space as were needed to protect and perfect the nuclear deterrent. But the dual thrust of American space strategy also opened the United States to charges of hypocrisy from Moscow and Western critics, which only increased as hopeful rhetoric found little echo in deeds.

The RAND Corporation weighed in first with a study of the political implications of the Space Age. Despite the flights of fancy of some space law theorists, there was no "escape velocity" that took one beyond the political rivalries of this world. The Soviets had already made clear the uses they saw in space triumphs, that is, to support their claims that the USSR was the strongest power on earth, that the U.S. deterrent was obsolete, that smaller countries would do well to expel American bases. Meanwhile, Khrushchev made his usual offers of bilateral accords that would isolate the United States and make its allies feel abandoned. While Sputnik was not likely to smash NATO, "it would be folly to deny that the allies' estimates of the balance of power in the future are based in part on the expectation that Western science and technology will maintain a decisive lead over the Soviet bloc." Hence prestige and perceptions were as important as actual military force. The security of the United States might depend solely on the latter, but the health of the free-world alliance and the liberal values that cemented it depended on continued belief in American dynamism. Space strategy could not dispense with prestige no matter how silly a space race might seem. "From now on, the U.S. should recognize the need for restoring credibility in U.S. superiority, stress our peaceful intentions and their aggressive ones, and *disclose* and *publicize* U.S. outer space activities according, first and foremost, to the effect on the U.S. international position."[1]

A similar analysis emerged from the office of the Secretary of Defense. It insisted that national policy provide for the imminent use of satellites for reconnaissance, tracking, early warning, satellite interception, antimissile systems, communications, navigation, weather forecasting and perhaps control, as well as civilian uses. It stressed the importance of a positive

American position on proposals for space law at the UN and prior consultation with allies lest they make embarrassing proposals out of ignorance of U.S. requirements. But, while freedom of space should be upheld in principle, the right to interdict hostile spacecraft must also be reserved. "There is a real danger that we may harm ourselves by too early commitments before the full implications of space potentials are known. *Our policy and national interest* should be permitted to develop first: the law and commitments should follow, and be consonant with the former."[2]

Diplomatic thinking tended naturally to emphasize an American commitment to space cooperation and UN involvement in space law. But perceived commitment was more important than results. State Department counsel Loftus Becker testified that "any sound body of law is based on a system of facts that we just don't know at the present time with respect to outer space. . . . There is no magic in a rule. The very nature of international law is that it is consensual."[3]

Throughout the first half of 1958, while the space act was drafted and passed, the administration contemplated space law and policy. In the public domain, Eisenhower responded to American and world opinion, to his own hopes for control of technological competition, and to the needs of American propaganda, when he initiated exchanges with the USSR on outer space. In a letter of January 12, 1958, to Nikolai Bulganin, Eisenhower proposed "to solve what I consider to be the most important problem which faces the world today." He suggested that the United States and the USSR agree "at this decisive moment" to use outer space for peaceful purposes only. He recalled the failures of the previous decade regarding atomic power and urged a halt to the testing of missiles in outer space, as well as to their improvement and production. But "the capacity to verify the fulfillment of commitments is of the essence. . . ." Foster Dulles agreed that the time to control space development was now. In ten years it might be too late. Bulganin replied that the USSR was also prepared to discuss ICBMs and that the Soviets endorsed a multilateral petition to the UN including a ban on the military use of space, liquidation of foreign bases, and creation of "appropriate international control" and a UN agency to devise and supervise an international program for launching space rockets.[4]

As usual, however, the two sides divided over procedure. UN Ambassador Lodge called first for a technical study of controls for all missile testing, leading later to a ban on the use of missiles that plied outer space for aggressive purposes. But controls on missiles, as opposed to just spaceflight, would rob the USSR of its mighty ICBMs and offer nothing in return. Besides, wrote Bulganin, it was not the missiles that threatened the world but the warheads they could carry in place of "peaceful sputniks." Of course, the first argument—that banning ICBMs would only hurt the USSR—was the same argument the Soviets rejected

in 1946 when the United States enjoyed a weapons monopoly; and the second argument served no purpose unless the USSR permitted on-site inspection to determine the presence of warheads or sputniks.[5] Throughout the summer of 1958, Khrushchev discussed a nuclear test ban treaty but never agreed to the technical study on means of controlling missiles and space.[6]

In the meantime, Eisenhower ordered the NSC to do its own study and to draft an American strategy for space. Following the 1950 RAND report and the space act, this was the third, and most comprehensive entry, in the documentary history of the U.S. space program. It necessarily involved some compromise among the agencies: the BoB wanted to suppress alarmist language lest space command too many funds; State and the DoD conflicted on the extent of international cooperation to seek in space.[7] But the draft paper was completed and approved by the President in mid-August 1958. It was NSC 5814/1, "Preliminary U.S. Policy on Outer Space."

