Trinity at Dubna

The Russian nuclear trinity—nuclear designers, spooks and peasants—held its first reunion last May, in the town of Dubna, near Moscow. A lot of skeletons came out to dance in the warm spring sun.

Thomas Reed and Arnold Kramish

In feudal times, society was viewed as being made up of three estates, a "trinity," functioning under the king's beneficence: the Lords Spiritual, the Lords Temporal and the Peasants. For all of its modern aspirations, Stalin's Soviet society of the 1940s and '50s was, in fact, feudal. Certainly that was true of the nuclear community. The respect reserved for the clergy in feudal times went to the security services. The nuclear nobility, the designers, lived well and were accorded full honors. And then there were those who did the tough and dirty work, the peasants. Some were recent graduates in chemistry or physics; no one was concerned by the serious overdoses of radiation that many received. Others were engineers, pursuing one blind alley after another with no time for the ordered exploration of alternatives. Still others were prisoners and soldiers, building the foundations and infrastructure that supported the program. They all were "peasants" in this scheme of things.

The three estates of the Soviet nuclear empire assembled for their first reunion in May 1996. Like many such gatherings, it was a heterogeneous group. Some met in person for the first time, having been but names or numbers to each other in different compartments. Others were once comrades in dangerous and difficult places, circumstances now disappearing into the mists of time. And a few others were curious members of the younger generation, wanting to capture history and to make amends for the activities of their elders. The common thread was the glory of and sacrifices made for the Soviet nuclear weapons program in its massive and relentless quest to break the American nuclear monopoly.

Several hundred Russians and only a few dozen invited visitors attended. Russian was the essential language. There was none of the documentation usually associated with an international conference, such as lists of attendees and copies of papers. What follows are but vignettes, some brief impressions of the Conference on the History of the Soviet Atomic Project ('40s and '50s), known as HISAP-96, that we and our four American colleagues collected. All six of us have experience in nuclear-weapons design, testing and diagnostics. The others were Albert Ghiorso, from Lawrence Berkeley National Laboratory; Nerses H. Krikorian and R. Allen Riley, from Los Alamos National Laboratory; and Peter Moulthrop, from Lawrence Livermore National Laboratory.

Thomas Reed, *who designed two nuclear devices for tests in 1962, was Secretary of the Air Force in the Ford Administration and Special Assistant to the President for National Security Policy in the Reagan Administration. He is currently the head of the Quaker Hill Development Corp and a consultant to the director of Lawrence Livermore National Laboratory.*
Arnold Kramish *was a physicist with the Manhattan Project and the Atomic Energy Commission until 1951, then with the Rand Corp until 1969. He has long been involved in science and technology policy, and is currently an author and consultant to Science Applications International Corp and other organizations.*

Soviet royalty

Joseph Stalin and Lavrenti Beria were the royalty of the Soviet world, by whose leave all others played their dutiful roles. While Stalin had been made aware of the American atomic project during World War II, speakers at the Dubna conference felt that it was not until the devastation of Hiroshima that he understood the global political implications of the Bomb. Thus awakened, on 20 August 1945, Stalin signed the directive according top national priority to the development of an atomic bomb. Beria became the chairman of the Special Committee on the Atomic Bomb, which managed the nuclear-weapons program. Nothing was to be spared in achieving a nuclear capability in the shortest possible time.

Although Beria ran the program, Stalin was involved every step of the way. Conference speakers in Dubna displayed copies of short memoranda to Stalin, written by Beria, transmitting project reports; each memo had a summary and a recommended course of action if a decision was needed.

This was not a thoughtful program. Milestones were to be achieved, not when data would be available or when it would be safe to take action, but by Stalin's birthday or some other arbitrary date chosen for its importance to Soviet history. Speakers referred to the climate of the times in terms of war: "When a key hill must be taken to protect the army, one just sends a platoon and does not ask the cost." The result was a pell-mell rush to break the American monopoly, at any cost in terms of lives, resources or environmental damage. It was, after all, a system of royal decrees.

The lords spiritual—espionage

Vladimir Barkovsky was the senior man at Dubna from the security services. The conference itself had no aura of security or evidence of counterintelligence. Just like a family gathering, with a few invited guests and a bouncer at the door, casual conversations, reminiscences and gossip were everywhere. Even formal talks were often interrupted with cries of, "No, *we* did that first!" and the like.

