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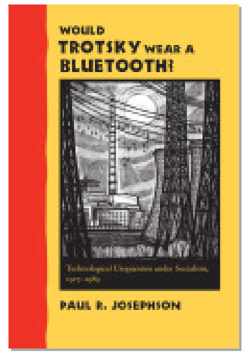

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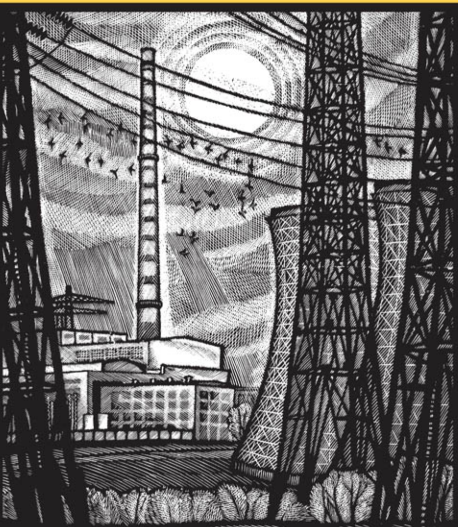

Technological Utopianism under Socialism, 1917–1989

PAUL R. JOSEPHSON

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Technological Utopianism under Socialism, 1917–1989

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Contents

Acknowledgments

On an unseasonably hot summer day in 2002, I visited a lumber mill in Arkhangelsk Province, Russia. It was lunch break, and the gang saws were silent. The mill owner wanted to show me the quality of his finished products, so he rousted the workers from their break. They appeared in sandals and shorts; most of them did not wear shirts, and no one had goggles, ear protection, or hard hats. They turned on the saws, and chips began to fly. When they learned that I was an American, out came the vodka, too, and we had several toasts to the quality of the finished moldings and wood frames. I wondered whether Russian regulations permitted work in that attire and with that beverage, and if safety regulations dating to the Soviet era, many of which were still in force, were that lax.

My research and teaching have enabled me to visit factories, mills, and power generators of various sorts. Their size, noise, steam, and smoke awe, and the people who operate them intrigue me with their matter-of-fact attitude toward the dangerous machines around them. I dedicate this book to the workers in factories under socialism in the hopes that I have described well the world they knew. In particular, I dedicate it to workers, intellectuals, and policy makers who support collective bargaining and have tried to make workplaces safer. My brother, Erik Josephson, who tends the subway tracks in New York City, worries about safety, equity, and justice, and he wears a Bluetooth device to communicate with his comrades.

As for big technologies, for me the bigger, the more intriguing, especially hydroelectric power stations and nuclear reactors, but also mills of various sorts. Over the years I have gained entry to the Chernobyl-type RBMK reactor in Visaginas, Lithuania, including its spent fuel storage basins thanks to Sasha Bolgarov and Andrei Sitnikov, and also spied dry-cask storage of spent fuel rods above ground tended by black-uniformed private guards armed with high-powered assault rifles in Wiscassett along the Atlantic Coast ("Maine's prettiest village"). I have warmed myself by the F-1, the first Soviet reactor, then still operating within the Moscow city limits, and toured the reactors of Obninsk, Chernobyl, and Seabrook, New Hampshire. I have taken my students to the Wyman Dam in central Maine, and I have been told by armed guards with raised rifles to back away when I tried to walk along the top of Grand Coulee Dam on the Columbia River in Washington. In some facilities, I have been invited to participate in the production process and was not alienated from my labor. In a meatpacking plant in Severodvinsk I was allowed to operate the hot-dog-making machine. In a brewery in the same town, my students and I learned about the beer-making industry and sampled the product.

I am enamored of mills that transform some part of nature into a product for consumption, and Maine—like Arkhangelsk Province—is full of them. My Colby students and I have driven three hours in a blizzard down east to the Atlantic salmon fish farm in Machiasport. The proprietors met us with a five-course salmon dinner. The sounds, smells, and colors of the processing facility made an impression on the students, especially the guts vacuum cleaner. Other students have been to the SAPPI pulp and paper mill not far from Skowhegan and to the FMC plant in Rockland, which makes carrageenan out of seaweed.

All of these experiences led me to write this book on technology and socialism. A number of friends and colleagues have kindly offered critical comments on this book, and I would like to thank them. I am deeply grateful to the anonymous reviewer of the manuscript for this book. He or she read carefully, with exacting standards, and insisted on a number of important revisions. Julia Vaingart offered suggestions for chapter 1; Elizabeth Wood offered guidance on chapter 7; and Charles Armstrong, Peter Ditmanson, Walter Hatch, and "CW" Kim helped me better to understand technology in North Korea. Johan Schot and Ruth Oldenziel provided intellectual stimulation for my thinking about technology generally, not only about technology in East Central Europe. Ruth and Sven also kindly opened their home on the Amstel River to me many times, and I know they would have let me stay with them had I needed to request political asylum if Obama lost the presidential election. Malgosia Magurzek and Dagmara Jajesniak-Quast have been tolerant of my efforts to learn about big technology in Poland. Ana Khladnik asked me to think about "grayness" yet again. Pal Germushka, József Sisa, and Kinga Rethy have shared their very good sense of the Hungarian experience with me. Dobrinka Parusheva and Katya Nikova introduced me to Bulgaria and listened to my ideas about Dimitrovgrad. Karl-Erik Michelsen, based on his studies of forestry, nuclear power, engineering, and technology transfer, always patiently explains his notions of the place of technology in the modern world. Hakon With Anderson patiently insists on considering all sides of any question, and through his hospitality he is an example to us all. Jonathan Coopersmith provides the proper levity to scholarship, and his only fault—a large one admittedly—is that he does not like Bartok.

Students and faculty at Pomor State University gave me the opportunity during my sabbatical to compare Soviet and western technology in a systematic fashion, although at first they were confused by the more spontaneous style of the American professor. Aleksei Feldt and Mikhail Suprun in the history department there stand at the forefront of excellent scholarship and teaching. Alexander Beliaev, Sergey Borsky, Olga Deriaeva, Katya Boikova, and all of Severodvinsk assisted in welcoming me to that nuclear shipbuilding city. There I learned about the construction of floating nuclear reactors. Students at Colby College challenge me to refine my ideas about technology by astute comments about my neo-Luddism. My Colby department colleagues help make teaching and writing compatible. Bob Brugger at the Johns Hopkins University Press provided extremely valuable comments on how to expand the scope of my study and increase its rigor. The editors of *History and Technology* and *Slavonic and East European Review* kindly permitted me to republish large parts of previously published articles as the foundations of chapters 4 and 5, respectively.

My thanks to Colby College, the Fulbright Program, the Tensions of Europe Project, and the Davis Center for Russian Studies at Harvard University for providing an intellectual home, financing, or both.

My thanks to my colleague Margaux Leonard for preparing the index.

My deep gratitude to Allan Gamborg and the Gamborg Gallery in Moscow, Russia, for permission to use the prints in this book, and for helping me in my search for Soviet art depicting industrialization and socialist progress.

As always, Roberto Clemente and Willie Stargell inspired me with their modesty, dedication to the task at hand, and humility. Hooper and Blues finally recognize the importance of fences; small-scale, democratic technologies do work. Isaac and Cathy have somehow managed to tolerate my early mornings and long trips, usually let me back into the house without a fight when I return, and generally provide me with a summer construction budget.

Finally, I am delighted to have had the opportunity to write this book in three locations, in each of which friends, colleagues, and family contributed to an engaging intellectual environment: Arkhangelsk, Russia; Cambridge, Massachusetts; and Waterville and Vinalhaven, Maine.

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Would Trotsky Wear a Bluetooth?

Lipa Grigorevich Rojter (1910–94), "Woman at Work," 1932, xylograph. The joys of socialism enable the female and male labor to stride forward, overcoming all obstacles, on the way to building an urban, industrial future. Courtesy of the Allan Gamborg Gallery, Moscow, Russia.

TRACTORS, STEEL MILLS, CONCRETE, AND OTHER JOYS OF SOCIALISM

Magnificent, ornate subway stations; massive hydroelectric power stations producing copious quantities of electricity; collective farms with fields of grain stretching to the horizon; literacy, public health, and other campaigns that succeeded in a matter of years in increasing the well-being of all citizens; universal medical care and free higher education; and an end to unemployment—these achievements of the socialist nations of the twentieth century astounded many observers in the capitalist democracies because of the scale and speed of these feats. A number of observers worried that other nations around the world might succumb to the allure of communism, its unquestioned economic achievements, rapidly growing industrial output and agriculture harvests, as well as the seeming equality of all people, attendant atheism, collectivist ownership of property, and rejection of the sacrosanct profit motive. Yet the fall of the Berlin Wall in 1989 and the breakup of the Soviet Union in 1991 indicated that the socialist experiment failed to measure up to its promises of equality of men and women and minority nationalities, plentiful goods and services, an end to backbreaking labor, and industrialization without the human and environmental costs that befell England, Germany, and the United States in the nineteenth century.

Socialist leaders were convinced that the performance of technology under socialist circumstances—as Marx would say, with socialist productive relations—would far outdistance that under capitalism. They largely viewed technology as value-neutral, independent of the system in which it was created. Even if capitalist engineers and scientists remained politically suspect, the fruits of their labor—based on understandings and applications of universal laws of nature—could serve either the businessman or the proletarian. Indeed, technology was the main engine of progress. Bolshevik leader Leon Trotsky referred to technology, specifically the tractor, as a "cultural tugboat," capable of bringing the peasant and worker into the modern era. For him, technology was the highest form of culture. Sergei Kirov, the Leningrad Party leader until his assassination in 1934 by order of Joseph Stalin, praised the internal combustion engine as worthy of prayer—and this in a nation of official atheism.

In spite of the centrality of modern technology to the economic successes and political legitimacy of the socialist experiment, and in the views of socialist leaders, we remain at an early stage of appreciation of its place in that history. The socialist economies—the Soviet Union, the countries of East Central Europe, North Korea, China, Cuba, and so on—all were at an early stage of economic development. Within a generation they succeeded, in one way or another, in catapulting themselves into the modern industrial world: in the case of the USSR, copying, importing, mimicking, or stealing advanced technology, often from the United States, Sweden, England, and Germany. The next generation of socialist nations drew heavily on the Soviet experience and sought to foster indigenous innovation and diffusion, with varying success, although alternative approaches were limited by the Red Army military occupation of Eastern Europe.[1]

Because of the cold war, the history of technology under socialism has been skewed toward the consideration of military topics; to the space race, nuclear weapons, and nuclear power; and to issues of industrial development.[2] Some of this focus is understandable given the fact that the leaders of the socialist world incessantly touted rapid growth of heavy industry as the sine qua non of their political, social, educational, and ideological systems. Because of cold war competition between the two world systems, capitalist and socialist, many analysts have sought to prove that their technologies—their space shuttles, their rockets, their reactors, their concrete factories and smelters—were first to space, or largest in the world, or perhaps the most prolific in spitting out cubic meters and tons of ingots, prefabricated concrete forms, lumber, and so on. When scholars have considered engineering education, they have focused largely on the contribution of technical specialists to increased output and other stratospheric achievements. They have given inadequate attention, therefore, to Marxist philosophy of technology, the attitudes of Marxian leaders toward technology generally and western technology specifically, and they have only indirectly considered the disjunction between the rhetoric of those leaders and the environmental and human costs of the chosen path to technological development. They have adequately investigated neither the worker's relationship toward socialist technology nor how women workers, peasants, and white collar workers were confronted with the paradoxes of socialist technologies of work and home.

Elsewhere I have argued that the essential features of large-scale technological systems held across political-economic systems. American leaders insisted that their hydroelectric power stations, highways, railroads, and mining and smelting operations benefited the worker directly, reflecting democratic politics. Soviet leaders made the same claims. Yet what I called "brute force technologies" required brute force politics in both systems, and the social and environmental costs of technologies prevailed in both democratic-market systems and authoritarian-planned economic systems.[3] In this book I again alert the reader to those features of technology that hold across systems. These include the leaders' assertions that technologies served the masses, demonstrated the system's superiority over other systems, and reflected democracy on the march. Technology in both systems was a symbol of progress and legitimacy.

Of course, in both capitalism and socialism the worker often paid the price for technological "progress" in low wages, poor housing, pollution, and perhaps even debilitating injury or death in the factory. Often, workers had to give up what was familiar and leave their homes in search of work, or they were forcibly moved to facilitate technology's advance in a new road, railroad, or dam. Even more surprising, efforts to free technological development from unnecessary regulations led officials in several U.S. administrations to adopt policies strikingly similar to their authoritarian counterparts—postponing, weakening, or disregarding laws pertaining to worker safety and pollution control, redefining such ecosystems as wetlands, and so on—that put workers and the environment at risk.

Of greater importance to this book is how socialist technology differed from capitalist: what is socialist about socialist technology? My concern here is how the leaders of the socialist governments in Eastern Europe, the USSR, and North Korea failed to live up to their claims and rhetoric to create socialist societies of technological plenty and ease of labor, in which workers, peasants, and managers alike engaged the production process in farm and factory with joy, and in which metaphorical sunshine prevailed rather than smoke and din. For a series of reasons, the technologies of socialism did not liberate the worker, and in fact the worker lived in greater squalor than his capitalist working brothers and sisters, in closer proximity to dangerous, highly polluting factories, and often without the right even to engage in job actions. First, technologies reflect relations of knowledge and power, so that the import, purchase, or theft of advanced western technology, in particular American and European technology, led to the import of unequal relations between worker and manager in socialism. Second, the socialist nations attempted to reach and surpass the technological West in one generation from largely poor agrarian to industrial societies. This led to investment decisions emphasizing industry over labor and heavy industry over light industry. Third, fearing imminent attack from fascist or other capitalist regimes, socialist leaders insisted on industrial development at all costs, ignoring investment in housing, schools, public health, and other sectors of the economy. Fourth, perhaps more than in other systems, socialist leaders saw large-scale technologies as symbols of their legitimacy that must be built by armies of laborers in short order. As a result (as the chapters in this book explore), they ignored worker safety; saw greater value in big dams, nuclear reactors, subways, and metallurgical factories than in housing and consumer goods ("concrete" not "kimchi"); and liberated women to work in factories but not from traditional family roles. They threw together dozens of smoke-belching factories that have destroyed the natural environment, leading to the creation of "industrial deserts." Further, in developing client states, the USSR exerted a tremendous influence on the technological style adopted in other countries that often rivaled indigenous traditions and engineering practices.

I use the word *socialist* because, in spite of their claims, no socialist society achieved fully the essential features of communism, including a classless society and an end to alienation of the worker from the machine. Indeed, Nikita Khrushchev caused his successors great embarrassment by promising to achieve communism by 1980 in the Third Party Program passed under his chairmanship at the Twenty-Second Party Congress in 1961. Feeling embarrassment over the realization that the USSR would not come close to the 1980 target, Leonid Brezhnev nevertheless proudly defined another stage of economic development on the road to communism: "developed socialism." This engendered the Soviet joke that yet one more stage awaited on the way to the glorious communist future: alcoholism.

In these essays I intend to begin a conversation to consider what was *socialist* about socialist technology and, in comparison with the technological experience in the West, primarily that of the United States, to determine what we can learn about the always crucial issues of safety, efficiency, justice, gender, environmental degradation, and so on, that are intimately tied to the development and diffusion of any technology but have surely been overlooked by analysts of the socialist experience. Socialist leaders and engineers recognized that technology has politics. They used technology as a tool of state power and legitimacy in their headlong pursuit of industrial growth and military might. During the cold war, spokespeople of the capitalist and socialist worlds insisted that their technologies were the best, fastest, and most efficient; that they benefited all citizens; and, in rhetoric if not in reality, that they demonstrated the ideological superiority and legitimacy of those regimes. Yet socialist leaders did not fully recognize—or publicly admit—that the paths they chose to achieve high output or to record great tonnages required a subservient relationship of the citizen to their plans and technologies. The socialist leader, engineer, and manager claimed equality of all citizens before technology, and they insisted that the worker would relish labor in clean, well-illuminated, and safe facilities. They believed that liberation of women from exploitation and patriarchal institutions would also accompany the diffusion of socialist technology. But the exhausting and dangerous experience of the worker in the factory, the deadening experience of the housewife/laborer at work and at home, and the subjugation of indigenous peoples to an inflexible ideology of modernization based on the unhesitating embrace of technology revealed quite another politics. In this book I investigate the rhetoric and reality of socialist technology in a series of settings and decades to evaluate the human and environmental costs of the technological experience.

The Russian Revolution and Technological Culture

Marxist philosophers, theorists, and leaders generally held a determinist view of modern technology as the engine of social progress and of its inevitable advance as the key to the transition from capitalism to socialism. Vladimir Lenin and Leon Trotsky saw technology as a panacea for the unfolding socialist society.[4] Surprisingly, Lenin, Trotsky, Kim Il Sung, and other communist leaders shared the views of their American counterparts about the place of technology in modern society. It was, perhaps tautologically, an engine of modernization that enabled rapid transformation of agrarian societies into industrial powerhouses. It freed workers from arduous labor. Rather than the smoke-belching, dark, and dangerous factories that existed under capitalism, well-illuminated, spacious, well-ventilated, and safe factories would arise under socialism. Crucial to the building of the socialist factory was the production of copious amounts of electricity; electricity would power agriculture and forestry as well. Other Marxist scholars stressed the apolitical nature of technology; the same technology that alienated workers in capitalism would liberate them in socialism. The productive relations, not productive forces, were the crucial factor. Did Marx and Engels share this enthusiasm for technology?

Marx and Engels argued in many places in their voluminous writings that the development of the productive forces—the means of production, tools, implements, machinery and equipment, and "technology" generally—drives the development of society. Adopting a seemingly technologically determinist argument, they put great store in socialism arising inevitably from capitalism when the productive forces have reached a given level of development. G. A. Cohen argues that Marxism is economically determinist, with the economy the driving force of history.[5] Donald MacKenzie has taken exception with this view, concluding through a careful reading of *The German Ideology*, *Capital*, *Grundrisse*, and other works that relations of production can and do hold back the forces of production; people do matter in history. Further, according to MacKenzie, Marx argues that capitalism arises not from changes in technology, but from changes in social relations, for example, in the emergence of a class of propertyless laborers. MacKenzie notes that the technological form of labor of mill workers (the mill) had not changed; the fact that they did not own it had changed their relationship to the technology.[6] A number of Marxist scholars eventually voiced critical evaluations of the place of technology in modern society. For example, Herbert Marcuse argued that technology was a potential tool not only of liberation but of enslavement in both capitalist and socialist systems that tended toward convergence.[7] But while MacKenzie effectively demonstrates that Marx did not argue that "machines drive history," one can argue that, according to Marx, technological change impels social change, and that transformation of the material basis of society is crucial to the socialist future. More important Soviet writers sanguinely asserted that machines *do* drive history. They expected to drive on tractors and other machines powered by electricity off into the socialist sunset.

Most Soviet leaders and political theorists never explicitly addressed technology from a philosophical, social, or political standpoint. We may infer from some of their pronouncements that many of them believed that technology was the highest form of modern culture, and that engineers and specialists would contribute centrally to the construction of the socialist future. Accordingly, they recognized that America, with its assembly lines and mass production of so many different goods and services, and with its high degree of standardization of processes, possessed precisely this highest technological culture. Certainly Lenin, Trotsky, and a number of other leaders had no problem borrowing from the West, let alone stating the obvious: that the USSR lagged behind Europe and America in technology. What remained was to acquire that technology, through importation, copying and reverse engineering, turnkey agreements, espionage, and theft. In the Soviet period, leaders and engineers fetishized standards and mass production, with five or six basic designs serving most apartments and other construction. They created a unitary system where, for example, only two factories, Elektrosila and the Kharkiv Turbine Works, produced virtually all of the large turbogenerators for the entire empire, another three all of the tractors, and even one, Atommash, was designed to mass-produce eight pressure vessels and associated equipment for 1,000 megawatt (MW) electric reactors annually à la Henry Ford. There would be no wasteful competition or foolish duplication of effort.

The followers of Stalin had a more narrow view of technology and its masters. Socialist leaders grew to fear not only those bourgeois experts on whom they relied to ignite the engine of socialism, but ultimately those engineers who were entirely trained within the socialist system. They orchestrated show trials to punish engineers for alleged "wrecking" and sabotage of projects. They arrested and shot many of them. They worried about the technocratic impulse that had given rise to such phenomena as America, Incorporated, in the United States in the 1930s.[8] Still, they recognized the need to industrialize rapidly on the basis of the world's most modern technology. They established educational and research institutes to foster indigenous innovation, but they created so many planning, bureaucratic, and other obstacles to innovation that they often had to import critical technologies from the West or to reverse-engineer many systems, from airplanes to computers, with the result of a built-in and persistent lag.[9] Because of the fear of financial, professional, or even criminal punishments, engineers were often afraid to push innovations with long-term promise if they meant short-term failures to meet output targets, and this hesitation led in a number of cases to rudimentary designs and inadequate consideration of safety or pollution features.

Marxist revolutions succeeded in agrarian economies, not industrial economies as Marx and Engels had anticipated. This had an impact on Soviet technological style by often requiring socialist engineers to play catch-up. Lenin asserted in *The Development of Capitalism in Russia* (1895) that Tsarist Russia had achieved the capitalist stage, a working class had formed, class struggle between the bourgeoisie and proletariat had intensified, and the nation was ripe for revolution. Yet many fellow Marxists disagreed with Lenin. Marx and Engels anticipated revolutions in industrial economies of plenty, not agrarian economies of want, where it would be an easier matter to create the workers' paradise. Many Russian Marxists, most importantly the Bolsheviks' major prerevolutionary rival, the Mensheviks, argued that it was premature to seize power and attempt to build socialism given the poorly developed industry and infrastructure, the relatively small and certainly unskilled workforce, and the fact that the vast majority of citizens were illiterate peasants who eked out existence with traditional hand tools.

Modern science and technology, which were central features of industry and agriculture in such countries as Germany, England, France, and the United States, had had only a minor impact on the Tsarist economy. Russian industry to a great extent relied on technology transfer from Europe and still largely produced raw materials while importing finished goods. The backwardness of Russia's military, transportation, and other sectors became fully noticeable during World War I. As for agriculture, no such thing as land-grant universities or systematic research existed. In country after country where Marxian revolutions succeeded, this lag in science, technology, and industrial development handicapped the attempt to build societies of plenty. The efforts to build modern industry; collectivize agriculture; fight off perceived internal and external enemies; establish social welfare nets, universal literacy, and education; and redistribute wealth fell short in so many ways. Granted, the USSR industrialized rapidly under Stalin, achieving in a few decades what may have taken longer in Europe. In spite of such achievements as production of iron and concrete, and later of *Sputnik* and tokamak fusion reactors, the workers remained poor, often lived in overcrowded and foul-smelling communal apartments if they had housing at all, and stood in lines for basic goods and services.