"The USSR," the document began, "has . . . captured the imagination and admiration of the world." If it maintained superiority in space, it could undermine the prestige and security of the United States. The connection between long-range missiles and space boosters was intimate, but, the NSC declared, missile policy would be treated separately from space. This was a decision of great importance, for it meant that U.S. diplomacy, and thus UN controls, for space would be restricted to satellites. Even a UN agreement on "space for peace," therefore, would not mean a freeze on missile technology. NSC 5814/1 also explained that this policy statement was "preliminary" because the implications of space research were still largely unknown.[8]

What was outer space? The NSC noted that no definition existed, although the question bore on the legality of overflight. It would, however, "appear desirable" to promote a common understanding of the term "outer space as related to particular objects and activities therein."[9] In other words, the United States favored a functional definition of space (an object in orbit was ipso facto in space) rather than a schematic one (space starts fifty miles up). For while the United States did not want to forfeit its freedom to launch satellites of any sort, neither did it wish to give up the right to denounce hostile craft or develop aerospace craft that could fly in the atmosphere *and* orbit in space.

The NSC then underscored the scientific potential of spaceflight and its applicability to civilian and military missions alike. Imminent military systems included satellites for reconnaissance, communications, weather, electronic countermeasures, and navigation. Future missions included manned maintenance and resupply vehicles, manned antisatellite vehicles, bombardment satellites, and lunar stations. "Reconnaissance satellites are of critical importance to U.S. national security," the paper emphasized, and went on to describe the spy satellites then under development. They

would serve missile targeting but also implement "Open Skies" policing of arms control. There were still potentially adverse implications, however, and "studies must be urgently undertaken in order to determine the most favorable framework in which such satellites would operate."[10]

Policy on manned spaceflight was also crucial. Present space research could be carried on with unmanned vehicles, but "the time will undoubtedly come when man's judgment and resourcefulness will be required. . . ." Furthermore no unmanned experiments could substitute for manned flight in psychological effect.[11]

International cooperation also appeared desirable from scientific, political, and psychological standpoints. The United States should cooperate in space so as to enhance its position as a leader in the peaceful uses of space, conserve American resources, speed up space progress by pooling talent, open up the Soviet bloc, and achieve international regulation. But genuine U.S./Soviet collaboration appeared unlikely. In March, at the time of Eisenhower's demarche to Bulganin, an NSC Ad Hoc Working Group on the Monitoring of Long Range Rocket Agreements found that much of the test data required for missile testing could be gleaned in the guise of "peaceful" space launches. It was American policy to try to prohibit the military use of space, but "contingent upon the establishment of effective inspection." Given continued Soviet secrecy, such a policy was probably barren. But since the UN would discuss space questions anyway, the United States ought to "take an imaginative position" in the General Assembly.[12]

The legal problems of space were already manifold, the NSC continued, and more were not even identifiable as yet. "The only foundation for a sound rule of law is a body of ascertained fact." Thus many legal questions could not now be settled. The United States ought to reserve its position on whether celestial bodies were open to national appropriation and declare an insufficient basis for drawing the boundary between air and space. Instead, the United States ought to make an analogy to the proposed treaty on the Antarctic and seek agreement on which activities in space would be permissible or prohibited. "*Generally speaking, rules will have to be evolved gradually* and pragmatically from experience. . . . The field is not suitable for abstract *a priori* codification."[13]

The NSC then lowered its gaze to the steppes where it all began. Conclusive evidence showed that the USSR placed a high priority on spaceflight but would not let it interfere with its ICBM program. The Soviet space program was believed to aim at manned spaceflight for military and/or scientific purposes. It would continue to lead in orbital payload for several years, but the American lead in miniaturization meant that the effectiveness of U.S. satellites was greater on a per-pound-in-orbit basis. The NSC assumed rapid American progress, and made the following prognosis:

Earliest Possible Time Periods of Various Soviet and U.S. Accomplishments in Outer Space

	Soviet[a]	*U.S.*[b]
1. Scientific Earth Satellites (IGY Commitment)	1957–58	1958
2. Reconnaissance Satellites[c]	1958–59	1959–61
3. Recoverable Aeromedical Satellites	1958–59	1959
4. Exploratory Lunar Probes or Lunar Satellites	1958–59	1958–59
5. "Soft" Lunar Landing	1959–60	early 1960
6. Communications Satellites	—	1959–60
7. Manned Recoverable Vehicles		
a. Capsule-type Satellites	1959–60[d]	
b. Glide-type Vehicles	1960–61	1960–63
8. Mars Probe	Aug. 1958[e]	Oct. 1960
9. Venus Probe	June 1959[e]	Jan. 1961
10. 25,000 pound Satellite—manned	1961–62	after 1965
11. Manned Circumlunar Flight	1961–62	1962–64
12. Manned Lunar Landing	after 1965	1968

SOURCE: NSC-5814/1, "Preliminary U.S. Policy on Outer Space," 18 Aug. 1958, p. 16: DDE Library, Office of The Special Assistant for National Security Affairs.
[a] Estimate by the Guided Missile Intelligence Committee of the IAC as of June 3, 1958.
[b] Source: Department of Defense, June 4, 1958.
[c] Defense comment: The United States plans to launch a reconnaissance satellite of approximately 3,000 pounds in later 1959. . . .
[d] The Joint Staff member of GMIC reserves his position on the date 1959.
[e] The Soviets most likely would attempt probes when Venus and Mars are in their most favorable conjunction with the earth for such an undertaking.