RUSSIAN NUCLEAR WEAPONS MUSEUM, at Arzamas-16, has many replicas of historic Soviet bombs. At the far left is a model of RDS-2, the first "native" Soviet atomic bomb, detonated at Semipalatinsk on 24 September 1951 with a 40-kiloton yield. Next to it is the first weapon to achieve significant thermonuclear burn—15–20% of its 400-kiloton yield. It used Andrei Sakharov's *sloyka* ("layer cake") principle, and was first tested on 12 August 1953, also at Semipalatinsk. At the far right is the Soviet superbomb, fired at Novaya Zemlya on 30 October 1961, with a yield of about 50 megatons. The Soviets realized that the super had minimal military value but great political usefulness.

Barkovsky, 82, is an elf of a man, with a twinkle in his eye and a dry sense of humor. As a young man he was assigned to the London station in 1941, where he served as the NKVD case officer for technical intelligence throughout the war. (The NKVD was the national intelligence effort, akin to our CIA. After the war it became the KGB, which was split in 1993 into two security services.) Klaus Fuchs, the best-known Soviet spy within the Manhattan Project, was a GRU asset; Barkovsky could stake no claim to that triumph. (The GRU was the Army's intelligence operation, akin to our Defense Intelligence Agency.) Barkovsky was, however, part of the chain that collected the MAUD report (named for Niels Bohr's prewar governess, Maud Ray) in the summer of 1941. This seminal technical document recognized the feasibility of an atomic bomb and advised the British Government to proceed with its development. The advice was welcomed by the scientists and some bureaucrats in Moscow as well, although Beria was not interested. Several authors of MAUD, including Fuchs, Otto Frisch, Joseph Rotblat and Rudolph Peierls, became members of the British mission to Los Alamos.

After the war Barkovsky was assigned to New York where he was NKVD station chief from 1949 to 1956. Despite the conflicts of the Cold War, he requested the assignment because his wife needed good medical attention. From 1956 to 1970 he directed the acquisition of scientific and technical intelligence for the Soviet Union. From 1970 to 1984 Barkovsky had an academic position, as chairman of the department of scientific and technical intelligence at the Andropov Institute of Intelligence in Moscow. He is retired now, but remains a senior advisor to the Russian Foreign Intelligence Service on new directions in the post-Cold-War era.

In his prepared remarks, Barkovsky began with a history of Soviet intelligence efforts. Starting in 1917, the importation of overseas technology was important—"Taking from abroad with both hands" in Lenin's words. Thus the scientific and technical intelligence services focused on the nuclear discoveries of the 1930s without needing to be told to do so. Barkovsky considered Beria "suspicious and ignorant" anyway.

The word "espionage" was not in Barkovsky's talk. His expression was "the united allied scientific effort." Barkovsky reiterated the point that Fuchs, "a hero who did the world a great service," was not paid. Agents were recruited based on ideology "to short-circuit the bureaucracies of allies committed to the defeat of Nazi Germany."

Barkovsky felt that intelligence saved time and thus accelerated the first Soviet test. On the other hand, such information was only useful when fed to technically competent scientists who could correctly interpret the clues being provided. In time, Soviet science moved out on its own and within a dozen years of its first nuclear test, the USSR was making strides fully competitive with the West. The transfer of practical "know how" was much more difficult. While the Soviets had connections into Hanford and Oak Ridge, it was virtually impossible to steal the details of fuel rod reprocessing, metallurgy, weapon fabrication and so forth.

At the conference windup, Barkovsky summed up his position: "This meeting debunks the theory that espionage had the most important role" in developing the Soviet bomb. "The scientific problems were solved by the Soviets." (For amplification of this position, and a detailed chronology, see the article beginning on page 44 by German Goncharov.)

The lords temporal—nuclear designers

Yuri Smirnov, 59, was still in elementary school in the 1940s, when Lev Altshuler, Victor Adamskii, Lev Feoktistov and Goncharov began to grapple with the fundamentals of A-bombs and thermonuclear ignition. They lived well by Soviet standards, but it was not a life of leisure. The necks of their superiors were on the line, and the ax would fall if the first bomb test failed. These gentlemen gathered in Dubna and talked about those days.