A number of leading liberal and leftist members of the Russian intelligentsia worried about the "backwardness" of the masses. By backwardness they meant the entire worldview of the peasant, his superstition and orthodox religious beliefs that made him resistant to change, his poverty, his lack of education, and other impediments to improving agricultural production and extending the market from local to national and international arenas. They believed that modern, western science was a major tool in the struggle with backwardness. The playwright Maxim Gorky joined with the agronomist Klement Timiriazev in 1916 to form a mouthful of an organization, the Free Association for the Development and Dissemination of the Positive Sciences (known by its Russian acronym, SARRPN), with the stated purposes of overcoming the *muzhik*'s (peasant or, better still, country bumpkin) narrow worldview and making him a citizen in a world of unlimited horizons.[10] In East Central Europe and North Korea communist leaders encountered similar challenges of economic lag and conservative resistance among peasants.

Because of the lag in technological acumen among the masses, the Bolshevik state became the prime mover behind the deployment of the machine and the factory, with the resulting technological style that placed the machine above citizen and had a decidedly negative impact on nature and worker alike. This attitude and impact spread inexorably from Moscow and Leningrad to Warsaw and Nowa Huta, Poland; Sofia and Dimitrovgrad, Bulgaria; Budapest and Sztalinvaros, Hungary; Pyongyang, North Korea; and beyond. The central role of the state in technological development persists in post-Soviet Russia in the space and nuclear power programs. Technologies designed and imposed impatiently without citizen input worked with brute force, not efficiency, leaving behind huge, hulking factories, open pit mines, clear-cut forests, polluted rivers and streams, filthy air, and hazardous waste. The worker—both the male and female worker—was supposed to be the beneficiary of socialist technology but remained the exploited afterthought.

One can make a strong case for overriding similarities in the embrace of modern technology in the capitalist and socialist states of the twentieth century. In both systems state power was crucial to the processes of research, development, innovation, and diffusion. In both, large-scale approaches predominated in most sectors of the economy, from transport to energy, from mining to metallurgy, from food production to education. Engineers and scientists, as products of the Enlightenment, viewed nature with a longing to improve it for the benefit of humankind, and they did not lack modesty about their ability to do so, what I have described as "technological hubris" elsewhere. Many of them see technology as a panacea for the various ailments of society: poverty, scarcity, hunger, illiteracy, poor health, and so on. Drawing on the history of a variety of technologies in the socialist world, I investigate these utopian aspects of modern technology, how socialist leaders ran smack into the realities of nations that lagged far behind their European and North American counterparts, how overriding political considerations deflected them from goals of using technology to benefit citizens equally, and yet the tremendous accomplishments of socialist states from East Central Europe to the USSR to Korea in transforming economic, educational, and social institutions literally overnight. In some cases, I offer implicit and occasionally explicit comparisons with the capitalist world.

Another question is to what extent technological choices facilitated or handicapped the efforts of socialist leaders, planners, and engineers to build socialism. Given that most of them believed that technology was value-neutral, a tool of great promise that might be abused (in capitalism) or used for the benefit of man and woman (under socialism), they believed it paramount to borrow technology liberally from the West, in particular from the United States and the European industrial powers, for application in hydroelectricity, metallurgy, transport, agriculture—virtually everywhere. They reveled in Fordism and Taylorism to increase production and productivity of labor. When they imported western technology, did they also import such constraints as labor-management disputes, problems in the training of personnel, problems in the effective operation of machinery and equipment, and so on? And, in developing "socialist technology"—what *was* socialist technology?—in what ways was it distinct from capitalist technology, if at all? The breakup of the USSR and the fall of the wall across Eastern Europe permit consideration of these and other questions, given the ability to engage in extensive field research, gain access to archives that were closed, and visit libraries and local and regional museums, all to get a better understanding of the social, political, and cultural contexts for technology. Recently, the leaders of North Korea have also permitted greater access to the nation, although it remains largely a closed society.

In the following chapters I explore the place of technology under socialism as a symbol, an engine of progress, and an all-too-real force of political, economic, and cultural change. I highlight the utopian aspects of the quest for modern technology to solve economic and social challenges that faced such nations as the Soviet Union, the People's Republic of North Korea, and the newly socialist countries of East Central Europe in the postwar world. I evaluate the technological experience in the USSR, Eastern Europe, and North Korea according to the rhetoric of socialist leaders, not according to some arbitrary, universal standard, nor in order to prove that capitalism is a better system, yet implicitly and explicitly in comparisons with the technological experience in the

United States, in large part because those nations often measured their success in relation to the United States. Leon Trotsky certainly measured Soviet achievements against those of the United States. He saw uses for the most modern technology of his day—the airplane, the radio, the railroad, and especially the assembly line—as a panacea for Soviet backwardness. He used the printing press and the locomotive to secure victory as he rushed from breach to breach during the civil war as Commissariat of War and organizer of the Red Army.

Did modern technology liberate the socialist worker? Did the quality of life improve? Did the worker not gain universal health care, overcome illiteracy, abandon superstition, and become a citizen in civic society? Did a new ruling class form with new beneficiaries and new sufferers? Were local peoples and indigenous peoples and peasants forced to conform to new ways of life? Furthermore, weren't the social, environmental, and cultural costs of the headlong push to modernize as great as those under capitalism? If this was the case, what does this tell us about the power of technology to shape our lives?

Shockingly, the socialist states failed to live up to the rhetoric of their claims that technology serves the masses in ways that are more complete and better than in capitalist systems. Rather, the socialist citizen endured a lower quality of life or standard of living, less attention to worker health and safety, and inadequate concern about housing, the environment, and health care. In chapter 1 I answer the rhetorical question about whether Trotsky would wear a Bluetooth. Yes, Trotsky believed that the embrace of advanced technology was the path to communism. It would raise industrial production, overcome the abyss between city and countryside, and promote a modern worldview among the peasantry. Trotsky's writings remain largely ignored because of the successful effort by Stalin to excise him from Soviet history. But an examination of his views reveals that Trotsky was not alone in recognizing how far the country lagged behind the West. Yet if other leaders shared this view, they achieved no consensus as to what steps to take to overcome the lag. During the Stalin era, if the Bolsheviks worried about the lag and insisted on making it up within a few short years, they also adopted autarkic economic relations that handicapped the effort to industrialize rapidly.

Millions of Ukrainian peasants perished during the collectivization campaign. Millions of others perished in gulag labor camps intended to provide cheap labor for road construction, forestry enterprises, and mining and smelting operations. Although the human and environmental costs of industrialization and collectivization were undoubted, Soviet leaders insisted that the East European client states follow the same paths. The similarities concerning rapid industrialization in Poland, Hungary, Bulgaria, and other countries extended to technology—machinery, equipment, factory organization, urban planning, and so on—everywhere, but especially in newly built "hero" or "production" cities dedicated initially to Stalin (chapter 2). As a consequence, political choices, resource constraints, and fascination with mass production conspired to create a landscape eerily recognizable to anyone who has visited socialist spaces in Hungary, Bulgaria, Romania, Poland, or Eastern Germany, even fifteen years after the fall of communism. A kind of grayness of life prevailed east of the Elbe River because of the "proletarian aesthetics" of the technologies of life and work. Grayness extended to modern nuclear technologies as well.

Stalin's legacy spread far beyond the borders of the USSR to technologies and countries into the twenty-first century, particularly on the Korean Peninsula (chapter 3). Great Leader Kim Il Sung embraced large-scale technological systems for the Democratic People's Republic of Korea that reflected the Stalinist emphasis on heavy industry, massive scale, and collectivized agriculture. This emphasis resulted in depravations that rival Stalin's depravations of the Ukrainian peasant in the 1930s. Rather than provide good, inexpensive housing or adequate food, Great Leader emphasized the need for independence from all economic entanglements. This required tremendous self-sacrifice in housing, health care, transportation, and food. Metaphorically, the citizen had to give up kimchi, the hot pickled vegetable delicacy of Korean culture, for concrete structures.

A surprising continuity exists in socialist technologies in Russia in the twenty-first century. For a variety of reasons, the Russian nuclear ministry, RosAtom, is striving to rejuvenate the nuclear industry that stagnated after the Chernobyl disaster. The reasons include a geographical disjunction between fossil fuel resources, mostly in Siberia and the Far North, and population and industrial centers, mostly in European Russia, and a desire for continued status as a nuclear power among Russian leaders. Indeed, nuclear technology is one of the few technologies that Russia can sell on international markets, and it is a major actor in the development of the Iranian civilian nuclear power industry. Even more, Russian engineers maintain Soviet-era hubris about the promise of nuclear power. The design and construction of floating nuclear power stations, with the promise of sales to Morocco, Namibia, and elsewhere, suggest great continuity with the Soviet past, while greater openness in dealing with nuclear safety indicates changes in practices and attitudes. As a comparison with the nuclear industry in the United States shows, however, in order to be viable, engineers must address openly and honestly the problem of waste disposal (a sixty-year-old problem); the need to site reactors far from population centers for safety; and the true costs of construction, operation, and transmission. Without a strong state and government subsidies, nuclear power may simply not be economically viable (chapter 4).

Nuclear power was only one of the major contributors to a dreadful legacy of pollution and hazardous waste. The legacy of socialist technology is most obvious in its environmental impact, especially in metallurgical and mining operations. From Eisenhüttenstadt in Eastern Germany to Pyongyang, from Murmansk and Severomorsk on the Arctic Sea to the Aral Sea of Central Asia, the socialist worker toiled not in the glorious garden of plenty but amid dumps of radioactive waste, heavy metals, and petrochemicals, not in field rows of grain, but in erosion. The engineers who brought about this situation had a variety of fields of expertise—including pipe fitting. They carried out a self-proclaimed war on nature to force it to operate according to plan. The result was industrial deserts—vast regions devoid of much vegetation yet home to millions of people—in such regions as the Ural Mountains, whose industrial development is the focus of chapter 5.

Chapter 6, on historical, cultural, and psychological aspects of worker safety and risk in Soviet society, asks why the metaphorical hard hat found no role in socialist industry. The Stalinist emphasis on industrial production ensured that the workplace, the public sphere, and the home would all permit risky practices and behaviors not tolerated in other systems. Both manager and worker came to see accidents as unavoidable, if unfortunate. Their fatalism contributed to an epidemic of injuries and to their indifference toward the frequency. Perhaps no one seriously believed that greater safety would result from greater "discipline" in the face of crippling machines and exhortations to stop drinking. The call for discipline reflected an effort always to blame the worker, not the machine, while drink made monotonous and dangerous work occasionally bearable.

And what of the female worker, the female collective farm laborer, the housewife whose responsibility it was to get the drunken man off the sofa and out the door to work, to dress the children and get them to school, and to provide a communist upbringing on the way to raising pliant, devoted citizens? What of the dual role of the socialist woman to maintain the home and hold down a second full-time job? I am a novice on questions of technology and gender, but I have tried in the last chapter of this book to engage the reader on the paradoxes of socialist liberation, pro-natalist policies, and technology in Stalinist Russia.

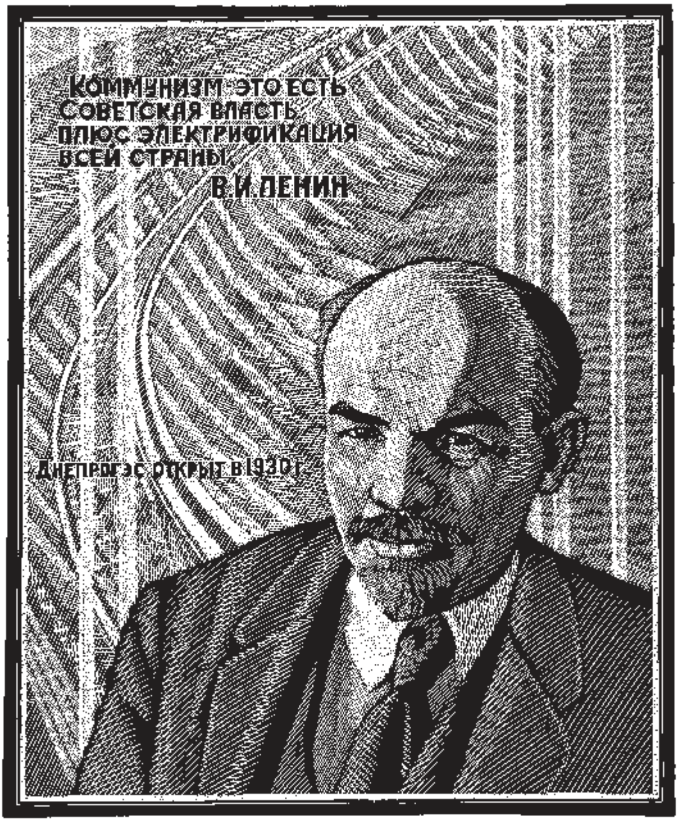
In violent worker demonstrations in East Germany in 1953, in revolutions of 1956 in Hungary and Poland and in the Prague Spring of 1968, and in a series of lesser known uprisings in the USSR, many workers and socialist intellectuals sought the establishment of "socialism with a human face." They wished to build socialist society on the foundation of modern technology. They believed that true equality of all peoples, and of men and women, would arise on this foundation. Perhaps their goals were utopian, as were their views of the way technology would liberate them from poverty and want, darkness and cold, even despotism and control. The lesson of these chapters is that public involvement in decisions about investment of scarce resources may be the only path to the creation of technologies with a human face. We must also have openness—greater openness—about the place of technology in all polities if human and environmental rights are the goal. Yet for such Bolshevik leaders as Lenin and Trotsky, Poland's Boleslaw Bierut and Bulgaria's Georgi Dimitrov, and of course North Korea's Kim Il Sung, technology was no more and no less than a solution to the great problems facing the early USSR.

The effort to mobilize the labor force and yet to plan every aspect of economic, political, and ideological life led to a series of inherent contradictions in the economies of East Central Europe. They became economies of shortages, lines, and bottlenecks, and then campaigns to solve the bottlenecks. The planned economies that so faithfully strove to embrace advanced technology gave birth to a new dialectic, for a campaign in one area meant a shortage in another; a shortage in one area led to criticism of economic managers and party leaders now "responsible" for that shortage who might be accused of malfeasance, deviations, or even sabotage and wrecking; and all of this exacerbated tension between the center and the localities, the managers and the workers, the workers and the peasants, and anyone else who was paying attention. The worker and the peasant paid attention to the glories of socialist technologies and the shortages of necessities that accompanied their construction.

Socialist technology differed from capitalist technology literally and figuratively in a variety of ways and for a variety of reasons. Socialist leaders directed it toward solving industrial, extraction, smelting, grinding, pouring, and other important tasks that they placed before the worker. They paid less attention to housing, road, sewerage and water treatment, communications, medical, and other technologies. Choosing autarky under Stalin, they had to seek indigenous sources of innovation. They succeeded in areas of importance to the power of the state—rocketry, nuclear power, metallurgy, and so on. They employed rudimentary but functional designs and approaches. But they often failed to embrace designs that placed emphasis on safety and environment. They were fearful of the influence of so-called bourgeois experts and of continued reliance on the West for the innovative push. When they turned to capitalist technology through trade, espionage, and reverse engineering, they committed the economy to playing a constant game of catch-up and surpass—or "reach and surpass," as the Stalinist slogan exhorted them. They generally resorted instead to campaigns to make the best of capital and labor inputs without considering how they might employ either input more rationally. If a tractor, skidder, hoist, turbine, or some other technology worked, then it worked well enough. The pressure on engineers to meet targets discouraged them from seeking innovations that might slow plan fulfillment in the short run but would have paid dividends in the long run.

It may be that the employment of slave labor in the gulag system of the 1930s, 1940s, and early 1950s convinced leaders and engineers alike of the expendability of human life and of the feasibility of relying on brute human power equipped with hand tools and insufficiently provided with machines. How else can we understand the fact that Russian historians and chroniclers of the construction of the White Sea–Baltic Sea Canal to this day praise the slave laborers for figuring out how to organize themselves to use wheelbarrows and sledgehammers to cut and move stone?

Of course, functional technologies have universal attributes based on various laws of physics and chemistry, geology, hydrology, heat engineering, and so on. Strength, weight, durability and availability of materials, local climatic and geophysical conditions, and so many other factors require that all successful canals, dams, buildings, airplanes, reactors, steel mills, etc., resemble each other or they would not work. Thus, when Stalin and his followers insisted that socialist technology existed, he meant that it served the worker, not the exploiting class, and that it could be mastered in a short time for universal application within the countries of socialism. But in this way, once again, the socialist system discouraged innovations that took into consideration geographic, seismological, climatic, and other differences. Leaders feared spontaneity not only in politics, but in engineering, and thus contributed to the belief that one technology was appropriate not only for an entire sector of the economy but for the entire country and the entire socialist world. This led them frequently to run roughshod over local, regional, and national programs, and roughshod over the worker, male or female, as they tried to force them to conform to technological norms established in Moscow, Warsaw, Kyiv, Leningrad, Budapest, and Sofia state committees for standards, construction, and engineering.



Masabikh Akhunov (1928–2008), "The Dnepr Hydroelectric Power Station," 1970, linocut. Vladimir Lenin, Leon Trotsky, and other Bolshevik leaders were technological utopians. They believed in the power of technology to create communism. The slogan imposed on the Dnepr Hydroelectric Power Station in this linocut—"Communism—Is Soviet power plus Electrification of the Country"—reveals this sentiment exactly. Courtesy of the Allan Gamborg Gallery, Moscow, Russia.

CHAPTER ONE

WOULD TROTSKY WEAR A BLUETOOTH?

Technological Utopianism in the Soviet Union in the 1920s

We are accustomed to reading about the central role of technology in the mindset of North Americans and Europeans. Technology serves both as a symbol of modernity and national achievement and as an engine of economic progress. Political leaders, engineers, writers, and journalists have consciously embraced the railroad, the automobile, magnificent hydroelectric power stations and other major public waterworks, sleek airplanes, the powerful nuclear reactor, and the rocket ship as confirmation of a society's manifest destiny, its ability to conquer all frontiers, its superiority over other nations, and a sign of the legitimacy of its leaders. Whether recognizing it or not, they have embraced an Enlightenment view of nature, and not only the desirability of controlling it for the betterment of humankind, but the ability to do so. Technological progress represents to many of these individuals the highest form of civilization. They believe in an almost moral imperative to bring the benefits of modern technology to those "backward" people, nations, and societies that must manage without it. They also have economic, geopolitical, and other reasons for promoting technological development elsewhere; they have sold hydroelectric technology to Brazil and Egypt, green revolution seeds and fertilizers to Indonesia and India, and pharmaceuticals to other countries, all in the name of progress and democracy. Remember the admonishment of David Lilienthal, chairman of the Tennessee Valley Authority (TVA), that the TVA—the New Deal program to bring figurative and literal illumination to the hollows of Appalachia, end poverty, overcome illiteracy, and improve agricultural production—was a sign of "Democracy on the March."[1]

In socialist systems, many of these same beliefs held. For leaders and engineers, technology was unquestionably a sign of modernity. Because the nations that have followed the socialist path have invariably been agricultural, they sought to acquire the most modern industrial technology as rapidly as possible. They believed that it would transform backward peasants into conscious citizens, simultaneously providing them with life's necessities and thus securing their loyalty. They sought advanced technology for strategic considerations since they were surrounded by "hostile" capitalist countries. After all, American and British troops intervened in Russia during the civil war, later Germany invaded the USSR, and indeed North Korea has faced relentless economic pressure and aggressive rhetoric from such nations as the United States. Similarly, technology served as a panacea for such economic problems as drought and repeated agricultural failure, inadequate transportation and communications infrastructure, and low life expectancy. Hydroelectricity and irrigation would end the scourges of flood, draught, and famine. From Lenin to Stalin to Kim Il Sung, technology found a central place in ambitious, even utopian development programs.

At the same time, these same leaders frequently found it expedient to forget that technology is not value-neutral, but embodies political and economic considerations. As a result, they encountered significant difficulties in what they expected would be a simple matter of lifting up, extracting, and importing modern technology from the leading capitalist nations, even as they anticipated industrialization without the great human and environmental costs that capitalist nations experienced—or so they promised the workers. In socialist and capitalist nations alike, the embrace of modern technology led to such great social disruptions as cathartic migration from the countryside to urban centers, where the workers faced crowded, dirty housing in spite of the best efforts to provide them with spacious, clean homes and apartments. Migration ripped families apart, especially since it often resulted from forced collectivization in socialist nations. Under socialism, workers received poor pay and had few consumer goods. Millions starved in the process of industrialization and collectivization in the USSR in the 1930s, and again after World War II in North Korea and elsewhere. At work, they confronted noise, pollution, and accidents at levels likely significantly higher than in capitalist factories.

Believing that they faced opposition from all sides and seeing the need to resurrect the economy at all costs, Communist Party leaders often felt compelled to put the needs of the machine ahead of the needs of the worker. They bridled at the call for workers' management of the means of production when workers' management meant plummeting productivity. When the Workers' Opposition movement in Soviet Russia in 1920 and 1921 demanded the replacement of so-called bourgeois managers with communist workers, Lenin and the Bolsheviks rejected their concerns, even expelling members of the opposition from the party and harassing the movement's leaders. Lenin, Trotsky, and other Bolshevik leaders were correct in noting that workers often misunderstood how to use machinery and equipment or to organize labor in factories, and they were rarely a source of innovative impulses. In this atmosphere, the leaders made fateful choices about the importance of modernizing rapidly on the basis of modern, and often large-scale, technological systems. This drained scarce resources from other sectors of the economy that might have benefited the worker more directly and certainly more immediately. Socialist leaders overestimated the power of technology to transform their societies overnight into paradises of plenty and underestimated its power to disrupt society's social, cultural, and political structures. But while Lenin and Trotsky stressed the universal characteristics of technology, Stalin argued that socialist technology as distinct from capitalist must be created in the USSR, and he insisted that it would be built within a few short years.

Culture and Technology in the Russian Revolution

When the morning whistles resound over the workers' suburbs,
It is not at all a summons to slavery. It is the song of the future.
. . . .
A million workers seize the hammers at the same moment.
Our first blows thunder in accord.
What is it that the whistles sing?
It is the morning hymn to unity.