These predictions were understood as the "earliest possible" dates. They were not presented as a function of given spending levels, nor could either country meet all the goals in any case. It is still remarkable how optimistic the NSC experts were about the rapidity of space technological development—especially on the Soviet side. If it was U.S. policy to win the space race, its chances seemed slim. The one clear prerequisite to any vigorous American space program, however, was rapid development of big boosters. NSC 5814/1 did not specify program recommendations, but did recommend basic and applied research and exploration to determine the military and nonmilitary potential of outer space, and planning for at least a decade in the future. Immediate action should include "projects which, while having scientific or military value, are designed to achieve a favorable world-wide psychological impact."[14]

In the international arena, the United States must "seek urgently a political framework which will place the uses of U.S. reconnaissance satellites in a political and psychological context more favorable to the U.S. intelligence effort." At the same time, the United States must maintain its position "as the leading advocate of the use of space for peaceful purposes. . . . Recognize UN interests in outer space cooperation, but do not encourage precipitous UN action to establish permanent organizational arrangements." A UN planning committee should be established, but not an international space agency. The United States should also reserve its position on legal issues, but study them urgently.[15]

In the aftermath of NSC 5814/1, Eisenhower's Operations Coordinating Board (OCB), responsible for executing NSC decisions, formed a Working Group on Outer Space. For its first meeting, OCB Vice Chairman Karl Harr drafted a briefing on the importance of space activities, the management of which, "particularly the emphasis on military or non-military aspects thereof," went far to define "the basic attitude and philosophy of all government programs."[16] Preparatory to the UN General Assembly session, the OCB put together coherent policy on international aspects of spaceflight. The State Department saw in this a double goal: the United States must maintain its image as a force for cooperation but also establish "an acceptable policy framework for the WS-117L program as a priority task."[17] But since nothing could be done at the UN without Soviet compliance, what, asked the OCB, was "the feasability of developing a cover for such reconnaissance satellites?"[18]

By the time the General Assembly convened in September, American officials had pondered the wisdom of various approaches to international control of space technology. A maximum solution—complete prohibition of military use of space—required nothing less than a comprehensive arms control treaty including on-site inspection or an operational UN agency to manage space activity. The NSC had already nixed the latter, romantic idea, while the former depended either on a complete change in Soviet policy or on the perfection of satellite reconnaissance, which must, in that case, be exempted from control! A minimum solution offered a better chance of meeting American desiderata, as the OCB concluded in October. The UN delegation should seek to: (1) create an informed and understanding national and world opinion identifying the United States with peaceful uses of space for the benefit of the whole

PIONEER 1

The next event in the space olympics, beyond the first satellite and weightlifting, was "shooting the moon." Smaller rockets made the United States an underdog again, but it made the first try in this round on October 11, 1958, when a Thor-Able (the IRBM plus a modified Vanguard) sent *Pioneer 1* on a trajectory for the moon. The media speculated whether the first country to achieve lunar impact, or plant a flag, or land a man, might "claim" the moon. But one sensitive guest at a Cocoa Beach party, gazing at the heavy half-moon on a languid Florida evening, told an air force officer: "If you try messing up anything as beautiful as that, I hope you miss it by a mile—by a thousand miles!"[19] It did miss, but reached a record distance from earth of 71,300 miles and discovered the radial extent of the Van Allen belts. *Pioneers* 2 and 3 (the latter an army spacecraft) failed in November and December, but returned more data on particle fields in cislunar space.

world; (2) create a worldwide understanding that the U.S. military space program helped to provide the free world with a deterrent against Soviet aggression or control over outer space; (3) promote free world progress in space; (4) establish a global climate of opinion that condoned operation of certain classified space programs. To these ends, the United States should cover its military program with a rhetorical blanket of "space for peace" and define it as vital to deterrence and therefore peaceful. Since the Eastern bloc and other states would oppose or misunderstand American intentions, a minimum of international control was desirable. The OCB foresaw a UN committee to pursue agreement on satellite orbits and radio frequencies, and bilateral cooperation in space science, but nothing more.[20]

The State Department, nevertheless, still hoped for direct U.S./Soviet cooperation in space. The difficulties in sharing strategic technology were obvious, but the gap between appearance and reality in the "space race" was what really stymied such cooperation. The Soviets seemed to be way ahead in space and did all they could to sustain that impression. In fact, they trailed in everything except big boosters and possibly space medicine preparatory to manned flight. Therefore, the United States would gain little from bilateral programs that "gave away" technology to the Soviets, especially since the world would assume it was the United States that sought help in rocketry from the Soviets! The USSR, in turn, had no desire to reveal how backward it really was in overall technology. Dulles, supposedly intractable where the Communists were concerned, was the only leading figure who still favored cooperation with the Soviets. The PSAC and OCB were both skeptical, except for sharing of scientific data "in matters on which we had equality with the USSR."[21]

Nevertheless, the U.S. delegation prepared to make a great display of its concern for international cooperation in space.[22] In September 1958, Dulles called on the UN to take immediate steps for an Ad Hoc Space Committee and study further "organizational arrangements": "As we reach beyond this planet, we should move as truly 'united nations'."[23] Ambassador Lodge renewed his request for Soviet participation in a technical discussion of inspection systems for space technology. In November, even Senator Johnson addressed the General Assembly to demonstrate the unanimity of American opinion behind "space for peace." He asked, among other things, that a UN space committee "consider the future form of internal organization in the UN which would best facilitate cooperation in this field."[24]