Their early problems included visualizing the dynamics of implosions, measuring detonation velocities and pressures, determining equations of state for the new fissionable materials and ascertaining their nuclear cross sections. Later came the thermonuclear stepping stones, the various designs. The speakers tracked thermonuclear history from the Council of Ministers' approval to proceed, in May 1949, to the test of the first solid-fuel, two-stage weapon on 22 November 1955.

On 10 July 1961, Nikita Khrushchev held a meeting in the Kremlin with his senior nuclear design team, Andrei Sakharov included. He told them that the Soviet Union would resume nuclear testing, including atmospheric testing, on September first of that year. He would announce the tests publicly one day in advance. A 100-megaton superbomb was to be included in the test series for maximum political impact. Upon his return to Arzamas-16 (the "closed city" for weapons production now known by its historic name, Sarov), Sakharov selected Victor Adamskii, Yuri Babaev, Yuri Trunev and the newly arrived 24-year-old physicist Yuri Smirnov to pursue the design work on this superbomb.

The work was frantic, and design work continued in parallel with device fabrication. Calculations confirmed that a full 100-MT bomb would create serious radioactive fallout problems for the Soviets, even in a test. Escape by the delivering aircraft would be a challenge as well. The solution to the first problem was to build the test device with some inert components. This would cut the yield in half, but any competent scientist inspecting the bomb debris would recognize its 100 MT potential. The solution to the problem of aircraft escape required a parachute so large that it disrupted the Soviet production of nylon hosiery.

The test, on 30 October 1961, produced 50 MT, the desired political shockwaves, and a place in the *Guiness Book of World Records* for the designers. In the US, a week later, young American scientists of Smirnov's age began to pick apart the bomb debris. They came to the expected conclusions, and several of them came to Dubna 35 years later to meet the designers. (See the box on page 34.)

Smirnov spent four years at Arzamas-16, long enough to oversee the transformation of that bomb into a practical weapon. He then turned his attention to the peaceful uses of underground nuclear explosions. More recently, Smirnov moved on to the Kurchatov Institute, in Moscow, to pursue the study of nuclear history. His design partner, Adamskii, presented a paper at Dubna on the making of the Soviet hydrogen bomb. Smirnov's talk was entitled "The Moral Responsibility of Scientists and Political Leaders in the Nuclear Age."

The peasants—technicians and the rest

More than a decade before the superbomb test, Liya Sokhina collected plutonium oxide from the rafters at the Mayak complex for producing nuclear materials. It had gotten there as a result of a pyrophoric explosion, and her job as a young chemist was to recover it with a dust broom and bag but without benefit of mask or gloves. Sokhina, now 71, received her chemistry degree from Voronezh State University in 1948. She promptly reported to work at Mayak (also called Chelyabinsk-40) where the "A" reactor began operation on 10 June of that year. Her job was to extract plutonium from the reactor's fuel rods and deliver it, in metallic form, to the bomb builders. Of her colleagues, 80% were women; the men were still "at the front" even though WW II was over.

The Radium Institute had devised a processing scheme with a predicted purification coefficient of 10^6. In practice, however, the coefficient turned out to be only 860, so the entire reprocessing system had to be redeveloped from scratch, using only university lab equipment without shielding or health protection of any sort.

On 22 December 1948, the radiochemistry plant received its first irradiated fuel rods, from which 100 mg of Pu were extracted. By February 1949, concentrate containing 15 mg of Pu per liter of very radioactive solution was being produced. Again, there was no shielding of any sort. By the end of March, the first sample of metallic Pu had been produced—all 8.7 grams of it. By the end of June, there was enough Pu for the first bomb, but deliveries continued until August. Assembly tests began on the 18th of that month. The first Soviet A-bomb explosion took place 11 days later. (Soviet nuclear weapons were named RDS-1, RDS-2 and so on. RDS was a code, to which individuals ascribed their own interpretations. To some it was "Stalin's Rocket Engines." To others it became "Russia Does It Alone." But in 1949, in the US, Arnold Kramish dubbed the first shot "Joe-1," in deference to the Soviet leader, Joseph Stalin. This naming protocol became a permanent fixture in the US weapons lexicon.)