ALEKSEI GASTEV, "The Song of the Workers' Blow"[2]

A healthy kind of technological utopianism burst forth after the Russian Revolution. Rene Fullop-Miller, Kendall Bailes, Richard Stites, and others have described its manifestation in public displays, exhibitions, and festivals, a number of which were sponsored or organized by the Bolsheviks, but many others of which were spontaneous and inspired by a wide variety of cultural and social movements unleashed by the revolution. The Bolsheviks saw technology as the solution to falling industrial production and declining productivity of labor. Anarchy had spread through the factory when workers' committees threw out their former bosses, and machinery broke down with no one to fix it. Unskilled laborers ruined equipment. Production fell idle. The Bolsheviks believed that various techniques and technologies from the West might be employed to great benefit in fighting the precarious situation. In the absence of new capital, Taylorist methods (known in Soviet parlance as NOT, or *Nauchnaia Organizatsiia Truda*) would ensure that the worker more efficiently used his energy in the workplace to operate existing equipment. Next, the introduction of the assembly line ("*Fordizm*" in the Russian) would facilitate mass production of inexpensive and reliable necessities.

The Bolsheviks were fascinated by America's position as the "paradise of machinery" and found the modern assembly line of Ford especially virtuous. They were convinced that under capitalism the worker could never be a natural appendage of the machine. He would fight Taylorism and its "strictly enforced psycho-technical system of work." Under socialism, Taylorism served the worker. For Russia, with scarcely any modern industry (and little of that large scale), a small working class, and the great masses of the peasantry still working the soil with the most primitive tools, where "Asiatic medieval methods of work and organization prevail," Fulop-Miller wrote, "American mechanization" was "the loftiest expression of human perfection."[3] The former "medieval methods of work" would be replaced with a technical culture greater than that in America, Germany, or France. The entire state would be electrified; motor plows, tractors, and threshing machines would be sent to the remotest districts, with political instructors accompanying the machines to the countryside to convert the peasant to the new way.

Outside of Bolshevik circles, other intellectuals embraced the machine. Alexei Gastev, a radical involved in workers' causes since the 1890s, was fascinated with industrial production as the basis of new ways of living, working, and thinking and spread ideas of proletarian culture after the revolution. In such poems as "We Grow out of Iron" he celebrated a new relationship between workers and technology, with collective effort turning onerous work into celebration. In the Proletarian Culture movement (*Proletkult*), Gastev joined other activists, poets, and playwrights who exalted the machine. Artists and musicians wrote concerts and organized processions of steam whistles and factory sirens. They all saw a future of machine cities based on engineering culture. Proletkult promoted uniformity, standardization, and collectivism—and thereby true equality under socialism—at home and at work.

Given America's position as the greatest technological power, and given its seeming mastery of standardization, Gastev and others, including Lenin, were drawn to its technology; to its assembly lines, skyscrapers, automobiles, and tractors; and to the iconic leaders of its technology, in particular Henry Ford and Frederick Winslow Taylor.[4] Ford's *My Life* was translated into Russian a half-dozen times and became a best seller. Soviet Fordists—and other individuals who found the cantankerous Ford to be an industrial hero—ignored his rabid anticommunism and anti-Semitism. They believed that his ideas about the conveyor belt for the factory were apolitical and could be applied to bring order to production in any society.[5] Similarly, Taylor's *Principles of Scientific Management* (1911) promised to maximize industrial output and end disputes between workers and managers; in addition, Taylor's book claimed that these principles might be applied to a broad range of human activities with equal aplomb—housework and the kitchen, resource management, even government. While failing in each of these areas (workers rejected the further diminution of their power over the production process inherent in time-motion studies conducted by "objective" experts in white coats holding stopwatches to inform them how best to economize their labor on the shop floor), Taylorism found broad response in the Soviet Union, as did fascination with American technology generally.[6]

The Bolsheviks promoted both economic and cultural revolution through technology. They struggled with illiteracy, they fought to bring modern medicine to the masses, they attacked religious belief, and at least initially they supported women's liberation from traditional roles while ridiculing the patriarchal family. (Under Stalin, the Bolsheviks returned to the nuclear family as an institution of stability and political conservatism.) Trotsky advocated a redoubled effort to use the media in a variety of areas of "cultural construction" and propaganda toward the ends of cultural and economic revolution. He believed that the proletarian newspaper correspondent, or *rabkor*, was a "key factor of cultural reform." Trotsky asserted the following: "Yes, the monopoly of the press is in the hands of that party through which the workers realize their power, through dictatorship. The press is one of the most important instruments of class dictatorship. This weapon preserves, however, its vital force at the time when it serves not only the dissemination of ideas, slogans and resolutions from above, but the free expression of opinions, evaluations, and criticism from below. Yes, we have the free expression from those below immeasurably greater than in any capitalist country."[7] Recognizing problems of illiteracy, he called for new newspapers, with better paper, easier to read print, and better content. Science, technology, and literature were the means to fight lack of discipline in all its forms.[8]

Yet the great disparity between the aims of the Bolsheviks and their preliminary conditions of a backward and war-torn economy belabored efforts to create the workers' paradise. As Fullop-Miller commented, they faced the daunting task of reeducating the peasant against his fatalistic pessimism, his anticipation of agricultural failure, and his fear of innovation in the effort "to inculcate a technico-mechanical spirit, to end patriarchal and primitive methods of work" with modern, American machines. They had no industry and no trained technicians but still exhibited a "naively enthusiastic infatuation [for] the simplest technical achievements, the religious ecstasy with which they rave about 'rationalized industry,' 'mechanization,' and 'complete automata.'"[9] The Bolsheviks believed that they could perfect this "technical wonderworld" simply by imposing socialist productive relations and Bolshevik willpower on the machine. Given this view, Fullop-Miller observes, "The simplest objects of technology immediately became sacred religious paraphernalia and fetishes for the orthodox Bolshevists." They worshiped the machine; they were "modern ecstatics" of rationalized labor, of bliss with belts, pistons, valves, and flywheels.[10]

While the genesis of Taylorist and Fordist systems and technologies was the capitalist system, given socialist productive relations they would be employed to the full benefit of the work. In a word, through technology the Bolsheviks set out to transform the *muzhik*, or peasant, and the worker into allies of Soviet power. Literacy campaigns focused not only on reading but on teaching public health measures, good work habits, and dedication to the collective. To promote new thinking, the Bolsheviks used the political poster, often with technological themes. The poster connected with the barely literate worker through vivid colors and designs and simple messages. In posters such technological images as machines, tractors, and entire factory edifices replaced religious figures and themes; the poster supplanted the religious icon. Sports festivals and spectacles in which the machine occupied a prominent position brought workers and peasants together, giving the authorities direct access to them for propaganda purposes. At the myriad large-scale construction sites for dams, steel mills, and entire cities that were the centerpiece of Stalinist industrialization, the authorities extended the lesson of technological enthusiasm among inexperienced workers who streamed into those sites.

Amerikanizm: Tractors and Taylors

In spite of their determination, it took decades to create technological culture among the Soviet masses. Maurice Hindus was born in a Russian village "so deaf" that he did not see a train or a lightbulb until he left for America at the age of fourteen. He returned to Russia in the 1920s almost annually, visiting those backward villages to follow the course of the revolution. One hot Sunday afternoon he strayed into a small town on the Volga River and ran into a "bizarre" wedding procession coursing back and forth through the village with bride and groom sitting in a small cart drawn not by a troika of horses but by a Fordson tractor, and this in a village "where some folk still shared their abodes with pigs and chickens." Posters of Marx, Lenin, Kalinin, and other Bolshevik heroes adorned the cart and tractor. For Hindus this was another confirmation of the glowing admiration of Russians for America, dating to the first days of the revolution when the American Relief Administration, under the direction of the capitalist engineer and later president Herbert Hoover, saved millions of peasants from starvation.[11] The *muzhik* and the Bolshevik leader both wanted American technology to secure the success of the revolution.

In so many ways the pursuit of "mechanical civilization" in the USSR involved the effort to assimilate West European innovations and to "Americanize" production and attitudes toward work. Strong interest in America, its business practices and industry, predated the Russian Revolution: for example, Count Sergei Witte and others promoted the Tsarist Empire's industrialization through the Trans-Siberian railroad and other state-sponsored programs.[12] At first U.S. businesses had little interest in exporting to Russia for such reasons as poor terms of trade, geographical distance, and domination of the foreign market by France and Germany. The Soviets, of course, rejected American business practices as capitalistic and inappropriate but had great interest in its machinery, equipment, economies of scale, and techniques of labor organization; in Taylorism; in Fordist mass production assembly line techniques; and so on. Under Lenin, and indeed until the early 1930s, the Soviets frequently engaged American experts and purchased American technology. They wished to avoid dependence on Germany and were determined to develop indigenous industry—or be crushed by the capitalists. They needed to "master the highest technology," which meant American technology, including its industrial methods.[13]

While the U.S. government failed to recognize the USSR diplomatically until 1933 (the last major power to do so), American businesses were ultimately less reluctant to engage the Soviets. The Soviets sought out trade and other agreements in the mining, metallurgy, and machine-building industries, energy and agricultural sectors that they saw as the key to both American success and the success of the first five-year plans. Kendall Bailes writes that Bolshevik leaders did not trust their own engineers to be up to date with American achievements and found them to be too class or caste conscious. But they wanted American technology and expertise, and scores of American engineers journeyed to Russia—Hugh Cooper helping to build the Dniepr hydroelectric power station, John Scott working at Magnitogorsk, and many others. The Gorky Automobile Factory was modeled on Ford's River Rouge Plant. The engineer I. P. Bardin, who had worked at the Gary, Indiana, steel mills, chose them as a model for Magnitogorsk, while Gipromez, the Leningrad Design Institute for the Metallurgical Industry, had 2,000 employees, including 400 America engineers. The enlisting of the Cleveland, Ohio, design firm of McKee and Company in 1930 in the construction of Magnitogorsk reflected the desire to use "the experience of American technology that was progressive for that time." The Soviet officials came to believe that McKee "dragged out the term" of work; they replaced McKee with the indigenous Gipromez in 1932, and "real work began," including the production of iron in 1933. Yet when the Bolsheviks orchestrated show trials of western engineers in the 1930s, shockingly no American engineer was accused of wrecking and brought up on charges like the European (and Soviet) engineers.[14]

The satirists Ilya Ilf and Evgenii Petrov commented on the allure of America in *One-Storey America*, based on their 1936 cross-country road trip. While other Soviet authors had become increasingly negative about America, and to be sure Ilf and Petrov criticized American materialism and superficiality, they also reveled in America's technology, order, and cleanliness, even among the simple folks who lived not in the skyscrapers symbolic of capitalist power, but in one-storey houses. They traveled to Schenectady, New York, and the General Electric Corporation, where they were shocked to learn how much autonomy and financing engineers had to conduct research seemingly without immediate value to GE. They dropped in on Henry Ford in Dearborn, Michigan. They noted the following: "The Fordist method of work long ago has moved beyond the manufacture of automobiles to other objects. This system to a great degree had an influence on the life of the world. But the man, who thought up the system, did not evolve with it. He remains what he was, a mechanical engineer. To be sure a brilliant mechanical engineer, but no more. And at the same time as his action and the actions of other industrialists turned America into a country where no one knows what will happen tomorrow, he obstinately tells himself and those around him, 'This doesn't concern me. I have my own problem. I make automobiles.' "[15]

In agriculture, the legendary American tractor was the focus of interest. The Soviets established the Amtorg Trading Corporation in May 1924 to procure agricultural and other machinery, and they opened offices in several American cities. Amtorg engaged in small-scale acquisitions until the Soviets switched over from concessions to technical assistance contracts in 1928. They hired hundreds of engineers for employment in the USSR. Dozens worked at the Cheliabinsk Tractor Plant, twenty-one with the Tractor Plant Construction Trust, sixteen with the Stalingrad Tractor Factory, and twelve with the Kharkiv Tractor Factory. These engineers were involved primarily with agricultural machinery industry and to a lesser extent with the fertilizer industry and in irrigation. American firms shipped farm equipment; assisted in the design, construction, equipping, and operation of machinery plants; and offered management help in adapting farms to a mechanized agriculture.[16]

In absolute numbers and symbolically, the tractor was the *technology de résistance*. Dalrymple writes, "Seldom has a major agricultural technology been adopted so quickly and on such a vast scale as was the tractor in Soviet Russia." In the absence of a domestic industry, the USSR imported huge numbers of tractors toward the end of modernization of agriculture. The United States was the only nation with the capacity to supply the tractors in the necessary numbers. From 1924 to 1933, 86,377 American tractors were shipped to the Soviet Union, nearly 23,000 in each of the peak years of 1930 and 1931. To ensure proper assembly and use of tractors, Soviet technicians visited U.S. plants, American and Soviet engineers visited sites to ensure working order, and such firms as International Harvester, Deere and Company, Caterpillar, and Advance Rumley opened training schools and tractor repair shops. The Soviets also turned to American technology and expertise to expand domestic farm equipment production. The Detroit firm of Albert Kahn, which designed the Ford plant, also provided the blueprints for the Stalingrad Tractor Factory, while

Leon Swajian, who worked on construction of River Rouge, was involved in the Kharkov Tractor Factory and later at Cheliabinsk.[17]

Soviet industry turned to American designers and engineers to expand production of their own tractors at the Putilov Steel Works in Leningrad (for example, the Krasnyi Putilovets, "a rather poor replica of the Fordson" that the Soviets had reverse-engineered poorly and at greater expense than import of a Fordson would have cost) and in Cheliabinsk (with the Stalinets 60, a ten-ton replica of the Caterpillar that was a crawler tractor, less nimble, but grew out of military designs for tanks). To a smaller extent, the Soviets worked with American companies to expand the fertilizer industry, in particular with Du Pont of Wilmington, Delaware, and Nitrogen Engineering Corporation of New York. Americans were also involved with two substantial irrigation projects: the Central Asian Water Trust (Sredazvodkhoz) and the Transcaucasian Water Trust (Zakvodhoz). For example, Arthur Powell Davis, former director of the U.S. Bureau of Reclamation, served as chief consulting engineer with Sredazvodkhoz.[18]

In a decade the number of tractors increased from 1,000 to over 200,000, a fact "all the more remarkable because it took place in a rural economy which had, from a technological point of view, changed little from the Middle Ages." These tractors later enabled rapid collectivization. The Soviet government invited Ford to send a delegation to Russia in the hope that they could interest him in erecting a factory there. The delegation rejected the plan, and Fordsons were too small for the collective farms that would be established. The Soviets therefore turned to larger tractors with more horsepower from International Harvester, John Deere, Case, and Allis-Chalmers. This suggests that, although the tractor was American in design, and the Soviets acquired it through turnkey plants or through reverse engineering, it could serve either capitalism or socialism.[19]

American specialists reported that Soviet tractors did not meet American standards of quality and that maintenance was still a severe problem owing to substandard raw materials and severe production difficulties. The problems included leaking radiators, poorly cast cylinder heads, loose bearings, broken valve springs, unsatisfactory threading on spark plugs, and so on.[20] The poor quality of the tractors was accentuated by their misuse, even though initially American agricultural specialists were engaged in training Russian peasants how to use the tractor properly. The Russians lacked mechanical background. They took little interest in proper operation because the tractors were owned by the state, not the operator. Hindus, after a tour through his home area, spoke of "the reckless treatment of machinery on all the socialized lands." He continued: "The resulting breakage is colossal. Fleets of disabled tractors dot the Russian landscape . . . machines are left with no cover over them in yards and in far away fields, exposed to the devastation of wind, rain and sun."[21]

The tractor was important as a symbol of the unification of industry with agriculture. Lenin saw more in the tractor than just an implement for tilling the soil; he saw it as a vehicle for luring the peasantry to communism. On March 23, 1919, he told the delegates to the Eighth Party Congress that tractors would create communism: "If we could give 100,000 first class tractors tomorrow, provide them with gasoline, with mechanics (you all know quite well this is a fantasy), then the middle peasant would say, 'I am for communism.' " The peasant, Lenin continued, "needs the industry of the city, without it he cannot live."[22]

Beyond *Fordizm* and *Amerikanizm*, beyond tractors and factories, technological enthusiasm had a number of cultural manifestations. Everywhere one went, one encountered street names honoring technology or workers. Stamps and posters were based on technological themes.[23] New words and names for organizations appeared that were often drawn from bits and pieces of other words and left no doubt about the organizations' functions (Sredazgiprovodkhlopok—the Central Asia Water Melioration and Cotton Institute). Peasant enthusiasts named their children "Forge" (*Domna*), "Electrification," "Tractor." Such journals as *Novyi Mir*, *Sibirskie Ogni*, and later *Raduga*, *Angara*, and many others also rejoiced in the modern machine in publication of poetry and literature. Writers, critics, and political authorities used this venue to discuss the anticipated achievements under Soviet power and the political and social role of technology. Stalin's "poet of the revolution," Vladimir Mayakovsky, spent three months in the United States, visiting New York, Chicago, Detroit, Philadelphia, Pittsburgh, and Cleveland; giving readings and lectures and joining in the workers' struggle; and penning *Poems of America*, which included "Chicago" and "Brooklyn Bridge," in the latter praising the bridge as "a paw of steel" that would bring "the seas and the prairies" into a single clasp, suggesting that modern technology would supplant religion ("as a crazed believer enters a church") and would bring the shamanistic people of the north into the Soviet fold ("I stare as an Eskimo gapes at a train").[24]

The dystopian side of the headlong rush to embrace technology would be felt increasingly in the Stalin period, although it was evident already with the first days of the revolution. The Bolsheviks increasingly poured resources into large-scale technological projects, while funding for housing, food, heating, and public health lagged, even though they were at much higher levels than before the revolution. Workers did not experience joy; they suffered at every work site from exposure to machinery, pollution, and the elements, and their low wages and long hours also gave little reason to celebrate. They abused the machines as much as the machines abused them. The situation for engineers was no better. Party officials, perhaps fearing their potential power and certainly distressed by the pace of industrialization (since superhuman pace was insufficient), attacked specialists for their alleged transgressions. The resulting loss of autonomy over research, innovation, and diffusion created extremely challenging conditions for engineers and scientists in which to work. If at first Stalin had declared that the Bolshevik Revolution depended on technology ("Technology decides everything!"), he came to realize that getting peasants, workers, and specialists to fulfill their obligations to technology was crucial ("Cadres decide everything!"). And yet he still emphasized investment in large-scale technologies, always technologies, and rarely in social overhead capital of benefit to the worker. The darkest vision of a society in which the state used technology to dominate human life to the depth of our very feelings, Evgenii Zamiatyn's *We* (1921), was actually written in response to events and experiences before the revolution. But Lenin and Trotsky shared none of these dark visions of technology.

Lenin Electrified

Vladimir Lenin unyieldingly attacked opponents. He hated compromise. He insisted in *What Is To Be Done?* (1903) that only devoted, professional revolutionaries had a role in his party. He rejected the "god-building movement" of Maxim Gorky, Anatoli Lunacharsky, and others that sought to "deify" the liberated worker after the revolution as no better than any other reactionary religious belief. He condemned as naive the Proletkultists for denying the value of such bourgeois institutions as science and technology in the construction of socialism; after all, Marxism grew out of capitalist society. He described the violent means necessary to establish the proletarian dictatorship in *State and Revolution* (1917). He presided over a bloody coup to seize power and authorized the formation of the Extraordinary Committee, the Cheka, under Felix Dzerzhinski, to terrorize enemies, including by carrying out summary executions. He methodically issued proclamations to seize land, confiscate possessions, and nationalize industry and banks to cement Bolshevik control over economy and society. He has deservedly earned a reputation for hard-nosed, pragmatic, and even opportunistic policies, all intended to maintain the Bolshevik dictatorship. For these reasons many people find it hard to believe that Lenin was a technological utopian. Yet Lenin entertained visions of a glorious communist future, a land of contented, productive workers; of well-illuminated, spacious, and well-ventilated factories; of peasants toiling in the fields replaced by electrical machines that increased yields while lightening the burden on the *muzhik*. At the base of all these visions stood such technologies and techniques as electrification and Taylorist time-motion studies, roads, railroads, and communication systems.

On the eve of the revolution, Russian roads and railroads were the worst in Europe. There were no more than 25,000 kilometers of highway, and most turned to mud for much of the year. Boat travel was important, yet even during the good seasons it took months to ship grain to its final destination. Between 1890 and 1913 Russia was the faster builder of railroads in Europe, adding 31,000 kilometers to the system, but this was insufficient to meet the needs of a rapidly industrializing society and totally inadequate to handle the vast numbers of men and supplies during World War I. By the end of 1915, 4.4 million Russian men had been killed, wounded, or taken prisoner, and the railroad was choked with replacements, sick, wounded, and soon deserters. Disorganization encroached on the system, and supplies ultimately failed to reach the front or the cities. Long lines formed for fuel and food. The railroad became the major vehicle for the spread of disorder, bottlenecks, and dissatisfaction with the Tsarist regime on the eve of the revolution.[25]

The telegraph was an instrument of revolution; the telephone, post, and radio played a minor role. On the eve of the revolution, the empire had only 7,618 post offices in Russia, 80 percent of them in European Russia. Many towns were dozens of kilometers from the nearest post office. By 1870, however, 714 telegraph offices and 91,000 kilometers of line were added. The Tsarist government feared information and desired to repress communications; thus, it heavily censured the post and telegraph, so much so that when Empress Aleksandra sent telegrams to Tsar Nicholas at the front, they came back marked “Whereabouts of the addressee unknown.” The Provisional Government ended censorship; sought to improve post, telephone, and telegraph service; and was fortunate to have the support of workers in this industry—railway workers tended to be Bolshevik supporters. However, as the situation in the economy worsened throughout the summer, many of the other workers in transport and communications, too, grew sympathetic to Bolshevik calls for "Bread, Peace and Land."[26]

Lenin recognized the great possibilities of control of media for propaganda purposes and feared access to "the means of communications" by all others. Lenin understood perfectly that loyal Bolshevik soldiers must immediately seize bridges, printing presses, and telephone exchanges during the October 1917 coup. The railroad, post, and telegraph also must fall into Bolshevik hands. The control of these means of communication ensured that the successful seizure of power was relatively bloodless, if not preventing a long, bitter, and bloody civil war. Lenin realized that he must use them as a tool to link the nation and contribute to the fanning of the revolution out from Petrograd. After seizing power, it took two to three weeks for the Bolsheviks to force civil servants to follow their orders and issue their decrees, but eventually they controlled this important communications nexus, too.