Such language could easily be interpreted as an invitation to the UN to assume strict management of all human activity in space. Certainly no enterprise fell more clearly under UN jurisdiction, but neither had any been so charged with the Cold War politics that made the UN ineffective. The Soviets' own resolution called for a ban on all military uses of space, elimination of foreign bases, international control of space,

and a UN agency to include an international program for launching long-range rockets. Having made points with this offer, the Soviets hastily withdrew it and called instead for the same Ad Hoc Committee on space as the United States. But the USSR envisioned a committee made up of three Western, three neutral, and five East bloc countries. The Western proposal named a prospective membership of eighteen that more accurately reflected the physiognomy of the UN, but restricted Soviet-bloc participation to a small minority. On November 24, the General Assembly defeated the Soviet plan and opted, fifty-four to nine, with eighteen abstentions, in favor of the Western resolution.

This vote gave birth to the UN Ad Hoc Committee on the Peaceful Uses of Outer Space (COPUOS), the forum in which space law would be crafted in coming decades. Its first instructions were to survey the resources of the UN relating to space, report on areas of likely cooperation, organize exchange of information, and suggest future organizational and legal problems for UN consideration.[25] The rhetoric was uplifting; the mandate restricted. There would be no UN space agency, no discussion of space disarmament, no action of any kind without agreement between the two space powers. What was more, the USSR protested the "unbalanced" composition of the COPUOS and boycotted the committee's labors.

The circumstances in which space technology emerged, the military and political importance of it for the Superpowers, American policy as drafted by the NSC in 1958, and the deadlock at the UN all meant that there would be no "control at the outset" of space technology. U.S. and Soviet stances both made the outcome inevitable—but whether the outcome was vexatious is itself debatable. The United States surely won out in the short run, for its goals were fulfilled by passage of the Western resolution. "Space for peace" came to be associated primarily with the United States, but there was no danger of its being translated into perverse UN restrictions on national technology. The American formula of space for "peaceful" rather than for explicitly "nonmilitary" purposes also won out and served to guard the U.S. military space programs.

Few diplomatic issues seemed as urgent and loaded with implications for world peace as the law of outer space. Here were a new complex of frightening technologies *and* a virtually limitless medium, opened up simultaneously to human exploitation. And just as the voyages of the Age of Discovery stimulated inquiry into the law of the sea that advanced international law generally through the work of Hugo Grotius and others, so the launching of the Space Age inspired a burst of inquiry on the fundamental principles that ought to guide *all* the deeds of nation-states. The most beguiling legal problems were those tied to sovereignty: could nations claim space; divide it into zones according to some scientific, political, or technical principle; make it off-limits to weaponry;

extend the cooperative framework of the IGY? What legislative and enforcement mechanisms were preferable for space law? What arrangements could be made for advance notice of launches, exchange of data, assessment of liability for damage caused by space vehicles? Who owned the moon or the electromagnetic spectrum? How could space boosters be distinguished from military missiles? Was space development best served by an international effort or by national programs operating under ground rules?[26]

A handful of visionaries tackled such puzzles even before Sputnik. John Cobb Cooper, air law expert and fellow of Princeton's Institute for Advanced Study, took up the question of sovereignty in a 1951 article, reviewing the history of air law from the Romans (who said land ownership extended "*usque ad coelum*") to the great jurisprudential theorists of the seventeenth and eighteenth centuries (Samuel von Pufendorf limited sovereignty in the air to the ability for "effective control"), to the Chicago Convention of 1944 (which recognized complete and exclusive national sovereignty over air space). But how far up did air extend? Sounding rockets revealed that the atmosphere did not just stop, but gradually dissipated. Cooper opted for "effective control" (also the formula chosen by the 1885 Berlin Conference, which set rules for the colonization of Africa). "The territory of each state extends upward into space as far as the scientific progress of any state . . . permits such state to control it."[27]

After Sputnik, numerous proposals were advanced for defining outer space. The so-called von Kármán line set the boundary at the point at which a vehicle traveling seven kilometers per second loses aerodynamic lift and becomes a "spacecraft." Such an event would occur about fifty-three miles up. Cooper and common law (post–October 4, 1957) indicated that space simply stopped at that point below which an orbit could not be sustained. But such "lines" were a function of velocity and therefore of technology, and were in no way innate. Everyone knew where land ended and the ocean began, but now man had entered a realm that, in a real sense, did not exist except as a function of man's own tools. Any definition of outer space was a solipsism.