In her talk at Dubna, Sokhina described in detail the terrible radiation doses received by the workers, and the complete disregard for the most basic health and safety precautions. "This was a most dangerous place to be . . . typical radiation doses were 100 rad per year . . . we were constantly breathing radioactive aerosols . . . respiratory diseases were widespread . . . many colleagues died in the



THE THREE ESTATES of the Soviet nuclear society were represented at the Dubna conference. Vladimir Barkovsky (left) was an intelligence chief, Yuri Smirnov (center) was a nuclear weapons designer, and Liya Sokhina (right) was a chemist who swept plutonium from the floor and rafters.

1950s . . . the doctors worked heroically . . . but the country depended on us."

Processing efficiencies were equally terrible. Pyrophoric explosions scattered plutonium oxide throughout the building, and cleanup was even needed outside, on the roof, in minus 30 °C weather. "Most of the plutonium went out in waste or ended up on the ceiling as dust . . . only 40% of the metallic Pu made it through fabrication."

And yet Sokhina, a survivor who beat the odds, described those years with pride as unforgettable. "Secrets from the US helped, as did the Smyth Report (see the box on page 34), but Soviet scientists had to do the hard, dangerous work of actually producing plutonium . . . We all remembered the War which had ended only three years before; we worked with famous scientists; we did our duty."

Materials for the witch's cauldron

There is no "secret" to the basics of nuclear weapons. Even terrorists could make a crude one, but in a major city that would still have quite an impact. The only question is efficiency. Experienced designers can coax kilotons of yield from kilograms of bomb materials.

Aside from a modest technical competence then, there are but two requirements for admission to the nuclear club. One, the most expensive, is several kilograms of plutonium or enriched uranium. Political will is the other. The Soviet Union was not lacking in the latter, so it is instructive to see what that nation, as an early proliferant, was willing to pay in terms of lives, resources, and environmental damage to join the nuclear club.

Serious nuclear weapons work in the USSR began in 1943. (Prior to the battle of Stalingrad, November 1942–January 1943, national attention was riveted on survival.) Laboratory No. 2 (now the Kurchatov Institute) in Moscow was organized on 12 April 1943.

During World War II, uranium was in short supply. There was no market for it. In the Soviet Union in 1945 there were about five tonnes of uranium on hand and few known deposits of ore. This lack of material formed the basis of the American belief that a Soviet A-bomb was decades away.

Speakers at the Dubna conference revealed that a stash of 45 tonnes of uranium was located in eastern Germany at the end of the war. Directed by good intelligence, that material was soon liberated. Its delivery to Laboratory No. 2 allowed the Soviets to start work there on the F-1 reactor at once, saving perhaps a year's time.

Simultaneously, a crash effort started to mine known Soviet uranium reserves, in some cases with horses. Soon, 63 000 people were involved. Major national radiological surveys began, with over 250 teams combing the entire USSR. Every geologic survey, no matter what its original purpose, was to look for signs of radioactivity. As a result the Soviet government found 50 uranium deposits with reserves of 84 000 tonnes. In the decade 1945–55, the Soviet uranium inventory grew from 5 tonnes to 6800 tonnes.

Some speakers at Dubna made the case that the presence of uranium mines in the mountains of Germany and Czechoslovakia became a driving force behind the Soviet postwar ambitions in those lands.

Once uranium was in hand, the next steps were uranium enrichment and the construction of plutonium-production reactors. In early 1943 (one speaker set the date as 22 March, another said June) the intelligence services delivered detailed information on the characteristics of plutonium, and that metal soon became the preferred route for the early Soviet weapons program. The first chain reaction in the F-1 reactor was achieved on 25 December 1946. The time from this event to the detonation of Joe-1 on 29 August 1949 (32 months) was virtually the same as the American interval. (Fermi achieved the first chain reaction in the Chicago pile on 2 December 1942. Trinity was detonated on 16 July 1945, 31 months later.) The F-1 reactor continues to operate, on its original uranium fuel, to this day.