Once the Bolsheviks seized power, Lenin faced the pressing problems of world war opposition from the right and left, then civil war, and precipitously failing industrial production. Inadequate food and fuel deliveries threatened the Bolsheviks' tenuous hold over the cities, forcing them to turn to forced confiscations by armed soldiers in the countryside. In these conditions Lenin still found time to think about how best to promote the diffusion of modern technology to overcome these problems. In 1920 Lenin promoted the fifteen-year State Plan for the Electrification of Russia (in Russian known as GOELRO), with Gleb Krzhizhanovsky as its first director and later head of the State Planning Administration, Gosplan. Lenin considered GOELRO a kind of "second party program." Some 200 engineers, most of whom had clamored for a national electrification plan since before the revolution, joined Krzhizhanovsky in working out the details of GOELRO. They premised the system on central production and distribution stations (largely peat and increasingly hydroelectricity) serving eight districts. GOELRO would overcome extremely low capacity in comparison with Europe and the United States and miserly per capita production. The plan required a complete technological revolution to replace or rebuild outdated and small plants in a miserable state of repair. While modest by today's standards, GOELRO involved the construction of a series of central power stations to increase energy capacity and production four and a half times, a goal achieved essentially by 1931.[27] To be clear, electricity was a panacea; it would increase productivity of labor, ease onerous work, rationalize the workplace, and transform agriculture. Krzhizhanovsky recalled nearly forty years later that "GOELRO was the banner of the economic rebirth of the country, of the first attempt of planning of the entire national economic complex on the basis of its technological reconstruction on the basis of advanced technology—the technology of electricity."[28]

Like Lenin, Trotsky saw electrification as a key to the country's future. Trotsky spent several months in the United States, and he remarked on the conveniences of life that were rare even among European workers: electric lights, gas cooking ranges, baths, telephones, automatic service elevators, even a chute for the garbage, and of course the automobile;[29] meanwhile, the Soviet worker toiled manually to provide firewood, peat, and shale. Impressed apparently by the oil-based economy, Trotsky found peat to be an old-fashioned source of energy and looked forward to the day at the end of the civil war when the Bolsheviks had secured the Don Basin, the Northern Caucasus, Baku, and Embensk oil. Until then, peat had to suffice.[30]

In a speech at the Eighth Congress of Soviets in 1921, Trotsky spoke about the need for a unified economic plan and the central place of electrification in that plan. Electricity had both economic and symbolic significance. It "attracts the *muzhik* to the unified economic plan," while unifying the economy. To this point, economic activity occurred in "isolated islands in the ocean of disconnected peasant economy." The solution was to integrate the peasant economy into a socialist one through planning, simultaneously securing the peasant's dependency on the government. It was necessary for the peasantry "to receive power that moves, heats and illuminates from central stations along power lines; necessary that the thoughts of the peasantry were turned to technology, to culture, and this may be solved most surely of all and best of all through the means of electrification, through the means of the provision of goods and services of the countryside, of rural workshops, schools, peasant huts, of electrical energy for work, for illumination, and may, in the future, for cooking, food and heating." Trotsky concluded that acceleration of the tempo of electrification was the key to turning the peasant "to technical progress, to culture. Without the solution of the problem, the socialist economy will be a series of disconnected islands in the ocean of agriculture."[31]

The Bolsheviks focused on other technologies as well. They quickly brought the means of communication under their control and used them for regime purposes. They shut down opposition newspapers of parties on the right, the Socialist Revolutionaries and Mensheviks, and even those of their allies when the tone against the regime was too sharp. Maxim Gorky's *Novaia Zhizn'* (*The New Life*) published articles increasingly critical of Lenin's undemocratic methods, the bureaucratization of government life, and the need to save Russia's intelligentsia from complete loss owing to famine, ill health, and displacement at the hands of the working class; although a longtime associate of his, Lenin shut Gorky's paper down. The Bolsheviks saw the media as a tool not only of repression but of education and exaltation. They sought to combat backwardness in the face of daunting obstacles of illiteracy, intervention, and civil war. They encouraged and took advantage of genuine popular enthusiasm in a variety of campaigns—against alcoholism and illiteracy, for new programs in public health. They organized "agitational" trains and ships, processions of automobiles and tractors. They intended both to persuade the masses to support them and also to change mass consciousness in the effort to create a new Soviet man and woman. The Bolsheviks used the press, books, films, and posters with great success in perhaps the world's first effort at mass politics.[32] By the late 1920s the Bolsheviks controlled all publishing houses fully (and required all typewriters to be registered with the authorities) and the press, radio, and film. The language of state control was socialist realism, a genre of art, literature, and music. Of course, through the media party officials carefully orchestrated cults of Lenin and Stalin and other infallible party leaders so that no one had reason to question the legitimacy of the communists.

Lenin embraced time-motion studies in the form of Taylorism as another technological fix for the economy.[33] Rhetorically, Lenin and other Bolshevik leaders saw the application of Taylorism as a way to raise productivity while easing the labor of the worker, who would lose superfluous, outmoded motions. But in fact, the Scientific Organization of Labor (NOT) was intended to eliminate "laziness, panic and wildness, vice," to internalize "success and efficiency, awareness and attentiveness," all the while giving researchers and managers control of the use of tools, timing, tasks, and organization. Alexei Gastev, who penned the article on *Fordizm* published in the first edition of the *Great Soviet Encyclopedia* in 1937, shortly before his arrest and disappearance in the Gulag, gained Lenin's approval to establish an institute for NOT, while a quasi-voluntary and national "Time League" formed, and its columns filled regional and local newspapers with advice. The *Herald of the Communist Academy of Sciences*, a center of Marxist social scientific thought, briefly offered a section of the journal on Taylorism.[34]

Trotsky also embraced Taylorism as a value-neutral tool of capitalism that could be applied to the socialist economy with great effect. Trotsky noted poor performance and lag in all regions of economy. The Soviet iron and textile industries produced at best one-third of the Tsarist level. In addition, the labor force was in disarray, with the most capable, energetic, and talented elements of the working class drawn into administrative work and into the army. About half the labor force was truant, and the worker spent too much time and energy on the acquisition of food and other necessities. An American engineer, Kelly, a Taylorist and supporter of Soviet power, studied the situation and concluded that the Bolsheviks could apply Taylorism scientifically to the socialist economy with good results.[35]

Trotsky recognized the close connection between military methods and Taylorism. In the United States, the military played a central role in the development of Taylorism, applying Taylorist methods on a large scale and learning firsthand that the worker rejected the methods as deskilling him and weakening his position vis-à-vis the factory manager. At the Watertown, Massachusetts, arsenal, officials applied Taylorism to improve the production of munitions. In spite of the worker's rejection of Taylorism in Watertown, Trotsky believed that it had important applications under socialism. He noted that many of the military techniques applied to the labor force during War Communism, when the Bolsheviks were forced to "militarize" production, were in essence Taylorist, a "more precise form of exploitation of labor activity, the most ruthless, so that each movement and each breath is calculated." Trotsky compared the disorganized movement of a crowd with the rapid, coordinated movement of a regiment to argue that Taylorism was a positive, creative force that could be applied to industry. He wrote, "I do not doubt that those tens of thousands of workers return from our army that they built not as slaves, but built consciously, will transfer their habits into economy and into industry." He continued, "The socialist manager should assimilate this side of Taylorism fully."[36] Taylorism and the concomitant militarization of labor would overcome the problems of unskilled labor and the breakdown of machinery that followed the war and revolution.[37]

The embrace of NOT indicated yet again that the Bolsheviks believed that technique could be transferred from capitalism to socialism successfully. Socialist productive relations guaranteed that the worker benefited from NOT; engineers determined the maximum output of the human organism in laboratory settings to serve the proletariat, not profit, and transferred that knowledge to the factory and field. NOT simultaneously overcame the outmoded attitude of the worker. Unfortunately, under socialism, too, while the primary goal of NOT was the improvement of labor efficiency to give the worker the benefit of science, it also involved regimentation of every aspect of labor that the worker rejected as deskilling and inhuman. Under Stalin, Soviet officials determined that NOT gave suspect engineers, not reliable communist managers, too much control over the pace and organization of work, and they closed Gastev's institute.

Yet in this earlier period, scientists and engineers retained autonomy. Lenin and Trotsky believed that scientists and engineers were "spontaneous materialists" by virtue of their craft and their rejection of superstition, the supernatural, and other idealist trends. Lenin presided over the rapid expansion of the scientific enterprise through Glavnauka (the Main Administration for Science of the Commissariat of the Enlightenment) and NTO (the Scientific-Technical Department of the Supreme Economic Council). Glavnauka officials supported the establishment of a network of research institutes, scientific societies, and professional organizations connected with basic research, while the bailiwick of NTO was industrial research and development, with administrations for major sectors of the economy. Dzerzhinski joined Lenin in recognizing the need for the help of bourgeois specialists. He supported their autonomy through his work in NTO, and he determined that "specialist baiting"—class-based interference with crucial research and management endeavors—was an act of terror.

Yet throughout the late 1920s and especially with Stalin's rise to power, many officials criticized scientists and engineers for being "divorced from practice," that is, not paying sufficient attention to research with immediate application. Scientists meanwhile criticized bureaucrats and party activists for failing to understand that scientists themselves would best determine the direction of research. Still, the existence of national bureaucracies to support science and technology distinguished the USSR from the United States, Germany, and other countries where no national organization existed to coordinate the funding and organization of research or express the state's policy interests. Glavnauka and NTO were subjugated to the Commissariat of Heavy Industry under Stalin in the 1930s, a move that reflected his view that scientific research must be linked directly to industrial production.

Trotsky recognized the need to rely on bourgeois specialists to develop industry, at least until such time that a new proletarian specialist had been trained. While the Soviets had significant success in literacy campaigns, the revolution had destroyed the system of professional education that had been created under capitalism, so that they lacked the "professionally-trained worker" who was a "critical lever" in the current economic situation.[38] The Bolsheviks had to rely on the scientific intelligentsia of the old order, whom they would require to focus on questions of importance to the proletariat. Trotsky insisted that specialists must orient "their attention, interests, and their efforts to problems and demands of the new social order." Scientists would carry out the task of overcoming the "horrible backwardness" of the nation, not "in the interests of a privileged minority, but in the name of the material and spiritual growth of the entire people, with the inclusion of the most heavily backward peasant strata." Since the time of Peter the Great, Russia had attempted to raise the cultural level of the nation through western science, but, Trotsky asserted, Peter had not opened a "window" on European culture 200 years ago, only a tiny "porthole" that had served the upper classes while leaving the masses behind.[39]

Socialist Nature Reorganized as a Conveyor

Like other Russian Marxists, Leon Trotsky believed in the power of modern technology to liberate the worker, and he believed that Russia needed to master specifically American technology as the world's most advanced. After Stalin defeated Trotsky in the battle to succeed Lenin as party leader, Trotsky was increasingly marginalized, then exiled, finally forced to leave the USSR, and murdered in Mexico in 1940 by Stalin's agents. On his way out of favor, Trotsky occupied a series of less important positions in the bureaucracy, for example, the Scientific Technical Department; such other rivals of Stalin as Nikolai Bukharin were also pushed into NTO as demotion from the power struggle. Trotsky wrote extensively about technology and politics in the 1920s, although his views on this topic are scarcely known. This is because, after his defeat by Stalin, he was systematically written out of Soviet history, even excised from photographs. Yet his views on technology were instrumental in the formation of many Soviet policies or in triggering debates about those policies. He was certain that capitalist technology would serve the working class, and absent the Bluetooth he employed the locomotive, printing press, radio, film projector, and poster. He was an Americanist in his admiration for the conveyor belt, standardization, and mass production.

Trotsky believed that socialism enabled science to achieve its full potentialities only when it was "nationalized, emancipated from the internecine wars of private property and no longer required to lend itself to the corruption of individual proprietors but to serve the economic development of the nation as a whole." The Revolution of October 1917 was a mortal blow to backwardness, enabling the entire people to rise up on the achievements of science and technology. Trotsky wrote that "socialist construction is in its very essence conscious planned construction which concentrates technology, science and well-articulated social forms and methods of their utilization on a scale unprecedented earlier."[40] He characterized socialist construction as "the aspiration to rationalize human relations, that is, subordinate them to reason, that is, arm them with science."[41] The network of research institutes being established by the state was a small "material indication" of the "limitless possibilities" before society. On top of the elimination of greed from social relations, state sponsorship of science and technology would ensure that no revolution was necessary in the transition from socialism to communism since the transition depended wholly "upon the technical progress of society."[42]

Trotsky turned to Marxism in his early years, joined the Russian Social Democratic Labor Party, worked on the newspaper *Iskra* (*Spark*) with Lenin, and became a member of the Mensheviks and then chair of the Petersburg Soviet during the failed Revolution of 1905, spending much of the next twelve years abroad. He returned to Russia in 1917 to join Lenin in rallying the Bolsheviks to victory as chair of the Military Revolutionary Committee. More than any other Bolshevik, except perhaps Lenin, he saved the revolution, heading the Bolshevik delegation in negotiations at Brest-Litovsk in 1918 to secure peace with Germany, serving as Commissar for War (1918–25), creating the Red Army, leading it to victory in the civil war, and working as a member of the Politburo until 1927. In another position as chairman of a commission on the Central Administration of Railways, Tsektran, that was responsible for rebuilding the railroads from world war and then civil war, Trotsky gained firsthand knowledge of the role technology must play in securing the future of the young socialist state. Finally, Trotsky served briefly in the Supreme Economic Council as a member of its collegium and head of three industrial departments—the Concessions Committee, the electrical technical board, and NTO—where he continued to think about the place of technology in revolutionary Russia.

The experience as commissar of war and head of Tsektran convinced Trotsky of the need to create a militarized "production atmosphere" by incorporating trade unions directly into the state apparatus. The "militarization of the economy" during War Communism (1918–20) would raise "labor discipline, selflessness and steadfastness." It would facilitate the struggle not only with interventionists, whites, and monarchists but with "hunger, cold and epidemics." Red Army troops, together with "the best elements of the local proletariat in a given territory," would defend to the death such strategic sites as mines and the territory surrounding them.[43] Trotsky treated each economic crisis he encountered on the war front that delayed the establishment of the dictatorship of the proletariat as one that could be treated through military organization, whether raising labor discipline, increasing the supply of food and fuel, repairing engines, or resurrecting transport and industry from the Don coal basin (Donbas) to the Ural Mountain region.[44]

Trotsky carefully studied the history of technology even before the Bolshevik seizure of power forced him to consider what socialism might borrow from capitalism and address directly how socialist industrial, agricultural, and military technologies might differ from those under capitalism. The miserable performance of the Imperial Army during the Russo-Japanese War in 1904–5 triggered this interest. The Russian Army as of 1904 had not really been involved in military campaigns since 1878. The war showed that it lagged technologically and in the training of soldiers. A great gulf existed between officials and soldiers, many of whom were one generation from the countryside. As Heyman points out, along with other socialists and Marxists, Trotsky had always hated the military for its role in quelling civil disturbances. He despised the chauvinism of the military campaign against the Japanese and the exploitation of the worker-soldier. Yet in various failed mutinies, he noted that skilled military leadership eventually overcame radicals' enthusiasm for revolt. Military discipline was the bourgeoisie's advantage, and he hoped that revolutionary industrialization in Russia would mean that increasing numbers of workers would enter the military and take control of it from within.[45]

As in other areas of the economy, the capitalists had industrialized war. Trotsky observed that there wasn't a great difference between capitalist and socialist countries in the sphere of industry, nor in the quality of their cannons and shells, but in the capacity to produce huge quantities for the duration of the war.[46] The Great War "threw into motion all that military technology which . . . militarism skimmed off, like cream, from capitalist development. And Europe endured. How many times was it said that the newest technology would make war absurd and make it impossible? This hasn't happened."[47] When war broke out in Russia, Trotsky considered the impact of mass mobilization on a backward, feudal country, anticipating that social tensions would bring the autocracy down. The Russian war turned Trotsky's attention to military issues and affairs, away from social and political questions, even as he recognized that the failure of the Russian army to perform well was the problem of a peasant army run by upper class officers, not only Russia's great technological lag. The technology of war was always getting more advanced, by which he meant more industrial. Yet the principles of "military art" had not changed.[48]

As commissar of war, Trotsky commandeered a special armored locomotive replete with printing press, telegraph, telephone, and movie cameras to record his exploits for propaganda purposes, to print newspapers, and to stay in contact with battle leaders to strike quickly as needed along the front. For two and half years, as he explained in *My Life*, he lived in his heavily armored train with two engines. During this time, the Red Army grew from 800,000 to 3,000,000 and fought on sixteen fronts simultaneously. With his speeches Trotsky stirred up villagers, illiterate peasants, and troops, all of whom were often cut off from news. Through his travel from front to front, from the central industrial region to the Ural Mountain region and to the Donbas, the latter two the crucial mining and metallurgical centers of the country, Trotsky became acquainted firsthand with the country's critical technological weaknesses, and first of all with the ruination of the transport system that had left the city isolated from the countryside, without food and fuel. What little equipment and machinery the Bolsheviks had nationalized when they seized power was outdated, and what little they actually controlled was in need of repair or simply ruined by years of war, especially steam engines. Nothing could be achieved without repair of transport and engines. He proclaimed, "Proletariat, to the machine tools, proletariat, to production!"[49]

Trotsky realized that science and technology reflected the politics and values of the ruling class. He noted that "technique and science have their own logic—the logic of the cognition of nature and the mastering of it in the interests of man. But technique and science develop not in a vacuum but in human society, which consists of classes. The ruling class, the possessing class, controls technique and through it controls nature. Technique in itself cannot be called either militaristic or pacifistic. In a society in which the ruling class is militaristic, technique is in the service of militarism."[50] Similarly, technique and science undermined superstition and religion but also abetted it. Anticipating the persistent attack of modern science by religious fundamentalists into the twenty-first century in the United States, he noted that radio broadcasts of church sermons meant that the radio could serve to spread prejudice. In the Soviet Union, since it was controlled by the vanguard of the proletariat, it would summon the masses to victory: "We have guaranteed the victory over poverty and superstition by advancing technology forward! We cannot lag behind other countries. The first and basic slogan which should be anchored in the consciousness of every friend of the radio: don't lag behind!"[51]

The solution was for the USSR to surpass the advanced countries in the high culture of modern technology. Because of its Tsarist Russian inheritance, the USSR was "extraordinarily backward in relation to the advanced capitalist countries." Given that the capitalist countries continually moved ahead, did this mean that the USSR would always lag and risk being crushed? Trotsky pointed out that capitalism had entered a period of final decay, a blind alley, while the USSR had liberated man's potentialities through new organizational forms, including the planned development of science and technology. But he urged his comrades to remember that "the material accumulations of technique, i.e., not that technique which exists in men's heads, but that which is embodied in machinery, factories, mills, railways, telegraphic and telephone services and so on, here above all else it is clear that we are fearfully backward." He therefore urged his country to focus precisely on communications: steamships, postal services, radio, the telegraph and the telephone, and railroads.[52]

Widespread, inexpensive access to telephones in twenty-first century Russia that extends to all regions of tundra and taiga represents a stunning turnaround from the Soviet era, when phone service was miserable on all counts (and is also a shock to Americans given the spotty and costly service U.S. cell phone companies provide). It took years for a citizen to get service unless he or she was a member of the elite. Calls required tremendous lung power; customers often had to scream into the receiver to be heard across town let alone in long-distance calls, a phenomenon that led to the joke, "Vanya, why not just open the window to yell. You'll be heard just as well in Rostov." In 1917 the nation had about 240,000 telephones versus 700,000 for Britain. While in Europe and the United States telephone service expanded as a matter of course in the early twentieth century, in the USSR it actually shrank in the 1920s for both reasons of technology and reasons of service, in spite of the fact that the Bolsheviks and Lenin in particular understood the importance of controlling the telegraph, the telephone, and the postal service.[53] The civil war and growing significant shortages of labor and capital led the Bolsheviks to order volume of telephone communications cut, with the remaining capacity serving essentially governmental and economic services. This led to communalization of phone service for citizens. During the New Economic Policy, the authorities likely deliberately suppressed service to prevent unmonitored horizontal communications, at the same time learning to monitor conversation. Another reason for the shrinking of phone service was that the Commissariat of Heavy Industry had limited budgets and other obligations, so it dumped unprofitable telephone exchanges on local government that had even fewer resources; this stifled development for the long term. The suppression of numbers of subscribers was surprising given that both Lenin and Trotsky believed that communications and transport technologies would help create that all-important *smychka* (the economic and cultural connection between city and countryside).[54]

Spotty and poorly funded service was particularly pronounced in regions far off the beaten path. Poor telegraph, telephone, and postal functions in the Russian north indicated the scope of the problem. How could the Bolsheviks establish industries, collective farms, and other enterprises; monitor their operation; and ensure public safety and emergency care when many of these organizations did not have telephones until the 1960s? Regional officials, managers, medical personnel, and others recognized the role that phones would play in promoting economic growth, political control, public health (emergency medical service), and so on. Unfortunately, precisely low population densities and great distances convinced planners that limited investment funds might better be used in other sectors of the economy, notably in heavy industry. Officials also worried about their ability to control information. Hence, they supported the growth of telephone service in larger cities and made phone numbers available largely to well-placed individuals.

Yet even being designated a priority was no guarantee of success. For example, in the mid-1930s officials of the Arkhangelsk Automatic Telephone Station had to exert great pressure on the "Sevkabel" factory to produce telephone line after years of unfulfilled production promises. Sevkabel production of telephone line reached 24 kilometers in September, 39 kilometers in October, and 35 kilometers in November 1935. Soon they would have 3,000 customers in this important city of lumber, fish, and shipping, which would also serve as a Bolshevik beachhead of political control—but only if the Krasnaia Zaria (Red Dawn) factory manufactured phones.[55] Nikita Khrushchev's greater openness and desire to invest in the consumer sector led to rapid expansion of service in the 1950s and 1960s. Still, investment in this sector was one-third the level of that in the United States, and long-distance service lagged two to three decades behind that in the United States in 1970. The alternative to home phone service was to place calls through the local post office. Citizens usually had to wait an hour or longer to get a connection, meaning that on average the citizen had only two conversations per capita annually. Industrial enterprises dominated phone service. As of 1970, residences had roughly half of the nation's phones, with only 14 percent of telephones in villages, mostly concentrated at collective farms.[56]

Bringing the City and Countryside Together: *Smychka*

One of the major challenges to the modernization of Russia that had baffled the nation's intelligentsia and its enlightened leaders was the backwardness of the Russian peasant, his outmoded agriculture, his lack of awareness of any world beyond the farthest fields, and the absence of any sense of civic culture.[57] Trotsky, too, believed that the low level of economic and cultural development of the *narod* (Volk or "people") created the main obstacles to building a modern socialist economy. This reflected the cultural and economic lag between the city and the countryside in all ways: the worldview of villagers, the poverty of their lives, their low labor productivity. Trotsky saw modern technologies as the way to bridge the gap between the city and the village, what came to be called the establishment of *smychka*, a link between them, between the proletariat and the peasant, the new and the old, the modern and the outdated. At the end of War Communism and during the New Economic Policy (NEP), Trotsky addressed the importance of the establishment of *smychka* in a series of publications and speeches, with various technologies serving as emissaries of cultural change.