The critical variable in the definition of space was perceived military interest. The higher the boundary of national sovereignty, the greater the protection against unfriendly overflight, but the lesser the ability to ply the lower reaches of space for any purpose. It was guesswork in 1958 as to which would best suit American or Soviet interests. Similarly, whether a low limit was good or bad depended on the international regime that would obtain in space. If a rigid system of international control was instituted, then national freedom was best served by a high boundary. If a laissez-faire regime arose in space, then national freedom would be greatest by lowering "outer space" as close to the earth as possible: "Open Skies."[28]

These ambiguities gave spacefaring nations no incentive to solve the riddle. State Department counsel Becker explained that the United States, while not recognizing any top limit to its airspace, nevertheless granted that existing space activities conferred the right to ply space wherever it was. In short, the United States believed in "freedom of space," but reserved its position on what that freedom entailed or where it took effect. "Moreover," he continued, "there are very great risks in attempting to transmute a body of law based on one determined set of facts (e.g., air or sea law) into a body of law with respect to which the basic facts have not been determined." The State Department was "inclined to view with great reserve any such suggestions as that the principles of the law of space should be codified. . . ."[29]

The principal concern of American policy was always the protection of spy satellites. But the right to launch satellites over the territory of other states was already established during the IGY. In this connection George J. Feldman, counsel to the Senate Space Committee, declared that security considerations alone would preserve the principle of sovereign air space and work just as powerfully against a definition of where that air space ended. Satellites had already been launched without protest, implying that formal consent to satellite overflight was either unnecessary or implicitly given. "It is tempting to accept the first explanation—which would mean, for example, that President Eisenhower's Open Skies proposal is an accomplished fact. However, any such assumption would be premature and unjustified." Limited agreements on space might be made, but none should be sought "which are more comprehensive or explicit than our present knowledge warrants."[30]

The same caution obtained in debate over sovereignty on heavenly bodies. As early as 1952 a UN lawyer, Oscar Schachter, asked "Who owns the universe?" and worried that we might someday read of colonial rivalries in space, of "lunar Washingtons and New Yorks, perhaps of King George mountains and Stalin craters." He suggested that space and celestial bodies belong, like the high seas, to all mankind. States should be allowed to develop settlements and mineral deposits, but in such a way as not to cause waste and destruction "against the general interest of mankind."[31] The fear of a "scramble for colonies" in space, more rapacious even than the nineteenth century's scramble in Africa, also motivated space law theorists after Sputnik. But if space was not subject to sovereignty, what was its legal status? Was it *res nullius*—space as belonging to no one, but presumably subject to claims? Or *res communis omnium*—space as "the heritage of all mankind" with an implied right for all powers to regulate and reap the benefits of spaceflight? Or *res extra commercium*—with sovereignty and jurisdiction vested in the UN? The first threatened to stampede the powers, but the others implied an international control over national technology that the US and USSR alike were unlikely to accept.

Early discussions of such problems fell roughly into two categories, a fact acknowledged by the leaders of the schools themselves, Andrew Haley and Myres McDougal. The former, an amateur rocketeer turned lawyer, counsel to the ARS and president of the International Astronautical Federation, was the major exponent of the "natural law school." According to Haley, law rested on universal moral principles derived from the nature of man: moral precepts such as the Golden Rule that found expression in all the great religions. Codified natural law theory arose, significantly, in response to the problems posed by European discovery of the New World. But the law of nations, as the moral law of individuals writ large, did not constrain the states of early modern Europe, with unfortunate results. Now the world's governments again faced virgin territory. This time states must join in advance of the conquest of space to set standards and principles of conduct, and so avoid the old pattern of abuse and competition.[32]

The "positivist school" of space law, associated with McDougal of Yale, argued that law emerged from patterns of common usage and could not be invented in advance of knowledge of the facts and emerging national interest. The difficulty in separating military and civilian activities rendered prohibition of the latter all but impossible, and space law in any case would always be a function, not a determinant, of international politics. High-blown principles and futile attempts to shackle the space powers would only make the ideals that inspired the principles appear ridiculous. Instead, the patterns of usage of space must be allowed to establish themselves before codification.[33]

The two schools could aptly be termed the idealist and the realist. The most striking vindication of the realistic positivists was the fact that the secret NSC decisions had already rendered the space law debate academic. The reasons for the Superpowers' aloofness included the one offered in disparagement by the natural law idealists—that nations were obsessed by power and flouted the ethical imperatives imbedded in every human being—*and* the one offered in sweet reason by the positivists—that it would be folly to make artificial rules for a vast area of human activity before the facts were known. Hence the USSR boycotted the Ad Hoc COPUOS entirely, while the United States sharply circumscribed its agenda.[34] The upshot was that discussion would proceed on such things as spacecraft registration and liability, sharing of the radio spectrum and scientific data, but not on restrictions on the development and use of space technology by competing national states. Many space law theorists expressed their disgust with this narrow nationalism and hypocrisy, but their cries of "space for peace" and "space for all mankind" carried no further than if they had been shouted in the vacuum of space itself. The irony is that those enthusiastic about the human adventure in space should have been rejoicing. Competition was the engine of spaceflight. Had space exploration been truly internationalized or demilitarized, the

Superpowers would have had little incentive to make huge investments for its realization. Space programs would have been stunted with malnutrition.