On 25 April 1946 the decision was made to create a nuclear-materials-production complex at Mayak, in the southern Urals. There was plenty of available power, developed for wartime industry, and there was a large lake to provide cooling water. The complex was to have three components, the "A" plutonium-production reactor, the "B" radiochemistry (reprocessing) laboratory, and the "V" metallurgical (fabrication) laboratory. Design of a production reactor started in the spring of 1945, before the project was accorded first priority, but it gained enormous financial and human resources thereafter.

The A reactor was to be graphite-moderated and water-cooled. Producing enough pure graphite was a major challenge. On startup, the A reactor used 365 tonnes of 1.7 gm/cm^3 graphite with a neutron-capture cross section of four millibarns.

The reactor was built in a pit 40 meters deep, using 45 000 workers and uncounted thousands of prisoners to dig the pit and build the surrounding infrastructure. Prisoners whose terms ended while working at Mayak were resentenced to longer terms and sent off to Siberia to protect the secret of Mayak.

This regular use of prisoners was one of the many grim violations of human rights that were typical of the Stalin regime, but it had a side benefit to the West. Many of these prisoners were inspired to escape from the USSR after their release, and a few did so, providing Western intelligence with useful insights into the Soviet nuclear program to complement other sources of information.

The A reactor was loaded with 150 tonnes of uranium and started up on 10 June 1948. The reactor then had a multiplication factor of 1.035, enough of a margin to overcome the problem of xenon poisoning—the buildup of neutron-absorbing fission products, which can cause a reactor to go subcritical, bringing the chain reactions to a halt. (Igor Kurchatov had been warned of this problem by intelligence sources.)

Reprocessing of fuel rods started on 22 December 1948, when the first irradiated product was delivered from the reactor to the radiochemistry laboratory. The challenges of that work and the disregard for the health of Soviet citizens were discussed above in Liya Sokhina's story, but some numbers bring the lessons home. In 1949, more than 30% of the people working in the reprocessing plant received 100–400 rads of radiation. (Today, in the US, 5 rads per year is considered acceptable.)

By 1955, 350 000 people were working in the Soviet nuclear effort. Of them, 29 had been awarded (some posthumously) the Stalin Prize and the title "Hero of the Soviet Union." The overwhelming majority of the recipients were in the materials-production complex.

Three Americans in Dubna

To give some perspective to "the American monopoly," three papers were presented at the conference in Dubna by Americans. All three were warmly and enthusiastically received by the Russians.

Early intelligence reports in the US were controversial, although some of them pointed to early Soviet nuclear capability. But the US knew for certain that the monopoly had been broken only when debris from "Joe-1" had been collected and analyzed. (See the article by Herbert Friedman, Luther Lockhardt and Irving Blifford on page 38.) At Dubna, Albert Ghiorso spoke of analyzing the debris from Joe-1 in rainwater from the Naval Research Lab. He had certainly confirmed that the debris was from a plutonium device, but he went still further. By counting the beta-particle emissions from Pu-241, which is made by the double neutron capture of Pu-239, Ghiorso was able to conclude that the production reactor that had generated the bomb material had been running for about a year. Thus the source of the bomb's plutonium and the probable rate of plutonium production was now understood. America had to come to terms with these facts.

Edward Teller had hoped to attend, but was unable to. He asked Tom Reed, an associate at Livermore since the 1960s, to read his paper, titled "The History of the American Hydrogen Bomb," which was warmly received and greatly appreciated. Russian scientists, including German Goncharov (see page 44), illuminated the parallel Soviet "super" program.

But an underlying theme of the Dubna Symposium was the role of espionage. General Groves had authorized Henry de Wolfe Smyth to write a carefully edited account of the Manhattan Project, which was to serve as a guide for what the scientists involved could reveal of their work. The Smyth Report was released a few days after Nagasaki was destroyed, and became a classic in the literature of science. By the end of 1945, tens of thousands of copies of the translated report had been published in the Soviet Union and served as a textbook for project scientists there. However, unknown to US authorities at the time, not only the Smyth Report but much more was already known to the top Soviet nuclear scientists. At Dubna, Arnold Kramish gave a talk about the "lost" chapter 12, written by Hans Bethe after Robert Oppenheimer's strong objections to Smyth's version (which nevertheless prevailed in the final draft).