The Soviet empire stretched from Europe to the Pacific Ocean and from the Arctic Ocean to Central Asia. Toward the ends of modernization, and of control over space, time, people, and resources in the vast empire, the Bolsheviks sought to impose industrial forms and organizations on what they considered to be an outdated, irrational way of life, on people, and on nature itself. They had to simultaneously impose new, modern ways of surveying, tabulating, arranging, organizing, and manipulating resources and people and employ vigorous methods of overwhelming local ways of seeing the world. As Scott describes it, the Bolsheviks needed to see this vast space like a state, using modern science to collect aggregated and accurate data.[58] Trotsky provided several examples of the peasant's outdated and inaccurate view of the world that needed to be overcome. If you asked a peasant how many versts (a little over a kilometer) it was to the village of Ivashkova, Trotsky wrote, he'll tell you three, while it might be seven or eight. As war commissar, Trotsky had encountered an arbitrary and inexact attitude to space and time that inhibited proper military action no less than it inhibited modernization of the countryside. When he ordered artillery to a critical engagement, he had to hope for modern roads and capable soldiers who understood space, time, and trajectories. Trotsky granted that the peasant of the 1920s, the peasant who embraced the tractor, was not the same peasant he had been in 1861 after emancipation, nor who he was on the eve of World War I. His conditions of life and consciousness had experienced great change. Yet the continued problem of the peasant's outmoded way of thinking would be heightened during pursuit of socialist construction because "industry, machine production, by its very nature demands exactness." A wooden plow may turn soil this way or that, but if the teeth of a wheel did not mesh precisely with the gears, "the entire machine will stop running or break." Peasants needed to learn how to operate machinery properly. Similarly, the machine would bring about a change in peasant worldview. Trotsky wrote, "Only broad development of machine economy, the proper disposition of labor and its correct organization will train the habits of exactness and accuracy."[59]

Trotsky was not worried about the fact that the first steps of socialist development occurred on the foundation of the technology, culture, and other remnants of the old regime. Political revolution ensured the proper direction of further development. Yet, while the Bolsheviks had taken great steps forward in securing political power, they had fallen short elsewhere, especially in the economy, agriculture, and technology. For example, electrification had moved ahead on an old path: first of all, on the programs of engineers from the old regime, and second, on peat, not on oil power. A successful national electrification program required not only advanced technology but the training of new engineers, technologists, and workers, with rural teachers leading the way in rural schools by propagandizing the virtues of modern technology, and with advanced research at such central institutes as the Timiriazev Agronomy Institute. This, in turn, Trotsky argued, would facilitate the penetration of advanced machinery and equipment into agriculture and enable agronomists to bring the latest discoveries to the peasant, with better harvests as the result.[60]

Trotsky believed simply that industrialization of agriculture, a central feature of socialist construction, would end the contradictions between the city and countryside, between the peasant and the worker. He envisioned a society "where mechanized field-crop cultivation makes up an equal part of planned economy, where the city absorbs the advantages of the countryside (its expanses and greenery), and the countryside will become enriched by the advantages of the city (paved roads, electrical illumination, plumbing and sewage)."[61] The modern, highly productive peasant would begin to think about the sale of surplus at distant markets. In general, socialist industry would thrive with the establishment of *smychka*, with raw materials from the countryside going to cities, and with tools, machines, and electrical energy going to the village. Socialist industry would produce the miracle of "mechanization of agriculture." Trotsky offered this metaphor for the socialist technological revolution in the countryside: "Every tractor is a small tugboat of industry that is charged with pushing the peasant economy out of the swamp of the open-field system[62] and thoughtless wasteful labor." He continued, "The tractor is not only technological, but also a cultural tugboat."[63] As noted, the Soviet Union imported thousands of these "tugboats" in the 1920s, using them to force the pace of industrialization of agriculture and transformation of the peasant worldview. The fact that most of them would be imported did not trouble Trotsky since the tractor could serve its capitalist masters to exploit the agricultural worker, or its socialist peasant to produce surplus of benefit to all.[64]

Modern technologies of transport were the final component of the technological revolution needed in socialist Russia. Trotsky noted that by all indices—total length, kilometer/tons of freight, and so on—Russia was far behind the United States and Europe; the United States had almost 6 times more railway than the USSR.[65] He wrote, "Our huge space without the railroad reminds us, first of all, of our extreme economic and cultural lag. Railroads—are the communication connections of the country, they are the channel of the cultural influence of the city on the countryside." Yet technology required socialist comprehension and application. Without Bolshevik leadership, the railroad could not fulfill its manifest goal. And if the railroad connected the empire's immense spaces from cultural and economic points of view, then from the point of view of politics the Bolshevik played "the same role that the railroads play in relation to our spaces. This—is the connection, this is *smychka*, this is the path of the cultural influence of the capital on the province, the province on the district, the district on the region and so on lower and lower."[66]

In a speech at the opening of the first All-Union Congress of the Society of Friends of the Radio on March 1, 1926, Trotsky referred to the way that radio established *smychka* with Turkmenistan, a republic larger than any European country, whose inhabitants lived in isolated oases. In the absence of roads and railroads, radio facilitated the first steps of socialism. Trotsky observed that three-quarters of rural inhabitants did not know what a radio was, and that the other quarter knew only because of isolated Bolshevik demonstrations of this modern miracle. Yet he ridiculed skeptics for doubting the ability of the Soviets to use radio toward socialist ends, or in general to use the latest achievements of science and technology in ways impossible under capitalism. He asked skeptics to consider the fact that within the last twenty-five years the automobile, the airplane, the phonograph, and the tractor had changed the world before their very eyes.[67]

The railroad would facilitate the next steps of modernization in backward Turkmenistan. An early hero project, the Turksib (Turkestano-Siberian) Railway, a "firstborn of the Five Year Plan," was intended to link the grain-surplus areas of Siberia with the grain-deficit but cotton-rich territory of Turkmenistan. Viktor Turin's documentary film, *Turksib* (1931), captures the enthusiasm of the workers who successfully built a railway 1,440 kilometers in length from Frunze in Turkmenistan to Semipalatinsk in Kazakhstan, through some of the most inhospitable and desolate landscapes in the world.[68] In *Turksib* technology plays a glorious role, unlike that, according to Pare Lorentz, who produced the film *The Plow That Broke the Plain* (1936), where modern agricultural technology creates the Dust Bowl in the Great Plains states in the 1930s. Yet while leaders saw technology as a tool to build socialism, to establish *smychka*, to develop resources, to train workers, and to modernize Central Asian peoples, the local Kazakh workers were treated as backward, unskilled, and unequal in spite of their contribution to the project.

For Trotsky, the leading technology, and therefore the highest form of culture, was the Fordist system of mass production based on the conveyor. Trotsky observed that the principle of socialist economy was harmony. Technologically, harmony found "its highest expression in the conveyor . . . Now it is generally known how Ford uses a combination of conveyors as a means for internal transport: transmission and supply." He continued, "Socialist organization of the economy should strive to remove the physiological burden of the individual worker" through the conveyor and "secure technical agreement with other workers."[69] He was so enamored of conveyors that he saw modern hydroelectric facilities as "gigantic melioration systems—water conveyors of agriculture." Once modern fertilizers, modern machines, and electricity made it to the countryside, "the more completely will our present agriculture be included in the system of the socialist conveyor."[70] Trotsky was overjoyed at the prospect of large-scale enterprises, standardization of production, specialization of firms, and transformation of entire industrial plants into mighty consolidated "works," apparently having in mind such facilities as Henry Ford's River Rouge factory.[71]

Standardization would achieve full success in socialism where it would be facilitated by the "true nationalization of the scientific-technical knowledge" and centralized planning. Instead of each purchaser having "to improvise and grope around," he instead had access to finished samples best representing his needs as a result of scientific investigation.[72]

Trotsky's willingness to force workers to employ military techniques to raise industrial production and his effort to impose on the entire nation every advanced industrial, communications, and transport technology to overcome spatial, temporal, and ideological distance between city and countryside indicate limited understanding of nascent environmentalism in Soviet Russia. In Trotsky's view, both people and nature had to conform to the desiderata of modern technology. A movement to create a network of nature preserves (*zapovedniki*) gained momentum in the 1920s, although it faltered gravely under Joseph Stalin and Nikita Khrushchev, who saw mainly economic value in exploitation of nature.[73] Trotsky supported the establishment of *zapovedniki* but was impatient with the capriciousness of nature. He seems to have called directly for the subjugation of nature. In an essay entitled "Literature and Revolution" (1924) he wrote the following:

> The present distribution of mountains and rivers, of fields, of meadows and steppes, of forests, and of seashores, cannot be considered final. Man has already made changes in the map of nature that are not few nor insignificant. But they are mere pupils' practice in comparison with what is coming. Faith merely promises to move mountains; but technology, which takes nothing "on faith," is actually able to cut down mountains and move them . . . in the future this will be done on an immeasurably larger scale, according to a general industrial and artistic plan. Man will occupy himself with re-registering mountains and rivers, and will earnestly and repeatedly make improvements in nature. In the end, he will have rebuilt the earth, if not in his own image, at least according to his own taste. We have not the slightest fear that this taste will be bad.[74]

Taken with his other writings on electrification, industry, the establishment of *smychka*, and so on, Trotsky was well within the Bolshevik mainstream of party officials and engineers who believed that the productive forces must be developed at breakneck speed, regardless of the environmental costs. He also shared the prevailing view of officials and engineers in other countries. Like their counterparts in the U.S. Army Corps of Engineers and Bureau of Reclamation, Soviet engineers with various construction trusts and engineering organizations hated swamps, despised meandering rivers, and detested the flow of water downstream without using it for a variety of municipal, agricultural, or industrial purposes. Bodies of water were meant to have utility year round; wastelands were meant to be gardens. Whether Turkmenistan or the Plains states, nature must be made beholden to the state.[75]

Trotsky, Lenin, and others believed that at least a generation was required to raise the level of culture of the peasantry. The NEP, passed at the Tenth Party Congress in 1921 to jump-start the socialist economy with small-scale private businesses, was a breathing space, a time for the "assimilation of the simplest information, knowledge, methods and habits." Shortly, modernization would occur along "socialist rails."[76] Trotsky discounted the fear that the USSR would always play technological catch-up behind the advanced western nations if it relied on capitalist institutions and technologies. But "never forget," Trotsky wrote, "that the work of scientific-technical thought in bourgeois society has achieved its full flowering in such a period when the economy of bourgeois society all the more falls into a blind alley and rots. The European economy will not go forward. Europe in the last fifteen years became poorer not richer. And it has had colossal inventions and discoveries."[77] The question was rather how to overcome backwardness in the USSR. "What will transform the country into a unitary economic and cultural whole?" Trotsky asked. His answer? Technology. He called for significantly greater expenses on post, telegraph, telephone, and other technologies to bridge the great space and time of the Soviet empire. Only technology would create *smychka*. Trotsky wrote, "Developed socialism signifies first of all the technological and cultural equivalence of the city and the countryside." Ultimately, the fusing of city and countryside was "a question of life and death."[78]

Technology Decides Everything, or Technology Masters Us

So long as Leninist attitudes toward the specialists prevailed, scientists and engineers retained a good deal of autonomy, and the efforts of such leftist groups as the Workers' Opposition, who found Lenin's position to be pandering to specialists at the expense of the proletariat who really ought to rule, and militant communists were blunted. After Lenin's death, tensions grew between party officials, responsible for seeing the resurrection of industry destroyed during World War I, revolution, and civil war, and scientists and engineers, who had become used to a modicum of freedom in establishing research directions in newly founded institutes. Pressure grew for them to produce technologies, techniques, and processes that served the state and the proletariat directly. During the industrialization campaign of the 1930s, this unrelenting pressure forced many of them to toe the line to production and turn to narrow technical subjects. Otherwise, they risked facing accusations that they engaged in "ivory tower reasoning" divorced from the needs of the working class. Still, such Bolshevik industrial leaders as Valarian Kuibyshev and Sergei Kirov defended the engineers against the most demeaning of these demands, although suggesting that they could do more for the national economy.[79]

During the NEP, Stalin warned of the need to build socialist industry in the coming years so that the nation would not become an appendage of capitalism, but rather an independent economy that relied mainly on an internal market and on *smychka* between industry and the peasant economy.[80] Although the nation had reached prewar levels of production by 1926, it remained agrarian. The next steps of the unfolding of socialist industry on the basis of advanced technology demanded great capital investment, and its lack meant that future growth would be only at the tempo of recovery. Yet in 1926 Stalin did not yet insist on rapid industrialization, but he called for investment in local industry to satisfy the people in each region, province, and republic, because without support of local industry there could be no *smychka*. Stalin referred to Lenin, not Trotsky, to justify this moderate view.[81]

In 1923 Georgii Piatakov, the deputy chairman of the Supreme Economic Council who had been involved in the resurrection of the Donbas coal industry and also worked in Gosplan (the State Planning Administration), tried to dissolve NTO and place each research organization directly under the industrial trust for which it worked. This would have tied research tightly to pressures for immediate application. But the chemist Vladimir Ipatieff, a patriot who had served Tsarist and now Bolshevik science, but eventually emigrated to the United States in 1931 over the increasing restrictions on his life and work, joined other scientists in convincing Bukharin, Trotsky, Dzerzhinski, and other party officials of the view that, inevitably, research would in all events lead to myriad applications for the benefit of the proletariat.[82] As noted, on their way out of political favor, both Trotsky and Bukharin were demoted to service as chairmen of NTO, a move that suggests how much respect for scientific autonomy had fallen since the death of Lenin. From this position Bukharin pushed for planning of science to ensure the proper level of funding, geographical distribution, presence of well-trained specialists, contributions to the economy, and an end of "ivory-tower reasoning."[83] However, the relatively poor record of NTO institutes in producing these applications, as well as the rise of communist bureaucrats who were impatient for results, led to the expulsion of Ipatieff and others from NTO. Subsequent NTO directors emphasized economic concerns and hoped to improve industrial performance by linking it to research.

Yet, NTO leadership still far from embraced the mercenary, mechanical view of science and technology that ultimately prevailed under Stalin. In the late 1920s, when Bolshevik leaders debated when to end the NEP and how rapidly to pursue industrialization, Kuibyshev, a major industrialist, and also head of NTO and later of Gosplan, fought to protect the autonomy of scientists and engineers.[84] He opposed Stalin's determination to bring specialists to heel through a series of show trials and other pressures, and he also defended autonomy for factory managers, recognizing that they might be an important source of innovation. He called for factory managers to be given flexibility in the formulation of plans and fulfillment of targets through "decentralization of operative activity." He wrote, "Real people who are building our industry, to whom this matter is near and dear, should not be deprived of initiative which may facilitate and will of course facilitate the development of industry."[85]

In a speech at the first All-Union conference on professional and technical education in September 1927, Kuibyshev urged acceleration in the training of large numbers of engineers to meet the growing challenges facing industry. Soviet engineers were not only few in number but also poorly trained. One of those challenges was "a lack of preparation when our personnel order equipment abroad for our industry." He declared, "We do not know the newest achievements of technology, and we do not know how properly to indicate specifications. Our technical thought is poorly tied to new production." This was a serious problem given that American innovations frequently "change the entire picture of industry."[86] Kuibyshev constantly urged the study and assimilation of western technology and consideration of how most quickly to master European and American achievements as crucial to the needs of socialist construction during the first five-year plan, not the short-sighted rejection of them.[87]

Like Trotsky, Kuibyshev was enamored of the assembly line and believed that it was essential for Soviet industry to adopt modern mass production techniques rapidly. In the journal *Standart* Kuibyshev published an article in 1931 in which he argued that the problem of quality control in industry could be solved through the application of centrally determined production standards. He wrote that only the USSR had propitious conditions for the further development of standardization. Under capitalism, different firms meant different standards that led to waste and duplication of effort, while in the USSR the central authorities could legally set national standards, order them throughout a corresponding branch of industry, and standardize on a much larger scale. Kuibyshev blamed the poor results in standardization on the factory manager who did not yet understand the relationship between his responsibilities and national programs.[88] The fascination with centrally determined standards found constant expression in technologies across the nations of East Central Europe (chapter 2).

Sergei Kirov, the Leningrad Party chairman until his murder in 1934 at Stalin's behest to eliminate this potential rival, began his party career in the Caucasus in political and military work, but he preferred agitation. He frequently visited Leningrad's major factories—Elektrosila, Bolshevik, Krasnyi Putilovets (known for its locomotives and its copies of the Fordson tractor), Red Nail-Maker, and others—to propagandize higher production and to celebrate the production of ingots, turbines, tractors, and no doubt nails. (He also spoke about the glories of the victory of Stalin over Trotsky and Zinoviev in the struggle to carry Lenin's mantle; later, he developed doubts about Stalin's leadership, but his murder prevents us from gauging the depth of his concerns about him.)

Kirov directly engaged modern science and technology. He pushed the expansion of hydroelectricity through GOELRO, in December 1926 praising the opening of the Volkhovskaia Hydroelectric Power Station. The Volkhovsk station, whose Bauhaus-like machine hall is visible to this day from trains out of Petersburg going north to Karelia, had symbolic and economic significance. The travails of its construction also reveal the epic obstacles the Bolsheviks would continue to encounter at every work site of building socialist industry. Lenin himself joined GOELRO engineers in approving the construction of this station, although he died before its completion in 1926. In virtually every discussion of the history of hydroelectricity, Soviet authors mention the station as the first "brilliant" step on the path to electrification. The station fostered regional development in Leningrad Province, including ultimately stimulating another "first": another resource-intensive facility, a factory that produced the first aluminum ingots of Soviet power in 1934.

Many of the Bolshevik hero projects had prerevolutionary roots. Scientists and engineers who fantasized about magnificent central electrical power stations and canal, lock, irrigation, reclamation, railroad, road, and bridge projects to end the scourges of drought and famine and to bring Russian industry into the twentieth century now had partners in the Bolsheviks, especially Lenin and

Trotsky. The engineer in charge of Volkhovstroi, Count G. O. Graftiiu, had published a series of articles in such journals as *Elektrichestvo* on a Volkhovsk project before the revolution, and he gave a speech to the Society of Electrical Engineers on the eve of World War I proclaiming its importance to the future of the nation. Bolshevik officials approved the project on May 26, 1918, just as civil war broke out.[89] The project moved forward slowly and manually, taking years longer than a peacetime project might take. Site conditions were the major reason for the slow pace. Men armed with pikes, picks, hammers, and sledgehammers felled trees, gathered boulders, built caissons, and laid rail. They lived in barracks and mud. In the absence of domestic sources, Volkhovsk engineers turned to the Swedish firm Nydqvist och Holm AB (NOHAB) for ten turbines and Allmänna Svenska Elektriska Aktiebolaget (ASEA) for four generators since Soviet industry could not manufacture them. In 1920 NOHAB received an order from the Soviet government for 1,000 steam locomotives, which was later cut to 500 owing to political uncertainties; these were delivered between September 1921 and December 1924 and paid for by fifty-six tons of gold.[90]

Officials always announced the next hero project as the first, the largest, the fastest built, the most progressive, or the one that excavated the most earth and poured the most concrete. Indeed, for the very first technological feat, the "child of Lenin," the Volkhovsk hydroelectric power station, officials touted its glories, although when completed it usually ran at half of its capacity. Workers and engineers joined hands to build the station during "the darkest pages of history of revolution" when they had literally nothing, "neither iron, nor brick, nor excavators, nor tools, nor even nails." Officials made the project a priority, requisitioning what they might from as far away as Siberia. Here they scrounged up some flywheels and ingots to resmelt, and there they scoured the country for timber, steel, cement, wires, motors, and bread to feed the workers. Construction dragged on for over five years, consuming 16,000 tons of iron, 80,000 tons of cement, 5 million bricks, and 40,000 cubic meters of stone.[91] Yet officials concluded that this was worth the expense and effort in order to honor the memory of Lenin, and because the construction site served the ends of both employment and training unskilled workers on the fly.