Congress and the press came only gradually to understand. Throughout 1958, "space for peace"—implying demilitarization—seemed an unassailable proposition. A Library of Congress study in February 1958 even sketched out a UN space agency to conduct all exploration—though its authors doubted that the United States would propose it or the Soviets agree to it.[35] But the leaders of both houses of Congress carefully guarded the clauses in the space act that committed the United States to peaceful space exploration for all mankind. In June John McCormack introduced a resolution to "ban the use of outer space for military aggrandizement" and pursue space exploration for "the good of all mankind rather than for the benefit of one nation or group of nations." The purpose of the resolution, which was reported out by the Committee on Foreign Affairs and passed unanimously, was to make clear to the world the repudiation by the American Congress of "narrow nationalism."[36] In July the Senate passed a similar resolution.[37]

This summer of the space act, hearings and resolutions on space law and cooperation, and preparation for the UN General Assembly session marked the zenith of American sentiment for the demilitarization of space. By late autumn the fears of a Soviet Damocles' sword in space had receded (the Sputniks being apparently harmless for the moment), the USSR had declined to participate in initial UN studies, and the U.S. government showed no interest in UN space agencies. By the time Congress reconvened in 1959, its leaders had also presumably been briefed on the importance of distinguishing "peaceful" and "nonmilitary" uses of space. U.S. military space programs, especially spy satellites, did serve peaceful purposes in that they promised to strengthen the deterrent, keep watch on the Soviets, and prevent a Soviet hegemony in space. Demilitarization, therefore, would not serve the cause of peace. As for the Soviet response to U.S. military programs, Sol Horwitz advised LBJ, "The Russians will scream on any occasion they think it desirable to scream." The only way to avoid denunciation was to have no satellite programs at all.[38] In subsequent years, critics on the Left would intermittently denounce American "militarization" of space, but the congressional mainstream never again took "space for peace" to mean closing down the Pentagon space programs.

While American diplomats maneuvered to establish the virtue of military spacecraft, ARPA projects bloomed like Mao's hundred flowers. To be sure, ARPA was given direction of all military space programs precisely to prevent interservice rivalry and runaway R & D programs. But space was unknown, and even skeptics like Roy Johnson and York had to grant that its military potential would never be known except at the cost of chasing up some blind allies.[39] Two philosophies of R & D

SCORE, LUNIKS, AND DISCOVERERS

The Soviet advantage in weightlifting could last only until the American ICBM entered the testing stage. Hastened along by Schriever's "concurrency" tactics, Atlas was ready for an orbital mission by the end of 1958. On December 18 world opinion was stunned by the news that the Americans had placed a four-ton satellite into orbit. This constituted the weight of the entire upper stage, of course—the payload was about 150 pounds—but the United States had learned from the Soviets how to manipulate data. Project Score was also the first communications satellite, a primitive relay device that broadcast Christmas greetings from President Eisenhower to the peoples below. It suited well the NSC requirement for otherwise useful projects designed for propaganda impact.

In January the Soviets entered the moon derby with *Luna 1*. The rocket missed the moon by 3,000 to 4,000 miles, but it sped past into a solar orbit, the first manmade object ever to escape the gravity of the earth.

On the last day of February 1959, a more substantive mission blasted off from the scrub and dunes of Vandenberg AFB, California. A Thor-Able A launched *Discoverer 1*, the first test satellite of the WS-117L program. Lockheed's Agena spacecraft, a cylindrical upper stage measuring about five by twenty feet, carried instrumentation in the front and command, guidance, and propulsion systems in the rear. Once lodged in its polar orbit, the Agena could circle the earth every ninety minutes while the globe rotated beneath it. The first Discoverers carried no film packs, but ultimately they would discharge their photographic intelligence for reentry and recovery in the ocean or by an airborne "snatch."

Discoverer 1 tumbled wildly while in orbit due to malfunction in the stabilization system. *Discoverer 2* (launched April 13, 1959) carried a biomedical capsule. It performed well, but human error resulted in a botched reentry. The capsule landed somewhere in northern Norway and was lost. *Discoverer 3* and *4* failed to orbit, and the next failed to reenter when improper orientation caused it to lurch into a higher orbit when retrorockets fired.[40] Spy satellites proved as tricky as a carnival shooting gallery—but the prize was worth waiting for.

inevitably clashed: the one that saw wisdom in spreading seed money liberally on the expectation that the few winners would soon become evident, and the other suggesting that no poker player ever won over the long haul without folding a few winning hands. The secret of efficient exploratory research was to cancel unpromising programs before they reached the expensive hardware stage. But R & D programs, like federal agencies, tend to acquire lives of their own. Big-ticket items of dubious promise but durable political backing included Project Rover, a nuclear rocket under study by the AEC, and the USAF follow-on to the [illegible] ("dynamic soaring"), a Sänger-type

spaceplane expected to provide the USAF with a manned military space program.