Products of the system

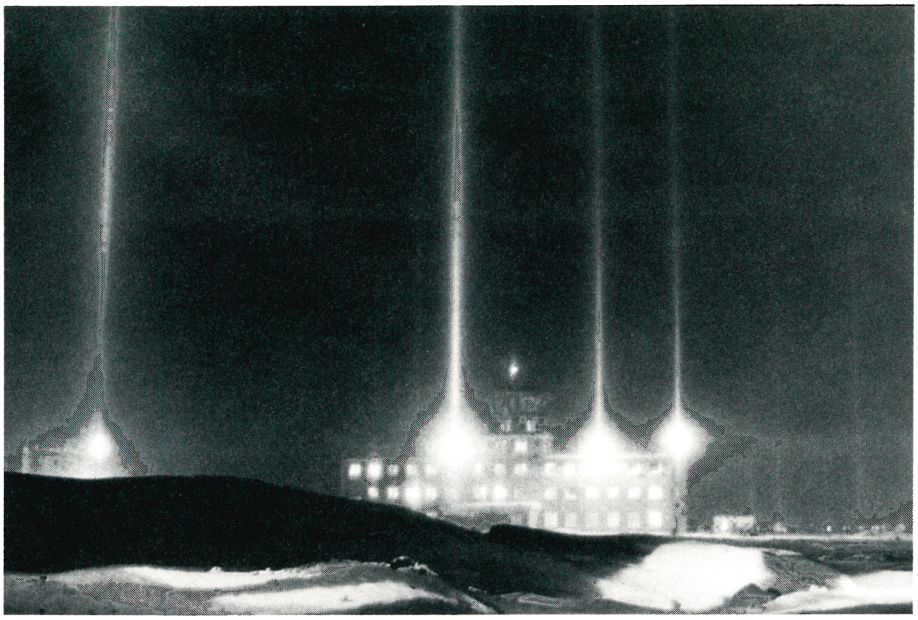
In December 1948, eight months before the first test (Joe-1), the leadership of the weapons program recognized the need for a weapons-production facility. It would be built at Arzamas-16. Stalin signed the authorizing order on 3 March 1949. The facility was sized to produce twenty weapons per year and required sixteen buildings. (To this day, laymen do not recognize the complexities of manufacturing and assembling—or disassembling and destroying—nuclear weapons.) As usual, the infrastructure was built by prisoners and the operating facility by technicians who were virtual prisoners. Arzamas-16 was completed in December 1951, with the first three weapons (RDS-1 designs) inspected and accepted by Scientific Director Yuli Khariton himself. They were already obsolete. The Soviet scientists chafed at relying on the stolen American "Fat Man" design for their first bomb, but the price of failure was execution. Once the Hiroshima-type RDS-1 was in hand, however, they began work on their own weapon. RDS-2 was half the diameter and two-thirds of the weight of RDS-1. It used significantly less weapons-grade uranium and plutonium to achieve twice the yield of RDS-1 when it was tested on 24 September 1951, just as the first RDS-1 production units were being accepted by Khariton.

On 24 March 1947, three months after the start-up of the F-1 reactor in Moscow, but a year before the A reactor went critical at Mayak, the Council of Ministers authorized the start of work on marine power plants. In time submarine reactors were built, but without the involvement of high navy officials. This was done not to maintain secrecy but rather to exclude a bureaucracy too fussy about safety issues. One result was a nuclear-powered submarine, No. 627, accepted in 1963 and capable of 30 knot speeds. (The American Nautilus went to sea in 1955 with an operational speed of 23 knots.) Other results, evident thirty years later, include a generation of radiation-afflicted crews now in naval hospitals, dozens of on-board fires, and a large number of used naval reactors dumped into the Barents Sea and Pacific Ocean. An unofficial byproduct of the Dubna Conference was broad support for Captain Alexander Nikitin of the Russian Navy, now under arrest for exposing this sad environmental record.

Two generations

Boris Altshuler, 57, a physicist at the Lebedev Institute in Moscow, is the son of Lev Altshuler, 83, one of the Grand Old Men of Arzamas-16. Both Altshulers were at Dubna, and both gave talks.