Already experiencing the kinds of spoken and unspoken pressures that prevailed in the Stalin era, engineers learned on the job much of what they ought to have studied before commencing such a large-scale project. Before sinking a shovel, they should have considered thoroughly the river's hydrology, currents, annual and seasonal flow, soil, and geology. Yet their enthusiasm to embark on grandiose nature transformation projects—and under Stalin the unyielding pressure to finish the projects—often led them belatedly to consider important physical and technical details. At Volkhovstroi, the engineers established a working group of hydrologists to focus on the "ice tyrant" (ice formation, ice flows, and so on) only in 1924, years into the project. Because of the poverty of the project, the haphazard nature of securing machinery, equipment, and supplies, and the high learning curve of engineers and workers alike, Volkhovstroi transmitted power to Leningrad only in December 1926 and as late as 1928 operated at only 64 percent power.[92] At its dedication, Sergei Kirov, by then secretary of the Leningrad Party organization, declared, "Leningrad workers today celebrate a new victory, but to us [the Volkhov station] already means very little. We are obligated to move forward and on the experience of Volkhov to build more powerful stations. We must learn to build so that we can escape the need to buy equipment abroad. Our government is doing all it can so that everything—from the first brick to the complex machines—is manufactured by our own hands in our factories. And we will achieve this."[93]

Kirov was involved in the establishment of the USSR's first aluminum plant, powered by the Volkhovsk station. Military officials love aluminum for its strength, light weight, and flexibility. Aluminum requires a great deal of electricity to produce. Many major hydroelectric power stations produce copious amounts of inexpensive electricity, and many of them were brought on line before consumer demand warranted the construction of such large stations, for example, on the Angara River in Siberia, on the Columbia River in Washington State, in the Tennessee Valley, and along the Sao Francisco, Tocantins, and other rivers in Brazil. In each case it was built to serve the masses, and yet in each case the lion's share of electricity went to industry, industry of importance to the state, and not only aluminum production but often uranium and plutonium production for nuclear weapons. Volkhovsk became such a site to produce aluminum ingots. Construction on aluminum smelters began in 1930 on the right bank not far from Khalturino where the employees lived. The factory arose again under very difficult conditions—much of the work was manual in the absence of machinery and equipment. Exhorted by political instructors and assisted by French consultants, the workers toiled in mud, rain, and penetrating northern winds, finishing construction in April 1932 and producing the first Soviet aluminum three weeks later. A series of accidents plagued production, and only in 1938 did the plant operate normally.[94]

For Kirov, too, the success of socialist construction depended on overcoming the obstacles of outdated machinery and outmoded thinking. This would not be an easy task since it required "to resurrect the old factory left by the capitalists, to repair old, rusty machine tools and bring them into operation, or to get this or that furnace that has been standing idle for several years to breathe and fire up . . . and to create on our soil new factories on the latest word of contemporary technology." Kirov urged not a follower's envy of America's great factories, but taking the lead in technological innovation. To build this modern technology required transforming the peasant's worldview. Kirov said, "It is necessary to wean the *muzhik* from praying before Nicholas the Wonderworker . . . so that, not in words but in deeds, he really becomes accustomed to electricity and other such things." He continued, "You cannot give a *muzhik* a tractor and other magnificent tools of production, if he still puts greater hopes in Nicholas the Wonderworker than in, say, an internal combustion engine."[95]

While Kirov welcomed foreign technology as a foundation for Soviet achievements, like other Bolsheviks he began increasingly to worry about the reliability of foreign experts and got caught up in the fervor of the antiwrecking campaign. Might capitalist engineers be in the service of foreign capital? He accused bourgeois specialists in a 1930 speech to the Caucasian regional party committee of sabotage. Kirov asserted that agents of the bourgeoisie and interventionists had penetrated literally every region of the economy, including transport, agriculture, even planning and economic organizations, although, Kirov assured his audience, they were not capable of slowing socialist construction. Still, the Soviets needed the participation of these specialists at Dnieprostroi, the Stalingrad Factory, Magnitostroi, and other hero projects of hydroelectricity, tractor manufacture, and the like. He declared the following:

> You all know what difficulties our new factories give us, our new giants, our new plants. We built the Stalingrad Tractor Factory upon the latest works of European-American technology—this factory has no equal literally in the world. We are insufficiently experienced in technology—in this relation we are still barely literate, but we invited to Stalingrad well-known specialists from around the world, and no matter how difficult it was, we brought the factory on line. Further, we are building the Magnitogorsk giant. And for this we enlisted the best, the well-experienced American engineers, but Magnitostroi for them was a new thing, and together with us they racked their brains. You yourselves understand this wasn't a very easy or simple thing.[96]

Kirov reminded the party faithful of the need to be free from dependence on capitalism. But to be fully emancipated from the West, they needed to create a working-class technical intelligentsia; many factory directors unpatriotically preferred foreign equipment to Soviet technology.[97]

Stalin Wants the *Muzhik* to See Him as the Father of All Technology

Recognized for his crude understandings of politics and society and unsophisticated interpretations of Marxist thought, perhaps Stalin alone among early Bolshevik leaders recognized that technology and science were inherently political, reflecting as they did fundamental beliefs about how nature worked, the human relationship to nature and to the operating economic system, and even epistemological understandings.[98] Technology in and of itself was no longer the key to the Soviet future. Stalin and other militant communists understood that economy and polity shaped technology and thus insisted that the political and economic systems be reformed to reveal the proletarian reality as they comprehended it. When the nation embarked on Stalin's self-proclaimed Great Break (*velikii perelom*) with past party programs, he announced that "Technology will decide everything!" But workers and engineers alike had trouble with this slogan—and with the machines. Within a few years, facing "hostile capitalist encirclement" and a variety of treacherous enemies within the socialist fortress, Stalin declared instead that "Cadres will decide everything!"

Stalin's rise to power fundamentally changed attitudes toward the place of western technology in the USSR. Stalin promoted autarky, at the same time exaggerating the innovativeness of Soviet industry and technology. He insisted on Soviet engineers going their own way, yet he required that they master western achievements through purchase, reverse engineering, and espionage. Stalin was a propagandist who spoke in riddles and myths so that his audience might debate the essence of his meaning. In his early writings he addressed the importance of modern western technology and expertise in socialist construction and in the transformation of agriculture. He gave the impression that he shared Lenin's view that some time would be needed before the peasant had reached a cultural and economic level suitable for collectivization. After he won the struggle with Trotsky, and then Zinoviev, Kamenev, and Bukharin, to succeed Lenin, however, he came to reject the NEP and expressed only impatience with the pace of industrialization and with the intransigent peasant who refused to ally himself with the Bolsheviks. He was enamored of huge increases in the output of the metallurgical, mining, construction, machine-building, and electrification industries[99] and regarded investments in the consumer, housing, and health care sectors of secondary importance. The Stalinist plan for the collectivization of agriculture was intended to extract capital from the countryside for industry, not to create *smychka*; until the collapse of the USSR, agriculture remained a sore spot in production, a place of poverty, shortages of consumer goods, inadequate health care provision, and out-migration of young men and women.

At the center of Stalinist development programs stood huge construction projects important for symbolic and ideological reasons as well as technical and economic ones. The authorities concentrated great resources on these projects—the Dniepr hydroelectric power station (DnieproGES in Russian), the Belomor-Baltic Canal, the Magnitogorsk Steel combine, the Moscow Metro—such that even crucial infrastructure of roads, hot and cold water, electricity, and railroads lagged, not to mention even greater lags in housing, schools, hospitals, and stores. Work sites were amorphous concentrations of mud and garbage, sewage and mosquitoes, ice, snow, and wind, tents and barracks, temporary buildings and piles of rubble, rarely with a formal plan for municipal works, let alone roads, buses, and trams to transport workers from home to work—yet with the intense motion of frenzied construction. The Stalinist projects were quantitative leaps in tons excavated and poured, numbers of workers employed, kilowatts of capacity planned, and symbolism of socialist victories achieved. DnieproGES, in the words of popularizers, symbolized victory over rapids that had been "foaming for ages." It was designed for 810,000 horsepower, at the time the largest station in the world. It reflected, as H. G. Wells observed, the switching on of the lights of the "Dreamer in the Kremlin [Lenin]," the "creator and inspirer of the ingenious electric Utopia of Soviet Russia."[100] Yet, technology became technology for Stalin and the state, not for the sake of the worker.

Early urban plans to provide the correct environment for hard work and joyous living were abstract, even unrealistic in design, reflecting ideals of "disurbanized" industrial life, not what was possible given Soviet poverty, backwardness, and the pressures of the leaders to meet superhuman targets ahead of schedule. For example, the first blueprints for Magnitogorsk saw the city organized along narrow ribbons of activity that tied industrial and agricultural regions together and ensured the preservation of green zones.[101] As with other production cities, Magnitogorsk turned out to be an agglomeration of housing, waste, and pollution, centered around smoke-belching industry, a city where one-third of the adults and two-thirds of the children under fourteen years old have suffered from respiratory infections, and where birth defects doubled from 1980 to 1990 (see chapter 5).[102]

Why did political authorities and planners decide to concentrate resources at a few major construction sites? Why did entire industrial cities come into existence? Was Stalinist coercion the only way to transform the worker's worldview in one generation, in one five-year plan? They were forced to make this choice for several reasons. One was a shortage of resources during nationwide building campaigns that stretched capital and skilled labor resources to the limit. Another was precisely the decision to use construction sites as forums to transform peasants and workers into conscious communist proletarians. A third was recognition of the symbolic value that large-scale projects would serve both at home and abroad to demonstrate the glories of the communist system. A fourth was the opportunity to try out such domestically produced and imported technologies as turbines, tractors, and other earthmovers on the fly while determining how best to employ them throughout the empire. There were two problems with the latter tactic. First, workers often poorly understood how to use them, and frequently the machinery and equipment were damaged at a work site or even rusted as they waited in a field exposed to the elements. Second, engineers sought prematurely to fix parameters for technologies that held across eleven time zones and wide-ranging climate and geography, since they did not have the time or resources to be constantly innovative in the face of plan pressures.

Those pressures grew sinister under Stalin. When party leaders signaled their intention to transform radically the relationship between specialists and the state, it triggered a violent campaign to subjugate the scientific and engineering community to economic development programs. It was directed physically at specialists whose training dated to the Tsarist era and at foreigners, both of whom communists had come to believe were inherently untrustworthy as representatives of the bourgeois social order, and it was directed psychologically at all future specialists. In 1928 and 1930 Soviet prosecutors held two public show trials at which they accused engineers of being wreckers and/or spies on behalf of foreign powers. The trials were the culmination of the so-called Industrial Party Affair and the Shakhty (Mining) Affair. In March 1928 the authorities arrested five German technicians and fifty Soviet engineers involved in installing—and allegedly sabotaging—turbines and mining equipment in the Donbas, accused them of being involved with a fascist organization, and implicated German firms in the affair. The Soviet Union needed western assistance, so this was a strange charge, all the more so since, at the subsequent show trial in the summer, it was clear that the authorities had orchestrated the trial to the last detail. While the German engineers were released, eleven prisoners received death sentences.[103] For the so-called Industrial Party Affair, during a trial of November–December 1930, the prosecution accused Soviet engineers of having formed anti-Soviet "Union of Engineers' Organizations" with ties to Mensheviks that set out to wreck industry and transport in the preceding four years.[104] For most scientists and engineers the lesson was clear: do not engage in politics, do not fight young party bosses over the appropriate role of scientists in Soviet society, and do not argue with the plan that should take precedence over any scientific consideration of what was rational or possible. Even more, be wary of innovation if it conflicted with short-term plans, and do not audibly praise European or American technology.

One foreign observer commented that the regime treated foreign engineers, its "engaged servants," with fear. They were "perpetually under a cloud of suspicion." According to a Soviet informant, the struggle with specialists was like a pogrom: "Specialists are terrified, much to the detriment of the cause. Frequently they do not venture upon any innovations, to avoid compromising themselves with a failure, but are content to imitate what has been well tried by others," he told the observer. Cultural works heightened the suspicion. Consider Nikolai Pogodin's play *Tempo*, with a run of over two years in Moscow Trade Union Theater, a "comedy" that revolves around bringing a factory up to full power and the relationships between red specialists and foreign specialists—that is, between inherently honest and dishonest people. Through *Tempo* audiences learned that enemies lurked everywhere at every construction site.[105] In *Tempo* the American engineer, Carter, perhaps modeled very loosely on Hugh Cooper, who helped build DnieproGES, notes that Soviet achievements—168 percent overfulfillment of the plan—are "outside the reach of any country with a different political organization from the one existing here."[106] The comedic aspects of the plot may have something to do with the treatment of bumbling "wreckers" and with characterizations of several Russian workers. Carter refers to the workers as "good men, but they do scratch themselves too much . . . Tell them not to be afraid to change their underwear occasionally. Tell them it is already seven and time to start on their work."[107]

Once the industrialization campaign had commenced, Stalin abandoned any pretenses about seeing technology primarily as a tool of liberation for the working class. It had become an instrument of state control, a symbol of state power, strategically essential to the preservation of the USSR and "socialism in one country." Soviet technology would differ from capitalist technology in its design, organization, speed, and efficiency. Beyond the claim that socialist technology would benefit the entire working class, it is unclear how in reality it differed except in being of simpler rudimentary design. At the same time, Marxist scholars and scientists argued strongly that science under socialism also differed from science under capitalism because only the former was planned and rational and served the masses, not the profit motive; it even had a different methodology. This thinking contributed to the rise of Lysenkoism in biology, a kind of Lamarckian system based on the notion of the inheritance of acquired characteristics that led to the official rejection of genetics in the USSR in 1948.

The belief among Stalin and other communists in a proletarian science and proletarian technology was accompanied by a reevaluation of the basis-superstructure theory that undergirded historical materialism. In many ways, these views resembled those of the discredited *Proletkultists*. Previously, Marxist theorists had argued that the productive forces of capitalism—the means of production, tools, instruments, and likely science itself—clearly continued to operate under socialism, albeit with different productive relations that ensured their service to the working class. As part of the superstructure arising on that capitalist basis, the juridical, legal, philosophical, and other institutions of bourgeois society were destroyed during the revolutionary transition to socialism. Now it seemed that Stalin and his followers saw science *and* technology as part of the superstructure, hence giving rise to the notion of distinct proletarian, or in this case Soviet, technologies and sciences, a view that prevailed until the late 1950s.[108] We see the manifestation of aspects of these ideas in Stalin's pronouncements about industry, technology, and the dangers of wrecking among foreign engineers and their sympathizers.

In a February 1931 speech intended to exhort workers to fulfill the first five-year plan in three years, Stalin indicated that the time had come for the working class to push aside the old experts and "master" technology themselves. For nearly a decade they had allowed old technicians, engineers, and specialists to carry on with production while communists had hesitated to interfere in technique. The communists often limited their involvement in production to observing the old specialists, studying technology, and persevering in learning industrial management, yet they delayed becoming leaders of industry. Stalin recognized that capitalist industry had been an engine of innovation, but he argued that the development of the productive forces under capitalism and further rationalization in industry led not to improvements in the standard of living of workers and peasants but to a crisis of overproduction, waste, poverty, and unemployment, as the Great Depression confirmed for attentive Soviet readers.

Further, as the Shakhty and Promparty affairs indicated, this had enabled wreckers and representatives of foreign capital to sabotage the industrialization campaign. Stalin proclaimed that "both the party organizations and the trade unions lacked revolutionary vigilance. It revealed that our industrial managers were monstrously backward technically, that certain old engineers and technicians, because of the absence of any control, were so much more easily being drawn into wrecking activities." He continued, "It is time, high time, to turn our face to technology. It is high time to . . . become specialists, business experts, we must ourselves become full-fledged managers of our affairs."[109] The working class had to master technique, acquire science, and refuse to slow down, fall further behind, and allow Russia to be backward. They had to adopt "a truly Bolshevik pace in the building of our Socialist economy." Stalin continued, "We lag behind the leading countries by fifty to 100 years. We must close this distance in ten years. Either we do this or they will crush us."[110] In a well-known injunction to his audience he called for the Bolsheviks to "master technology. It is time for the Bolsheviks themselves to become specialists. Technology in the period of reconstruction decides everything . . . They say that it's difficult to master technology. This is untrue! There are no fortresses which the Bolsheviks cannot conquer!"[111]

Stalin called for the development of socialist industry at rates that no capitalist country had achieved and for "reaching and surpassing" capitalist nations in short order.[112] During the first and second five-year plans, the USSR indeed made tremendous strides in the creation of indigenous heavy industry. Granted, the country met very few of the overly ambitious targets, and officials published false statistics to indicate success. Yet, as Stalin informed the nation, the USSR had undergone an industrial revolution in a few short years: they had had no nonferrous metallurgy, now they did; no tractor, automobile, machine-building, chemical, or aviation industries, and now they did. They produced electrical energy and petrochemicals among the world leaders.[113] But they had discovered that technology was not the panacea they anticipated.

Would Trotsky Wear a Bluetooth?

The Russian Revolution unleashed unbridled enthusiasm for all things technological. Not only Bolshevik leaders but such representatives of the artistic and educational worlds as proletarian writers imagined a world of magnificent factories and mechanized agriculture that produced all of society's necessities. Many workers and peasants anticipated that they would see within their lifetimes the construction of the socialist machine age. Initially, the world war, civil war, anarchy, and plummeting industrial production frustrated these visions. The Bolsheviks would be forced to make a series of doctrinal political and economic compromises as they struggled to hold on to power and resurrect the economy. They debated how best to renovate industry, modernize agriculture, and transform the peasant into a conscious Soviet citizen, with Lenin arguing for the breathing space of the NEP, and Stalin, Trotsky, Bukharin, and others fighting after his death over how quickly to force the pace of socialist reconstruction, whether and how to encourage revolution elsewhere, or whether socialism might be built in one country as Stalin ultimately insisted. In these crucial debates that generated deep personal animosities and destroyed political careers and lives, the place of technology was a central concern.

From Lenin to Trotsky, from Kuibyshev and Kirov to Stalin, they all agreed on the importance of mastering modern technology. They were not deeply philosophical about technology's place in the modern world, but to one degree or another they recognized its transformative power and sought large-scale, society-wide diffusion of modern machinery and equipment. They remained inconsistent, however, about whether technology was apolitical, serving the profit motive of the industrialist and landowner under capitalism, but benefiting all humanity under socialism. To master technology, Lenin insisted on working with the capitalist engineer and scientist for some period of time, for he doubted the receptivity of the peasant mind to adapt overnight to socialist productive relations, even if he believed in the power of the tractor someday to transform them into new Soviet men and women. Kuibyshev, Kirov, and especially Stalin worried increasingly that reliance on the capitalist world would leave the USSR always vulnerable. While they pursued the purchase of western technology and advice for Volkhovstroi, Magnitogorsk, and other hero projects of the early USSR, they intended to rely on it only until Soviet industry could fulfill its innumerable chores of rapid modernization. While entirely fabricated, the show trials of engineers indicated the determination of the Bolsheviks to create indigenous technological systems—and an autarkic engineering community. Stalin would have insisted on the creation of a Bluetooth, a heavier, bulkier Soviet model, occasionally made of lacquered wood to hide its rudimentary functions or prefabricated concrete to keep its cost down. Only Trotsky seems to have been convinced that the USSR must unabashedly acquire the highest form of culture—modern technology—as rapidly as possible and apply it to the Soviet system without delay, no matter its origin.

Despite calling Trotsky a sober critic of utopianism, Fulop-Miller noted that Trotsky fell under the spell of the machine. Trotsky saw in all modern devices and techniques the key to achieving socialism in short order. The railroad, the telegraph, the road, and the tractor were all far more than symbols of socialist modernity. They were the very tools of the transformation of outmoded capitalist institutions into socialist ones. He believed that "the socialist man will rule all nature by the machine." He would drive "the dark forces of nature out of industry and ideology, and replac[e] barbaric routine with technical science and religion by the theory of knowledge." Trotsky claimed, "The Machine is not in opposition to the earth; it is a tool in the hands of the man of today in all spheres of life." Man will make "the movement of his limbs more precise, more purposeful, more economical and thus more beautiful."[114] Precisely in this utopian fascination, Trotsky embraced the view that technologies were value-neutral. They could be abused by capitalists—used to exploit the worker with the result that the worker was alienated from his labor—or used to build socialist productive relations. Trotsky used his special locomotive to put out fires of counterrevolution during the civil war. He used the radio and printing press to proselytize the glories of communism. Trotsky wore the equivalent of a Bluetooth device to assist him in bridging space and time; in bringing up-to-date information, science, and technology to the masses; and in creating *smychka* between the city and the village, between the center and the periphery, and between the arctic and the industrial heartlands. It would not matter that the Bluetooth served the capitalist in making transactions, buying commodity futures, and exploiting the worker.

Ultimately, like other convinced Russian Marxists—and capitalist entrepreneurs, businessmen, East European socialists, and engineers from the Democratic People's Republic of Korea—Trotsky saw in the most advanced technologies opportunities to overcome those problems of geography, climate, illiteracy, and backwardness that had plagued Russia. Technologies of communication—roads and railroads, telegraph, telephone, and the press—were the most important. They would unite the countryside and the cities, close the distance from Europe to the Pacific Ocean, and serve as the foundation of communism. For a variety of reasons, as the next chapters explore, most socialist leaders enunciated similar views, yet they used technology precisely for political ends, to control the masses, to make them conform to ideological precepts of good and evil, and to build industry rapidly, but at the expense of good, accessible, and inexpensive housing and health care, and accompanied by great environmental degradation. Stalinist technologies in East Central Europe represent one of the greatest betrayals of socialist rhetoric in the history of the experiment that resulted in a gray if not colorless life.

“A bricklayers’ brigade reads the newspaper *Szabad Nép* to discuss the glories of their new socialist city, Sztalinvaros, Hungary.” At various construction sites throughout Eastern Europe, Communist Party leaders gathered enthusiastic workers together to build “hero projects.” Several of the hero projects were entire cities devoted to metallurgy, smelting, and concrete, such as Sztalinvaros, and also Dimitrovgrad, Bulgaria; Stalinstadt, East Germany; and Nowa Huta, Poland. Courtesy of the Magyar Press Agency (MTI).

CHAPTER TWO

PROLETARIAN AESTHETICS

Technology and Socialism in Eastern Europe

> And the work unit nearby shouts, "give me cement!"
>
> PENIU PENEV
> from "Beton i Mechti"
> on Dimitrovgrad, Bulgaria

A Czech poster from 1951 shows a studious young man momentarily abandoning his textbook to gaze in wonderment at a massive, new hydroelectric power station that is clearly of Soviet design. The poster reads, "Let us learn Russian. Let us learn from the Soviet Peoples. Work, think, live in a new way."[1] And learn they did, as did Bulgarians, Hungarians, East Germans, Poles, and Romanians. They learned to abandon outmoded forms of capitalist production for large-scale industry and collectivized agriculture. In less than a generation, and with the altruistic assistance of their socialist brothers in Moscow, the people of Eastern Europe mastered the modern industrial production of iron, steel, concrete, and petrochemicals. They increased capacity and production of electrical energy manyfold in the first five-year plans alone, and by the 1970s and 1980s they had even installed Soviet-designed nuclear power stations in Lithuania, Hungary, East Germany, Bulgaria, and Czechoslovakia. Peasants found the answer to back-breaking manual labor in new tractors and combines available from machine tractor stations, making many of them suddenly redundant in rural regions. They streamed to the cities, to such new industrial centers devoted to iron, steel, and petrochemicals (and later even to nuclear reactors) as Nowa Huta, Poland;

Eisenhüttenstadt, Germany; Sztalinvaros, Hungary; and Dmitrovgrad, Bulgaria, becoming transformed into devoted socialist workers, again in a few short years.

And yet, what had they learned? Had they learned the glories of industrial production and the production of vast quantities of electrical energy? Had they built a society where modern technologies replaced onerous manual labor with quiet, efficiently operating machinery set in well-ventilated factories? Were they not selflessly and joyously contributing to a new way of life for the new socialist man and woman? What did East European politicians, planners, scientists, and engineers hope to learn from the Soviet peoples? What did the Soviets hope to teach about the benefits of the embrace of large-scale technological systems to transform their nations into modern industrial powers? What power, politics, and influence were at work in this technological relationship? Did it differ from nation to nation? After all, East Germany and Czechoslovakia had relatively modern industries, while the other nations of the socialist brotherhood were highly agrarian. What was the legacy of Stalinist technologies in East Central Europe?