Applications satellites had more promise. The USAF and CIA cooperated, then clashed, over control of Discoverer, and the USAF instigated two more programs, the observation satellite Samos, and the infrared early-warning satellite Midas. They also pushed ahead on designs for communications, navigation, maintenance and repair, weather, and geodesy satellites. These last were especially vital components of the ICBM effort, since precise measurement of the shape of the earth and its gravitational and magnetic fields was a prerequisite to improved missile accuracy. Strange as it may seem, traditional survey methods had never established the exact relationship between the American and Eurasian land masses. Scientific and observation satellites not only located precise targets halfway around the world but increased one's chances of hitting them.[41]

Military space technology suggested other, more alarming novelties. Bombs in orbit had to be studied, if only to demonstrate their impracticality, as well as fractional orbital bombardment systems that traveled the long way around the earth before diving to their target. Since the Soviets would presumably develop their own military space systems, the USAF also researched antisatellite and antimissile weapons. All told, at the very moment when the President signed the space act with its commitment to a civilian program, Budget Director Stans was authorizing $294 million for ARPA and only $242 million for the new NASA.[42] The figures were small, and the balance soon shifted in NASA's favor, but the military space program had a huskier stature than its low profile suggested. In December 1958 the OCB space working group adopted a public information policy on U.S. space activities, and the administration imposed increasingly rigorous ground rules throughout 1959 to reduce publicity of DoD space launches.[43]

Indeed, the military space program caused increasing frustration. In private, civilian officials (not to mention the military) felt no shame about pursuing military advantage in space. Spy satellites in particular promised to be a tremendous boon to free-world defense and the prospects for arms control. Yet the subtleties were lost on most people, especially overseas, and the United States had to preserve its peaceful image. How to protect the coming spy satellites? The Itek Corporation, a contributor to Agena and consultant on space law, reported that "information from overflights of the USSR is now vital for U.S. security. . . . The problem is *not* a problem of technology. It is *not* a problem of vulnerability to Soviet military measures. The problem is one of the political vulnerability of current reconnaissance satellite programs." The Soviets would take powerful countermeasures, just as they had when the United States tried balloons and aircraft. "Satellites are our last chance. Should recon sats be 'politically shot down,' no scientific or technological opportunity can be foreseen to obtain this security information during the forthcoming

critical years. What is needed is a program to put recon sats 'in the white' through early and vigorous political action. . . ."[44] Indeed, the new NASC approved a strong position at the UN opposing "any activities which put unacceptable limits on U.S. freedom of action" in space.[45]

The UN Ad Hoc COPUOS completed its survey in July 1959. Its report waxed enthusiastic on the human benefits promised by satellites: scientific advances of all kinds, better weather forecasting, communications, mapping, navigation, and manned exploration. It pointed up the need for allocation of radio frequencies, registration of spacecraft, and other managerial functions. It made no mention of demilitarization or internationalization of spaceflight. On legal problems, the report endorsed the "freedom of space," stating its belief that, given universal acceptance of IGY satellites, "there may have been initiated the recognition or establishment of a generally accepted rule to the effect that, in principle, outer space is, on conditions of equality, freely available for exploration and use by all. . . ." The COPUOS reasserted the sovereignty of states over air space, but admitted no consensus on where outer space began and did not regard it a priority consideration.[46] In all these matters the American position triumphed.

What had become of Eisenhower's bold invitation to ban or control "outer space missiles"? It was not simply eyewash. Eisenhower put his PSAC on the task of studying the technical potential for a verifiable nuclear and space missile test ban as soon as the committee formed, and it remained one of its most time-consuming activities until the end of his term. But its findings were discouraging. A working group chaired by George Kistiakowsky reported in March 1958 that detection of Soviet rocket tests could be made reliable through expansion of intelligence systems then in place (in Turkey and Iran) and by new techniques under development (spy satellites). But the complications that would arise for space programs were consequential. "A complete prohibition of the launching of all large rockets leaving the atmosphere . . . would freeze the development of ballistic missiles and space vehicles near their present status and would prevent their use for 'peaceful purposes.' " Agreement to permit space launches under a U.S./Soviet or international agency was a possibility, but that would not prevent the USSR from going ahead with an operational ICBM force, if it was ready to go into production at that time. The only way to stop an expanded Soviet missile force was to ban manufacture of warheads and missiles, which posed a far more difficult problem of verification.[47]

Foster Dulles concluded from this evidence that a ban on long-range missile tests must come within the next six to eight months if it was to prevent an operational Soviet ICBM force and permit adequate inspection. After that time, "the only sure method of preventing such a capability would lie in controls on production and deployment which would be very difficult to inspect." He did think an immediate freeze that prevented

Soviet ICBM deployment while U.S. IRBMs were in place might be to American advantage.[48] Thus the United States could retain its foreign-based bombers and intermediate missiles, while the Soviets would have to give up their best means of reaching the United States. Such logic, of course, ensured that the Soviets would ignore such a proposal, which they did when Lodge called for a study of missile test verification in the fall of 1958.