The elder spoke with glowing pride about "Directions and Results" from Arzamas in the 1940s and '50s. He focused on complex implosion assemblies, the need for good equation-of-state data for compressed materials, the



SOVIET HEADQUARTERS for nuclear testing on Novaya Zemlya, above the Arctic Circle. Many nuclear tests were conducted on this large island in northern Russia. Most technicians, however, actually lived at sea aboard a transport ship.

diagnostic innovations employed to derive such data and the resulting success of RDS-2. That device showed that the Soviets could do twice as well as RDS-1/Fat Man if allowed to pursue their own technology.

The younger Altshuler had a different agenda. While he does physics at Lebedev, his card reads "Chair of the Board, Moscow Center for Human Rights." He became very close to Sakharov when the latter fell from favor and was exiled to Gorky. As a result Boris Altshuler became a non-physicist as well. He spent his exile years working as a janitor, but now shares his time between studying quantum gravity and investigating the cost of the Soviet weapons program to that society. His talk at Dubna was titled "Andrei Sakharov—Creator of the Soviet Thermonuclear Weapon: The Problem of Responsibility of a Scientist for Saving Life on Our Planet." Altshuler the younger talked about the terrible cost of pursuing nuclear club membership and about "hundreds of Chernobyls." But his most stunning numbers were economic.

Boris Altshuler has been collecting data on how various nations spent their "national income" during the Cold War. National income is a UN term which includes less than the full gross domestic product (GDP) but much more than just the government's budget. His conclusions: The US spent about 12% of its national income on defense during the height of the Cold War (6–7% of GDP in US terms). At the same time the Soviets were spending over 50% of their national income on their national security programs. (CIA estimates at the time were only 13% of Soviet GDP.) It was a load that crushed the country.

The touching part of all this was not the old man's pride in placing the Soviet Union on its own two technological feet (which he did), nor was it the young man's vision of what Russia could have been and can be now (which it can). It was the timeless Russian love of father and son, each in the front row, terribly proud of the other.

Through the looking glass

Viewed from the West, the scientific veterans gathered at Dubna were a very proud community, with a great deal to be proud about. Their earlier motivation and sense of duty were equally impressive but less understandable. From our point of view, the western democracies posed no threat to anyone. To understand the Soviet drive and determination, one must step to the eastern side of the looking glass, where Stalin applied the optical coating and thus the villains were viewed differently.

The Great Patriotic War had just ended and every survivor had felt its cruelties. The Americans had developed nuclear weapons and had used them in combat. The West had been antagonistic to communism from its birth. And some US military leaders (including Air Force Generals "Tooey" Spaatz, Curtis LeMay, and Lauris Norstad) were advocating "preventive war" against the Soviets. As a result, breaking the American nuclear monopoly was perceived as essential to national survival.

So in closing, we must return to the driving question of this conference—the role of the security services. Speakers repeatedly stated that they did not have the benefit of foreign intelligence. But how would they know? How does one prove a negative? Intelligence products were very tightly controlled. Information would be distributed to one or two people who then appeared as geniuses to their subordinates, because they always made the right guesses. Barkovsky had gallantly minimized the long-term role of intelligence in the Soviet nuclear success story, but he was, after all, a real professional. Unlike his scientific colleagues, he did not tell us anything we did not already know. No Third Man, no long-gone agents, were revealed even though there is incontrovertible evidence that they existed. So the puzzle remains.

But what does it matter? There can be no doubt that the names of Kurchatov and Khariton belong up there with the names of Tchaikovsky, Tsiolkovskii, and Tolstoy, for Russia is a nation that breeds genius. If the Soviet state used not only its arms but also its eyes and ears to build its nuclear power, so be it. It was the Liya Sokhinas who swept the plutonium from the rafters. They deserve our congratulations and, now, our help in recovering from that mad dash. Perhaps another conference will afford recognition to other great scientists—from the generation of the 1960s and '70s.

[For some of the consequences of these weapons programs of decades ago, see "Fissile Material Security in the Post-Cold-War World," by Frank von Hippel (PHYSICS TODAY, June 1995, page 26) and "Nuclear Contamination from Weapons Complexes in the Former Soviet Union and the United States," by Don Bradley, Clyde Frank and Yevgeny Mikerin (PHYSICS TODAY, April 1996, page 40).] ■