Judging by violent workers' rebellions in Germany in 1953 and those in Poland and Hungary in 1956 and by the evaporation of the Berlin Wall in 1989 in a matter of weeks, most citizens of East European countries never enjoyed the benefits of socialist technology. They toiled in noisy, dangerous factories that spewed pollutants into the environment and often backed up onto green zones and apartment complexes. They returned home at the end of the day to live in poorly built, mass-produced housing. Unless they were members of the newly formed Communist Party elite or the intelligentsia, they had limited access to such consumer goods as washing machines, televisions, and automobiles. Leaving aside the question of whether these goods ought to have a dominant place in the home, they often lacked even such necessities as good food, clothing, antibiotics, and so on. Soviet leaders had learned little from their failures to provide for the good life for the worker at Magnitogorsk, Norilsk, Asbestos, or any of the dozens of other production cities established under Stalin. They insisted that socialist East Europeans accept their model of development and their technological style—which they did, in some cases and in some branches of the economy with little modification, as they assumed that the proffered technological systems were the key to a modern, socialist life of plenty. Did they lack the resources to improve on Soviet designs? Or, were their options limited because of the political and economic desiderata tied inevitably to any technology?

By studying the history of the influence of Soviet technological style on such diverse countries of East Central Europe as Bulgaria, Czechoslovakia, Germany, Hungary, and Poland, we may begin to answer some of these questions and can learn a great deal about the complex relationships between the state, politics, and technology generally—and in this case imperial and smaller client states—in the twentieth century.

From Military Conquest to Hero Cities

When his armies crossed East Central Europe on the way to Berlin at the end of World War II, Stalin intended to keep them there to establish client states. The Red Army presence facilitated the installation of communist governments in Poland, Bulgaria, Czechoslovakia, Romania, Hungary, Yugoslavia, and East Germany. As part of both the Molotov-Ribentropp Non-Aggression Treaty of 1939 and the Soviet invasion, the Baltic states were also incorporated directly as Soviet republics, even if not all western governments recognized them as such. In the 1930s Stalin had offered sanctuary to communist leaders in the region. In Moscow they received office support, salaries, funding for political activities in their homelands, and indoctrination. It remains to consider the role of the Comintern, or Third Communist International, which operated from 1919 to 1943, and the Cominform, its successor organization that survived until 1956, both of which served at the behest of Moscow and were engaged in promoting not only Soviet political ends but also Stalinist economic, industrial, and agricultural programs. In any event, the communist leaders of East Central Europe were prepared to serve both their national comrades and Stalin at the end of the war.

The societies of these countries were largely peasant. With the exception of several sectors of the East German, Czech, and Polish economies, industry was at an early stage of development compared with most of Western Europe. Even East Germany, with its great industrial and scientific heritage, lagged behind the other nations of Europe, including West Germany, and the Soviets stripped both industry and specialists from it as reparations from the war.[2] As part of the process of the imposition of communist rule, the countries adopted the Stalinist model of economic development: rapid industrialization with emphasis on heavy industry, forced collectivization of agriculture, and violent change of the natural environment through harnessing of the extractive industries and the construction of power stations. As in the USSR, raw, working-class recruits advanced into managerial positions, Stakhanovite workers demonstrated the joys of overfulfilling production norms, and communist officials held show trials of so-called bourgeois experts, including engineers and other politically unreliable elements. An entire revolution—cultural, political, and social—was the goal. The impact of this revolution was visible in technology and other artifacts as well.

The Soviet subjugation of Eastern Europe was a central tension of the cold war. It led to Winston Churchill's famous pronouncement about the erection of an iron curtain around those nations. Zbigniew Brzezinski wrote about a Soviet bloc. Many observers posited that a uniform Soviet ideology, political and economic system, and so on, had been imposed on East Central Europe. Yet while Soviet control and influence in many spheres of activity must be admitted, its impact has been exaggerated. The Soviet bloc existed more as an exigency of cold war politics than as a monolithic system. To a greater or lesser degree, for example, Poland, Hungary, Romania, and Bulgaria embraced Stalinist institutions, and they were more Stalinist and less Stalinist in different periods and under different leaders. The countries experimented with their own forms of communism and economic organization, and they resorted to the tools of central economic planning in different ways and with more or less central control, for example, in Hungary with the New Economic Mechanism, by which Hungary adopted a decentralized planning system and established enterprise profitability as a desirable target in an effort to promote market relations. Several countries allowed for greater personal freedoms than in the USSR. The intelligentsia often served as a transmission belt for ideas and innovations to the USSR from Western Europe, owing to their proximity to it and to their longer tradition of contacts with and thinking about civil society.[3]

Still, most observers will agree that something distinctly "Soviet" distinguished the countries of East Central Europe from their West European counterparts. Political, cultural, and economic institutions are the most obvious. A one-party system prevailed, as did central planning, notions of proletarian democracy, and the creation of a new intelligentsia. Even more remarkable, we can see this distinction in various artifacts: factories, apartment buildings, urban plans, collective farms, automobiles, trucks and tractors, thermal power stations, dams, and so on. Each nation designed, planned, and carried out manufacture and/or construction of these artifacts with its own engineers, many of whom had been trained at European universities. (Many of them received training in the USSR, especially in fields of construction, metallurgy, agriculture, and even nuclear power and its peaceful applications.) When you stood in any square in Budapest, Hungary; Krakow, Poland; or Sofia, Bulgaria, you knew where you were. The influence of Soviet designs was unmistakable. A modest grayness covered most facades. Low-quality concrete was substituted for stone or brick; the concrete has crumbled prematurely. The lack of redundancies of safety and comfort struck the eye. The rush to mass production of basic forms and structures that homogenized the urban landscape was evident in every structure, every machine, every tool, every sidewalk, curb, and street lamp, and it is still evident. Virtually every industrial and agricultural process revealed Soviet influences even if national styles persisted in the generally accepted golden rule of engineering design: "socialist in content, national in form."

Granted, grayness existed for the workers of Western Europe, too, and planners added green zones to many of their cities only as an afterthought. But if you were blindfolded and taken to a European city, when someone removed your blindfold you would know whether you stood in a city of socialism or capitalism. Why is that? The answer is grayness. Two other factors contributed to grayness. The first was monumental architecture that contributed to a feeling of insignificance of the worker. The second was the absence of consumer culture, hence modest commercial districts with limited storefronts, signage, and shop displays and few decorations.

Of course, the graying of Eastern Europe did not involve calculated decisions to deprive the citizens of comforts and rights that their counterparts in the democracies of Western Europe took for granted. Given the destruction of the physical plants of the cities during the war, the devastation of the countryside, first by German soldiers and then by Soviet soldiers, the stripping of anything that could be stripped and carted off or sold (I have read prewar German physics journals from an institute of the Kaiser Wilhelm Gesellschaft in the library of the Kurchatov Institute for Atomic Energy), and the relatively low level of agricultural and industrial output to begin with, not to mention the underdevelopment of the consumer sector, the Matyas Rakosi government of Hungary, Boleslaw Bierut of Poland, and Georgi Dimitrov of Bulgaria faced difficult choices in the allocation of resources in rebuilding roads, bridges, railroads, power-generating facilities, and apartment buildings. The situation may have been worse in Budapest owing to the elimination of the Jewish population and its wealth when SS Commander Adolph Eichmann ruthlessly pursued the final solution. In Lithuania, the war lasted until 1948 as partisans and freedom fighters engaged the Red Army in a futile attempt to rid the land of the hated Soviets; this set back Lithuanian recovery. And the Jews of Vilnius suffered the same fate as those of Budapest.

Ultimately, however, the new socialist leaders, planners, architects, and engineers must share the blame for the failure to create architectural structures, energy technologies, and agricultural machines and processes that reflected truly socialist ideals. In keeping with Stalinist programs that emphasized heavy industry at the expense of light industry (housing, food, medical care), they denied investment to those sectors of the economy that would have benefited the worker more directly and immediately. In many cases they deployed factories notorious for pollution and filled with rudimentary and unsafe, if functional, mchine tools. They systematically promoted the collectivization of agriculture, seeing the peasant as an enemy of progress, and drained resources for the industrialization effort from the countryside. They harshly transformed the peasant into a worker (and the countryside into an agricultural machine), forced socialist upbringing on him, eradicated his worldview, and declared his way of doing things as unscientific. They redesigned cities to make them comfortable for automobiles, not for pedestrians; they built monuments to glorify the party and its leaders, and in so doing they eliminated human scale in construction. The aesthetics of socialist countries required large-scale, unappealing structures that proclaimed the importance of the state and its artifacts, not of the individual worker.

Leaders in Eastern Europe had two major paths to consider for postwar reconstruction and modernization. One was the capitalist West, with the paradigmatic industrial superpower, the United States, working closely with European democracies and the vanquished fascist regimes to rebuild them after the war through the Marshall Plan, through which the U.S. government gave $14 billion to reconstruction over four years. The eastern nations had maintained ties with both the West and Russia to the east; their scientists, engineers, and planners had frequently studied, attended conferences, and published in the West, so that the lessons of U.S. and European modernization were crucial. Yet given the influence of—and military occupation by—the USSR, and since their leaders had been frequently trained in the Stalinist Communist International, the nations necessarily oriented themselves toward the eastern Marxist model. They embraced to one degree or another heavy industrialization, collectivization of agriculture, and technological style that often reflected Soviet designs. After a brief period of divergent approaches and open governments, these nations entered a period of high Stalinism (1948–54). Soviet and East European leaders believed that rapid industrialization and collectivization of agriculture with their attendant political, social, economic, and technological changes would enable them to establish not only power and legitimacy but also security against the capitalist nations. They centered some of their efforts on the establishment of "hero" or production cities that were modeled on their Soviet counterparts. These hero cities garnered a substantial share of the budget and were crucial for symbolic cultural purposes as well as technical ones.

In the Soviet Union Communist Party leaders organized the mass transformation of peasant society into an industrial one at huge construction sites, at such so-called hero projects as Dnieprostroi, Magnitogorsk, the Moscow Metro, and the Belomor Canal. Parallel strategies were pursued at Nowa Huta, Dimitrovgrad, Stalinstadt (Eisenhüttenstadt), the Vitkovice Steelworks in Bohemia, Martin Machine Works in Slovakia, and elsewhere—cities that were dedicated to producing copious amounts of ore, iron, steel, cement, chemicals, and electrical energy. Hero cities consisted of a series of large-scale technological systems that were intended to trigger rapid social, economic, and cultural revolutions as well as an industrial one. Not unlike in the West, the socialists organized central bureaucracies to manage massive factories and the workers who toiled in them, but they believed that they would avoid the human costs of industrialization under capitalism. They simultaneously reformed scientific research institutes, universities, and schools, orienting them toward Marxist thought and standard curricula to ensure common approaches, with faculty constantly scrutinized to ensure political reliability. Engineering and vocational education often had precedence over training in the humanities. Political leaders believed that the technology of production was the essential force in the rapid transformation from capitalism to socialism, and they believed that the proletariat would benefit from the change. Yet here a kind of battlefield thinking emerged with laborers and materiel being sacrificed to ideology and being mobilized for the final assault on outdated capitalist approaches, often without regard for the very beneficiaries, their ways of life, and the local environment.

Those individuals east or west who have lived in or visited the socialist towns of East Central Europe and the former Soviet Union recognize the difference in the quality of life in comparison with similar factory towns of Western Europe and North America, such as Gary, Indiana; in the Ruhrgebiet in Germany; or Manchester, England. Although generally employing many of the same techniques and materials used in building these cities and towns, the result of industrial design under socialist direction was a poverty of styles and blandness in color exacerbated by rudimentary functionality. Nor in provision of schools, stores, clinics, or other social services did socialist urban centers distinguish themselves—even in the flagship "hero cities" of technological display and Marxian glory, this social overhead capital lagged considerably. In fact, they were often little distinguishable from each other, from the layout of traffic patterns to the squares and streets named after acceptable Soviet and national revolutionary leaders; from the trails, paths, and pruned trees and bushes in green regions to the smoke-belching trucks, cars, and buses that put parks under constant assault; from daily newspapers proclaiming the glories of the socialist experiment to the massive edifices of state and industrial buildings that indicated the glory of the state but not the worker; and most importantly, to the technologies of production that were the quintessence of the values of socialist politicians, planners, and engineers. Granted, workers were promised free, basic universal medical care and education; rents and food prices were kept low; and literacy rates rapidly increased.

Yet workers found housing to be minimal and uncomfortable, the cities often lacked basic services, and the agricultural sector never recovered from the socialist experiment. I refer to the sum of these political, economic, ideological, technological, and aesthetic factors as "grayness." Intended to ensure the docile cooperation of workers and their families, the towns failed on most fronts to achieve this end owing to their grayness. To be sure, there are shades of gray: there was no standard hero city, university, or research institute, no stereotypical peasant or worker. The countries were more or less industrial; more or less forced collectivization on peasants; more or less established modern factories, trained workers, and educated engineers and scientists; and were more or less gray. Our understanding of the ways in which the nations diverged from Stalinism and from Soviet practices for a variety of technological systems remains incompletely explored. The divergences include how East European countries adapted technologies and their ideological structures to local and national conditions. Here, however, I focus on the grayness as manifested in "proletarian aesthetics."

Proletarian Aesthetics: Soviet Technological Style in Eastern Europe

A series of engineering decisions, ideological positions, and financial considerations led to construction of gray cities and lifestyles, at the root of which was proletarian aesthetics. Proletarian aesthetics was based on four concerns that had far-reaching, interrelated social, political, and engineering consequences. The first concern was egalitarianism in technology. For example, in a classless society, workers would live in equally splendid—or equally dilapidated—apartment buildings. They would own the same furnishings. There was no need, as in bourgeois society, for status to be reflected in different furnishings, baubles, or styles. This egalitarianism would avoid endemic duplication of roughly similar goods, such as refrigerators, desks, dressers, even doors and windows, and at the same time also achieve efficiencies in production and lower costs. The leveling of quality that accompanied the development of a few basic designs for many products across an entire nation had the bonus features of keeping construction costs low and discouraging nationalism. If the genre of socialist realist art, literature, and music stressed qualities of the new socialist man and women, why could not homes and factories of similar design and function bring the fraternal brothers and sorority sisters of East European nations into harmony with their big brothers and sisters in Moscow?

The second source of proletarian aesthetics was an exaggerated level of interest in mass production, owing to these egalitarian ideological precepts, yet scarcities of finished goods, and to the fascination with, if not fetishization of, Fordism among many Marxists. Such Soviet leaders as Lenin and especially Trotsky wrote extensively about the glories of the assembly line that must be applied willy-nilly in the economy.[4] In the effort to rebuild rapidly after the war, socialist engineers and planners sought to find economies everywhere in huge engineering projects. This led to crash programs to develop concrete and reinforced concrete industries and to the adoption of simple, prefabricated concrete forms produced in them for apartments, offices, and highways. They used them as floors, walls, walls with windows, and walls with doorways; these could always be used for playgrounds or road surfaces. The Danube Cement and Lime Works (near Budapest) was a leader in this technology. The Polish industry built on substantial prewar foundations to become the largest in East Central Europe.[5] Factories sprang up like mushrooms throughout Eastern Europe in burgeoning industrial towns. Similarly, just as their Soviet counterparts, metallurgical, mining, and other facilities employed standard components and materials: corrugated steel roofs, steel staircases, and standard piping, conduit, generators, and machine tools. These facilities were functional but did little to ensure the safety of workers or the surrounding region in case of accidents or from environmental abuse.

Third, owing to the highly centralized nature of policy making, as part of the drive to keep costs down, and perhaps out of fear of local initiatives (and styles), the main bureaucracies in the capitals adopted universal specifications for pipe, conduit, concrete, prefabricated forms, wiring, telephone poles, roads, even turbogenerators—in a word, all construction technologies and practices. For example, in Poland the Ministry of Building and Building Materials Industry followed closely the example of Gostroi (the State Construction Committee), Gosstandart (the State Committee on Standards), and Gosplan (the State Planning Administration) in Moscow in quickly setting standards that then became difficult to alter even when safety and efficiency concerns indicated that they ought to. These national codes and specifications not only for building materials but for entire designs often followed the Soviet lead in a wide range of facilities and structures that held for an entire country, often irrespective of local geological, meteorological, and other considerations. On the one hand, the adoption of standards enabled them more quickly to turn to the task of rebuilding from the devastation of the war. On the other hand, while planners and engineers hoped that the application of these mass production techniques and materials might enable them efficiently to overcome the poor materials and workmanship they encountered in the field, they could not exhort underpaid and overworked laborers to perform, and the resulting facilities were often poorly built. A question that remains is to what extent engineers, architects, and planners from Moscow served as emissaries throughout Eastern Europe to spread the gospel of technological equality, visiting the bureaucracies and state committees of their counterparts in Bucharest, Budapest, and Warsaw, and how East European specialists both accepted this technological style and adapted it to their regional requirements.

The drive for mass production and the search for economies of scale may have led to premature fixing of parameters for many technologies for other reasons as well. Engineers pursued a reasonable effort to cut innovation and construction costs and time. Yet in some cases, this tied industry to the production of simple, functional designs that lacked safety and environmental redundancies. Once they had developed the prototype of a device that they believed worked well enough, they turned rapidly to commercialization of that device in a process that might be called the "prototype approach." An aesthetics based on standardization, rationalization, and mass production of components thereby joined with the political and economic pressures to meet production targets. This, in turn, generated technologies noteworthy for bland, functional designs in which safety and comfort played a secondary role and in which environmental issues were rarely raised. There were few redundancies or backup or safety devices that extended even to the nuclear industry. Similarly, and shockingly, workers toiled at agricultural and industrial sites without helmets, goggles, ear protection, protective clothing, or steel-toed shoes.

The last aspect of proletarian aesthetics was gigantomania. Gigantomania itself had several sources. One was competition with the capitalist West to be first, bigger, best. In addition, party leaders found it easier to organize the mass transformation of peasant society into an industrial one at huge construction sites and in hero cities. Armed with simple tools and exposed to the elements, the peasants cum workers toiled not only to build the factory or urban center or canal at hand, not only to create a site of great ideological significance for indicating the glories of state socialism, but also to master the tenets of Marxism-Leninism, atheism, central planning, selflessness, collectivism, and allegiance to the party and its five-year plans. At hero projects throughout Eastern Europe divisions of workers were assembled whose every movement was scrutinized to ensure that they remained in lockstep with plans. These workers were joined together in construction firms that rapidly grew to hold thousands of employees. Ultimately, both the environment and people were the objects of the transforming visions of large-scale technologies, with peasants and "enemies of the people" to be transformed into workers and citizens, and nature to become a rationally ordered machine that also functioned according to plan.

Shades of Gray

The focus on large-scale technologies to understand the notion of "grayness" may unsettle some readers who see in various locales, sectors of the economy, and specific technologies those individual cases that suggest a wide variety of technological styles across East Central Europe. No matter these cases, the Soviet influences in the reconstruction and establishment of large sectors of the economy loom large. We see rudimentary safety systems in energy and metallurgy, overriding interest in simple concrete forms in housing and construction, and forced collectivization in agriculture. To achieve these ends, political leaders, who were often trained in Moscow, established a political culture that resembled that in the USSR, from show trials to arrests, from embrace of heavy industry at the expense of the consumer sector to repainting of the educational and scientific research systems that turned out legions of narrowly trained specialists who sought to build and rebuild industry and agriculture in a socialist way.

Some readers may also worry that the entire concept of "grayness" is based on the intention to write a history of the victors. Indeed, several historians have adopted the position that because the capitalists won the cold war, we must examine closely the failings of the socialist losers. This would lead us to ignore the achievements of socialism in housing, transport, and so on. To ensure a nuanced discussion of areas of innovation and achievement, as well as the challenges and missteps of policy makers, planners, and engineers in East Central Europe, we consider those leaders' own pronouncements about what they intended to achieve through modern technology and what they promised in the way of benefits for the masses. They advanced a rhetoric of progress, they promised a radiant future, and they give us the benchmarks by which to judge their achievements in their own quite public five-year plans, editorials, and official reports. We will thereby avoid the temptation to condemn socialist leaders, policy makers, and engineers by western standards either for shortcomings in design or for the environmental and social costs of employing them throughout various landscapes of modernizing societies.

The socialist nations achieved remarkable success in meeting the goals of rebuilding war-torn societies in short order, setting out to create egalitarian societies, and striving to provide inexpensive housing, energy, education, and medicine to all citizens. The leaders rebuilt cities, housing, industry, and agriculture rapidly after the destruction of the war. And there were many levels of success and innovation associated with Stalinist technological style that suggest similarity with innovation in the West. Public works were one such region of socialist accomplishment, for example, the transport networks of Budapest, Warsaw, and Prague, the power generation systems in Czechoslovakia and Hungary, and so on. It would be well to keep in mind that many of the public works projects had roots in the 1920s and 1930s when not only the USSR but also National Socialist Germany, France, England, and the United States engaged in massive transportation, irrigation, flood control, hydroelectricity, road construction, and other large-scale efforts. Socialist leaders themselves recognized the value of their achievements here. At various construction sites for these public works "hero projects," political officers proselytized the gathered peasants cum workers about the glories of socialism in comparison with evil, exploitative capitalism. They proclaimed that technology would serve the masses, not the capitalist owners or managers. They pointed to the subway system with its huge, vaulted stations; polished granite walls, floors, and benches; and murals that spread the message of equality and victory over nature and capitalism as evidence that they were well on the path to socialism.