Despite the technical problems, the Soviet snub, and the contradiction embedded in the need for secret reconnaissance satellites to verify a ban on secret rocket programs (!), the notion of a missile freeze persisted. Jerome Wiesner, PSAC member, urged immediate action. If missiles were frozen now, he wrote in November 1959, each side would possess a barely adequate deterrent inhibited by the cost, size, unreliability, and inaccuracy of first-generation ICBMs. A freeze would slow down the missile race, and if it prohibited space shots "as it must to be effective, it would also get the U.S. out of the space race, which otherwise will continue to be a serious source of embarrassment and frustration."[49] But others thought such ideas unrealistic. It was true that the passage of time would make arms control increasingly difficult, but the realistic goal for the next five years, according to arms expert George Rathjens, was not a freeze but an increase in "stability." The United States should court a situation in which the deterrents of both sides were *more* secure so that no one would have an incentive to strike first or retaliate hastily. "Any proposed changes such as a cessation in testing must be examined with regard to whether they increase or decrease stability."[50] In short, the United States could not afford a freeze until its own missile deterrent was assured. In December 1959 the panel again thought a freeze on missiles in the primitive stage had "favorable implications," but warned that it would mean controlling space activities more tightly ("Is this realistic now?") and giving up the pursuit of a more stable deterrent through smaller, mobile missiles.[51]

Thus the two arguments that came to dominate American missile and space policies over the next decades had already surfaced by the end of 1959. The first was that stability, not disarmament, was the key to security in the missile age.[52] Once mutual deterrence was in place, both sides could pursue arms control with preservation of "stability" the determining factor. The second was that a missile test ban would shoot down the space programs of the world, a regrettable development for secular reasons but a tragic strategic contradiction, since ever more sophisticated spy satellites promised a technological end run around Soviet secrecy, itself the greatest barrier to arms control!

Space technology, like atomic power, was not to be controlled at the outset. Instead it would develop according to national interest in an international environment of distrust and competition. Each Superpower

blamed the other for the loss of these critical years after Sputnik when neither the COPUOS nor the UN Ten Nation Disarmament Committee made progress toward agreements on missiles and space technology. Khrushchev spoke of U.S. militarism, Eisenhower of "fleeting opportunities." But the fact was that neither was in a rush to engage even the narrow range of questions within the competence of the COPUOS. U.S. space strategy developed on a line from its initial consideration by RAND in 1950. First and foremost, space was about spying, not because the United States was aggressive but because the USSR was secretive. Whether arms competition or arms control obtained in the future, American space strategy must spin off from its first space program-reconnaissance satellites. This dictated a policy subtle in conception and delicate in execution. The United States must become the champion of "freedom of space," which sounded virtuous (and, in American eyes, was), but translated into a laissez-faire regime for space that other UN members, who tended to identify virtue with "controls," might well take amiss. But Eisenhower, with overwhelming congressional support, also identified the United States with "space for peace" and "space for all mankind," a thread in American policy that stemmed from traditional idealism and respect for the rule of law on the one hand and from Cold War competition for prestige on the other.

The same impulse that gave birth to NASA also produced the line that the U.S. space program was open, peaceful, and cooperative, in contrast to the Soviets. They had been first in space, and were likely to pile up more "firsts" for some time. The United States, at least, could rally its allies and neutrals alike with the promise of a vigorous but salutary space technology in the interests of humanity. All this made sense, even if it meant an abiding awkwardness in U.S. international space policy. But the lack of controls, the impossibility of cooperation, and the continued symbolic importance of space policy and achievement in the eyes of the world also meant that space technology would continue to evolve as a race. Eisenhower accepted, regretfully, the need to keep ahead of the enemy in military technology. He also feared that the technocratic method might come to be applied to civilian pursuits as well. But the peaceful, open image that he wanted to convey for the U.S. space program required precisely that a space race be civilian, not military. Unless Eisenhower and his successors junked the attempt to restore American prestige in space, or chose to ignore world opinion and pursue a heavily military program, then the space program would have to become just what Eisenhower hoped to avoid: a model for the application of the technocratic method to civilian goals.

CHAPTER 9

Sparrow in the Falcon's Nest

If strategic considerations were of surpassing importance in U.S. space policy, what was NASA all about? Was the main reason for a civilian agency, as Johnson's staffer wrote, the need for some nonmilitary body to present to the outside world? Or just for the propaganda value of a civilian space program? Or to conduct basic R & D and space science not immediately of interest to the services? All three played a role, but none of these necessarily implied a large and vigorous space program. Indeed, Eisenhower was skeptical of large-scale prestige programs in space, and a weak NASA fit his "rearguard" predilections concerning the role of government in technological change. But a weak NASA might also fall into the same relationship to the military as its parent NACA, and thus fail even as a showpiece for the civilian space program. If administration policy required the creation of NASA, it also required a willingness to shelter the agency from the military, sustain its image, and nurture it to maturity as a sparrow in a nest of jealous falcons.

The threat to NASA from the DoD was no delusion. For the army, USAF, OSD, and ARPA had all favored either no space agency at all or one patterned on the pliant NACA. The ABMA/JPL team itched for the primary role in space and even after the space act retained a near monopoly over the talents and facilities needed for big space R & D. The tension in Ike's policy for NASA, therefore, stemmed from the need to fashion a strong, competent civilian agency while still restraining the overall space effort. For a strong NASA, buttressed by congressional and industrial friends and feeding on the new symbolism, might itself promote the spread of command technology to wider spheres of civilian government. That was the danger of a space race and hence of placing inordinate value on prestige. The trouble for Eisenhower was, how many more Soviet triumphs could he, and his policies, stand?

The first step in building and controlling the new agency was to choose a suitable administrator. Throughout the spring of 1958 the frontrunner for the job was NACA Director Hugh Dryden. He was a renowned aerodynamicist and manager of research, but his reputation for professional conservatism troubled congressional leaders who wanted