What they produced nonetheless was gray. Bare, functional designs were intended to ensure longevity and ease of repair of many machines, buildings, roads, and other technologies, but they quickly wilted under the pressure of centralized economic planning. Apartment buildings were no sooner completed than they began to decay, fading from one shade of gray to another. While subway and railway wagon cars have stood the test of time in many respects—their unadorned plastic seats rarely crack and their linoleum floors have only thinned and darkened under the assault of passengers—they nonetheless transported workers lifelessly to work and back. Think also of the significant costs of the socialist development program for citizens of Poland, Czechoslovakia, East Germany, Bulgaria, and Hungary in terms of public health, environmental degradation, and quality of life, however the latter are measured, not to mention in terms of personal freedoms. After an initial burst of growth connected with rebuilding, the economies of East Central Europe themselves turned gray, stagnating in the 1970s and especially 1980s, and falling behind international standards in terms of productivity, competitiveness, and environmentally sound production. The promised future of the bright colors and plentiful consumption never arrived. In each country, officials presided over a lag in production of the comforts of life, at the same time as the factories rusted, or perhaps even melted away. Central planning failed to adjust to new circumstances. The advantages of the socialist economies of cheap raw materials and low wages were lost. The share of intellectual products and services related to production remained low. Overcentralization and the massive size of enterprises hindered reforms. The spread of electronics in production and management (numerically controlled machine tools, computers) lagged; superclean processes and materials were rarely employed; and biotechnology, telecommunications, and rational energy technologies had little place.[6]

Of course, the death of Joseph Stalin in 1953 and resulting de-Stalinization campaigns throughout East Central Europe had immediate and diverse impacts on the policies of all of the nations. A political, economic, and cultural thaw ensued to one degree or another, in some cases leading to short-lived rebellions. The effect on Stalinist technological style was also observable and measurable. Regarding housing, for example, the rapid adoption of simple prefabricated concrete forms and equally rapid deterioration in the quality of apartment buildings by the late 1950s and especially in the 1970s have led some observers to suggest that housing was notably "grayer" in the last decades of socialist power than under Stalin, and that true "grayness" commences with the Brezhnev era in Eastern Europe, especially after the Prague Spring of 1968. Stalin-era apartment, office, memorial, and other buildings were sturdy, with massive facades and ornate decorations, with spacious interiors, high ceilings, and parquet floors to suggest the glory of the proletariat. Later apartment buildings were mass-produced. They were small with narrow corridors and low ceilings. They were barely functional conglomerations of tight spaces and poor craftsmanship. Although they were better than the communal apartments, barracks, and dormitories in which most of them had previously lived, they suggested to the inhabitants—after the initial excitement of getting a home—that they had little more to look forward to, except perhaps to fill them with bookcases, overwrought storage cabinet wall units, and hundreds of books. Demand for appliances far exceeded supply. Lumber, wiring, plumbing, and other hardware were rarely available. All of this reinforced the feeling that citizens were nothing next to the state and its representatives.

Stalinist architecture set the trend for grayness in other ways. First, the best of the apartments—those most centrally located and with the finest appointments—went to the party and technical elites, not workers. Second, the massiveness of Stalinist buildings suggested the power of the state and party, not the glories of the proletariat. And third, the miserable and miserly experience of workers at Magnitogorsk, Nowa Huta, Eisenhüttenstadt, Volgodonsk, and Bratsk was always the rule, both under Stalin and after his death. Workers were often forced to live in unheated and insect-infested barracks while they waited for construction of the main factory objects to be completed, and schools, hospitals, and stores followed only at some delay.

Of course, citizens in socialist nations had a range of experiences across the processes of industrialization, collectivization, and political and cultural revolution. Some scholars argue, for instance, that collectivization in the German Democratic Republic was quiet successful, that peasants welcomed it, and that levels of production rivaled those in the Federal Republic of Germany.[7] Another scholar suggests that collectivized agriculture served as an inspiration for the rise of highly productive modern agribusinesses as farmers in the West recognized great potential in modern tractors, combines, and harvesters to work expansive tracts of land that stretched to the horizon.[8] Yet consider the basic point of collectivization: it was class war against the somewhat wealthier members of the peasantry, the so-called kulaks; in some cases it was murderous, and significant social costs and disruptions accompanied it as it triggered migration to the cities. Life was gray, Comrades![9]

Ubiquitous Smokestacks of Hero Cities

Smoke from smokestacks runs
Squint-eyed is the sun
Squint, sun, squint your eyes
If it were not for the smokestacks
worse would be our lives.

F. HRUBIN, Czech poet, 1952[10]

The states of East Central Europe lagged behind most other European nations in level of industry and the infrastructures to support them. They emerged from World War II with their lands and economies devastated, their populations having been displaced or lost to war, and their governments in shambles. When German armies withdrew, they often destroyed what they could not use. Stalin's Red Army replaced them, making it possible eventually for socialist governments to take power by force, subterfuge, and elections that were often rigged. Having taken power, the communists set out to duplicate the model of economic development that Stalin pursued in the USSR in the late 1920s and early 1930s of collectivization of agriculture and rapid industrialization. In three-, five-, or seven-year plans and their attendant political and cultural desiderata, Poland, Hungary, Czechoslovakia, Bulgaria, Hungary, and East Germany embarked on this path. They built up heavy industry as rapidly as possible, ignoring as a result light industry such as housing and medicine. They built showcase cities of the industrialization effort: Nowa Huta, Stalinstadt, Dimitrovgrad, Stalinstadt, and Sztalinvaros.[11] The countries of East Central Europe set out on that path from different levels of industrial development, social and political turmoil, and devotion to the ideal Stalinist program. Yet they all pursued the program.

Because of the focus of investment on heavy industry and on hero cities, such infrastructure crucial to the balanced functioning of society and economy as housing and public transport lagged. The towns and landscapes around them turned gray and unappealing. Sidewalks and muddy paths ended in fields of rubbish, sewer pipes remained uncovered, and poor finishing work distinguished stacks of concrete buildings in workers' towns and villages. Stalinist technological practices, while tempered by efforts to create distinctively socialist urban settings, ultimately centered on the search for proletarian egalitarianism in the technology of concrete and occasionally brick. That means that another source of grayness was, paradoxically, the effort to demonstrate the glories of socialism before the capitalist world. In keeping with Stalinist programs that emphasized heavy industry at the expense of light industry, they denied investment to those sectors of the economy that would have benefited the worker more directly and immediately, especially in workers' settlements.

While the authorities established the hero cities as monuments to workers, the cities fell short of this goal in a number of ways. First, the cities were homages to factories and production, not to the worker liberated from menial labor. In fact, he remained alienated from labor, having to work in dangerous environments with minimal safety equipment. Manual labor predominated. Second, the cities were laid out and organized to stress the importance of production and allegiance to targets set by central planning bodies. Factories were industrial temples with metaphysical meaning. The scale of avenues that led to the factories, the facades, and the buildings themselves spoke of the power of the state, not the privileged position of the worker. Third, construction of such social overhead capital as bicycle paths, tram lines and other transportation systems, and even schools, clinics, libraries, and stores always followed belatedly after factories had been erected. In terms of parks and public spaces, however, the socialist city occasionally exceeded its capitalist counterpart in size. In essence, hero cities were consciously constructed monuments to the socialist model of rapid economic development based on Stalinist precepts and technologies. These included the belief that heavy industry was the key to all economic growth, that the peasant would become a worker in the city, and that the peasant cum worker would recognize the glories of socialist state power precisely at the forge, on the scaffolding, or at the night school where he had the opportunity to learn a narrow technical specialization that prepared him to become a productive and satisfied cog in the socialist machine, if not an engineer.

In addition to the physical apparatuses, devices, and systems that link modern society, beyond the railways and roadways, the canals and engineered rivers, the bridges and harbors, power generation, transmission, and distribution systems, communications, and the buildings, factories, homes, and apartments in which users toiled and lived—in addition to all of these things, socialist officials, planners, and engineers employed another technology or technique in the form of Marxist-Leninist-Stalinist ideology. This ideology gave both symbolic and operational meaning to the physical structures. It distinguished those structures visually, physically, environmentally, even edaphically. It gave them meaning as forums for the creation of new socialist men and women. It stressed industry, especially metallurgical, construction, and extractive industries. Not surprisingly, since they were oriented toward the factories in all ways, the towns and cities that arose in the 1950s and beyond therefore had an industrial feel to them. Technique also included the de rigueur three-, five-, and seven-year plans.

The first five-year plan of Hungary reveals all of the features of Stalinist economic desiderata in full flower. In its introduction, the document refers to the role of the "glorious army" of the USSR in having "liberated Hungary from the regime of the German imperialists, [and] crushed the oppressive state-power of the Hungarian capitalists and large land owners." A three-year plan to rebuild the economy followed, which was completed—of course—eight months ahead of schedule. The subsequent five-year plan (1950–54) had the main goal of "the transformation of Hungary from an agrarian-industrial country into an industrial-agrarian country."[12] Just as Stalin set superhuman and outrageous targets for increasing industrial production in his first five-year plan (1929–33), so in Hungary by 1954 industrial output would be nearly 200 percent the 1949 level, and the number of workers would nearly double from 250,000 to 480,000, including "53,000 intellectual workers of different professions." Coal, iron, manganese, and bauxite extraction would increase, as would the foundry industry to process it: machine building would increase 138 percent; electrical energy production, 100 percent; building materials, 114.8 percent; and chemical production, 138 percent. Two-hundred and sixty-three enterprises centered on mining, metallurgy, chemical production, and electricity would be built. Szeged, Debrecen, Hodmezovasarhely, Bekescsaba, Mako, Szolnok, Keskemet, Zalaegerszeg, Veszprem, Gyöngyös, Szekszard, and other cities would become industrial centers almost overnight.[13] Of course, officials promised similar increases in light industry, but these did not materialize because of the overriding emphasis of investment in industry for state power.

The plans enabled Hungarian leaders to pursue a program of transformation of social and political structures accelerated by the creation of urban-industrial infrastructure.[14] In 1930 peasants were 31 percent of the population; agricultural laborers and day workers, about 20 percent; workers (skilled and unskilled), 19 percent; white collar and intelligentsia, 7 percent; and merchants, 8 percent. According to the 1949 census, workers still made up only 20 percent of the population. The war destroyed one-quarter of manufacturing capacity, one-third of all bridges, and more than one-half of all livestock. Manufacturing in 1948 was but 36 percent of the prewar level. Through a large-scale program for industrialization and collectivization of agriculture (essentially completed by the beginning of the 1960s), by 1970 50 percent of Hungarian wage earners were workers (although 30% still semi- or unskilled).[15]

The socialist nations chose different paths to industrialization and collectivization. Across the region communist leaders instituted collectivization in harsh or softer forms around 1948 as part of Stalinization of the economy. In Hungary, for example, under hard-liner Matyas Rakosi, the party abandoned notions of private ownership of land, called for pooling of private holdings in collectives, and lowered from 142 acres to 35 acres the amount of land needed to apply the label of "kulak" on a peasant; soon other individuals of modest background—merchants, priests, and others—became "kulaks." Collectivization slowed to a crawl because of peasant opposition. After the death of Stalin and Rakosi's replacement by Imre Nagy, Nagy relaxed coercive measures. But the unrest of 1953 and 1956 led many peasants who had joined cooperative farms to flee them.[16] The leaders recognized the need to scale back plans, to end coercive measures, and to increase the standard of living on the collective farms.

Hungarian officials confronted the great problem after the war that much of the housing stock had been destroyed. By the inauguration of the three-year plan in 1949, however, most of the dwellings destroyed during the war had been reconstructed or repaired, while 35,000 new dwellings were built in Budapest. Partitioning of apartments and homes resulted in more dwellings in Budapest in 1948 than in 1941, as well as an increase in population density. But this was insufficient because, in the turmoil of the late 1940s, a wave of migrants entered the capital, some 30,000 to 50,000 people annually. They came for jobs, having fled the countryside because of collectivization, many of them identified as kulaks. With the first five-year plan, the inadequate housing policy led to an "overall decline in living standards." The five-year plan had no provision to overcome regional or sectoral disparities so that egalitarianism disappeared in territorial inequalities between the center and periphery, between city and village, and industry and agriculture had little impact. Budapest received the largest share of industrial investment. The only explicit territorial conception was a plan for new socialist towns.[17]

In this atmosphere, this working class found little to rejoice about at work, home, or play. By the end of the 1960s, approximately 10 percent of the urban population lived in housing developments, but the people were not favorably disposed to them. The reason was the shortage of streets, parks, and squares, which led to formation of anonymous communities, "groups of people haphazardly brought together." This "dullness of life" was manifested in part "in the uniform, monotonous character of buildings . . . and in the low level of provision with various institutions." Many neighborhoods lacked shops, bookstores, and so on, and several were poorly served by public transport.[18] Hungary continued to suffer from significant housing shortages into the 1980s, and efforts by the state to redistribute flats and to offer subsidies to the state-owned rented flat sector did not level differences, but increased inequality.[19]

Would it be different in a city named after Joseph Stalin? Sztalinvaros (Stalin City), now the city of Dunaujvaros with 60,000 inhabitants, was home to the Lenin (now Danube) Steelworks. Sztalinvaros was a planned city built in the early 1950s near Dunapentele, 70 kilometers south of Budapest on the west bank of the Danube. The socialist government regarded the smallholders, fishermen, and manorial laborers who inhabited the fields in the area surrounding the village of Dunapentele and the craftsmen and small businessmen in the village itself with suspicion. The secret police expelled politically unreliable elements as a first step toward a new socialist city in which village, factory, city, and natural landscape would come together.[20]

Sztalinvaros involved the major features of Stalinist development: collectivization of agriculture and the formation of industrial centers as magnets for workers, where peasants, *lumpenproletariat*, and other individuals were transformed into conscious socialist citizens. Almost overnight Sztalinvaros developed from a small village into an industrial city with steel foundries, iron works, and chemical industries. Its population swelled to 28,000 by 1956. As at Stalin's steel city hero project Magnitogorsk fifteen years earlier, the process was wrought with violence to people and things.[21] The Stalin Steelworks dominated the city—and the nation—in many ways, including by taking the single largest investment component of Hungary's first-five year plan. Would the city indicate the promise of industrial transformation? Would Stalin City give industrial employment to the rural poor and transform them into loyal citizens of socialist Hungary?

Sztalinvaros was for party loyalists a beacon of socialist industrial future, but for peasants it symbolized an attack on their way of life. One thousand construction workers arrived in May 1950. Those arriving sought to escape poverty, high taxes, compulsory grain deliveries, and dislocation in the countryside like the Russian peasants who fled to Magnitogorsk to avoid de-kulakization. The locals deeply resented the new arrivals. Still, by Christmas 5,860 workers had joined the construction site, and by January 1952 over 14,000 laborers were at work. Like at Magnitogorsk, Sztalinvaros, as Pittaway writes, was "a workshop of chaos, low wages, despotic management and poor working conditions." Facing constant exhortation to meet impossible targets, the workers felt not in the least to be a part of the glorious communist future. And like throughout Eastern Europe, the Communist Party alienated them in new city designs that excluded a church from the city center; these were deeply religious peasants being forced to adopt a new worldview, suddenly if not violently. They resented the recruiters who had destroyed their way of life.[22]

In Stalin City urban planners adopted socialist monumentalist style that glorified state power and industry. They designed the main roads to display and facilitate industrial power, while residential areas were located away from arterial roads. The city lay at one end of the main road, Stalin Street, and the factory, separated from the city by 1 kilometer stretch of woodland, at the other end. The city's main square, according to the lead architect, was to be "a large, stone-flagged, vegetation free" area to serve as an end point for parades and demonstrations. In this way, as in Stalinstadt and Nowa Huta, politics and production were two poles of the city.[23] According to lead architect Tibor Weiner, the concept of the socialist city emerged during the construction. Hence, the project became a "school for Hungarian urban construction." According to Pittaway, Soviet models were important to the Hungarians, but they interacted "both with the material factors of Hungary's cold war industrialization drive and more local circumstances to produce Sztalinvaros's urban form."[24]

To some observers Sztalinvaros "managed to retain its human scale and friendly atmosphere." A number of the first planners were trained in the Bauhaus, and several of the buildings demonstrate its influence.[25] One observer wrote the following:

> In the center of Sztalinvaros they built low-rise, four-storey blocks of flats around wide streets laid out at right angles, interspersed with various public buildings in Stalinist neo-Classical style, though some were also built in the Modernist Bauhaus style. As it was a politically prestigious urban construction project, artists were drawn in, enrolled on the books of factories and given flats, with the result that the town came to have a high per capita ratio of artworks. Some of the heroic proletarian reliefs and statues produced at the time can still be seen today, as can a number of vibrant colored frescoes, notably above the main gate of the steelworks.[26]

Ultimately, however, the city was designed to pay homage to the steel mill. One journalist wrote, "At night the fires of Pentele's chimneys light the sky; their sparks like sparkling red stars breaking apart the darkness. Above the former prairie and the banks, the woods and the gardens they rise, lighting the tractors that stand in the fields."[27] According to Gabor Fencsik, "The press was filled with the praises of the heroic shock workers building the gigantic furnaces and rolling mills. The press was lying, of course: the plant was being built largely with slave labor. One economist calculated that for Hungary it would be cheaper to import steel from Belgium in one-pound air mail packages than to produce it at the Sztalinvaros plant. The economist was put in a labor camp for his pains, and the construction of the steel plant went ahead."[28]

The political leaders might have been able to erect industrial structures, but they were unsuccessful in creating a proletariat loyal to heavy industry. The hero workers in hero cities took their responsibilities as the vanguard of the revolution seriously. They noted that both their and the Soviet governments had abandoned principles of workers' democracy and egalitarianism. They objected vigorously to the privileged position of party hacks and the absence of workers' control. They publicly attacked the hypocrisy, writing letters to higher party instances and, during the revolution of 1956, going to the barricades. As soon as the revolution broke out, workers in the main industrial towns—Miskolc, Gyor, Szolnok, Pécs, and Debrecen—set up revolutionary committees and councils. The miners in Pécs, Sztalinvaros, Tatabanya, and Varpalota formed councils in the mines, the steelworkers formed councils in the steel mills, and power station operators formed councils in the power stations. They armed themselves, took over radio stations, and roused the masses to maintain their vigilance. The councils published programs in which they called for political and civil liberties, worker management of the means of production, autonomy for trade unions and political party, and of course immediate withdrawal of Soviet troops. After Soviet troops occupied Budapest on Nikita Khrushchev's orders early in November 1956, local resistance spread to other cities and neighborhoods. The fiercest fighting was precisely in working-class suburbs of Budapest such as Ujpest and Csepel Island. At Sztalinvaros, the workers battled Soviet troops, joining Hungarian officers and members of the local garrison irrespective of party or religious affiliation. The workers "declared that they would defend against invading Soviet forces the plant and houses which they had built with their own hands." When Soviet forces crushed the armed uprising, the workers continued to battle by mass strikes and passive resistance against the new regime and its Soviet masters.[29]

Because these authorities considered Sztalinvaros a symbol of the industrial ethos of modern Soviet socialism, they were shocked when the workers in a hero city followed the example of those in Budapest to organize a council to represent workers' rights. No doubt some of them realized that at best they had fostered docility toward arbitrariness and resignation toward the propaganda of increased production. These councils appeared throughout the nation under various names, but those in Dunapentele and Miskolc were among the first. The councils represented all segments of the population: workers, university students, soldiers and officers, intellectuals and peasants.[30] On October 25, hard-core communists ordered troops to fire on a Dunapentele demonstration. Eight people were killed and twenty-eight wounded. The workers fought back, and the soldiers had to retreat to their barracks. A helicopter came to rescue a Soviet official, his family, and senior army officers from the crowds, at which point the Hungarian army went over to the workers. As in other cities around the country, the workers seized radio stations and broadcast appeals for weapons and equipment. These Radio "Rákóczi" broadcasts (named after Prince Francis II Rákóczi, who led a rebellion in the eighteenth century against the Hapsburgs) appealed to the International Red Cross for help. Eventually Soviet troops put down the revolution, killing thousands of freedom fighters throughout the nation, perhaps 1,800 to 2,000 in Budapest and 2,500 to 3,000 in the rest of the country, destroying city infrastructure and arresting and carting off university students to unknown destinations.[31] Their constant encounters with grayness at home, with proselytizing of the joys of industrial production at work, and with the patent falsity of workers' democracy in daily life had led them to revolution. Would it be different in Poland?

Steel Production to Convert the Polish Peasant to Socialism

Powerful construction rises straight up
Somewhere else, in the arms
we left our sleep
moved out from our minds and thoughts
And here is only one thing:
Finish the construction
before morning

Our muscles are burning
from the labor

The challenging construction rises up
meter after meter
up
straight

And after work
our t-shirts
Stick close to the body cause of sweat
and then
They started to sing a song
which will also build the city.[32]

A Polish socialist realist poem

Rebuilding from the war devastation contributed to the decision to adopt streamlined projects to conserve capital and ultimately to employ industrial mass production construction techniques rather than other more aesthetically pleasing and comprehensive designs. The designs also skimped on safety and environmental equipment. At the same time, socialist goals for the transformation of agrarian societies into industrial ones through collectivization reinforced reliance on initially limited labor inputs to build and operate hero cities. Poland lost one-sixth of her population in World War II; her major cities were destroyed and her industry ruined. Stalin added economic insult by partitioning the country effectively with borders moved to the west. The Polish communists under the Stalinist Boleslaw Bierut installed one-party rule in 1948, followed by arrests and show trials of alleged enemies, persecution of the church, and harsh collectivization of agriculture. To gain favor with the masses, the Communist Party commenced socialist reconstruction of industry and agriculture in 1949 with the promise to provide them wealth, consumer goods, and cultural renaissance.[33] The renaissance appeared in the rebuilding of Warsaw and the building of Nowa Huta, as well as in mining and metallurgy, unfortunately at the expense of other regions of the country and sectors of the economy.

Socialist leaders emphasized the creation of the modern infrastructure for the metallurgical, mining, construction, and electrical energy industries. Investment in these industries meant that other sectors and other regions of the country received less attention. The emphasis on these industries is understandable given the desire to transform peasant societies into proletarian ones and the belief that increased production in iron and steel most likely would trigger growth in related sectors. In Poland the iron, steel, and coal industries grew rapidly between 1945 and 1955. Steel targets of the three-year Plan of Reconstruction from 1947 to 1949 were surpassed. With 6 percent of industrial labor force by 1955 and 7 percent of the share of value of output of industry, steel was crucial for machine-building, motors, transport, and other sectors that employed 22 percent of the industrial labor force and produced 24 percent of industrial output.[34]

At first, the rebuilding of Warsaw and all of Poland was a focus of modernist interest among architects who viewed this as a unique opportunity to build a new Warsaw centered on the needs of the population. Many of them had been émigrés based at the University of Liverpool. They saw Poland as a tabula rasa opportunity, a hope that seemed reciprocated when the government established an Office for the Supervision of Aesthetic Production (BNEP) within the Ministry of Culture and Art. BNEP stressed professional values over ideological ones during the three-year plan commencing in 1947.[35] Yet the cold war heightened the pressure to discern strict ideological differences between capitalism and socialism, including in its technologies, and this shifted attention to include culture and design, especially after purges of individuals seen to be anticommunist or otherwise enemies. As in the USSR, an “anti-cosmopolitan campaign” unfolded. Suddenly, the goal was to make Poland a Stalinist state with a crash six-year plan. In urban planning socialist realism replaced the modernist ethos. Officials of the Union of Architects attacked so-called antisocial and cosmopolitan functionalist architectural practices. They preferred to design huge office buildings and other structures to symbolize state power according to the doctrine “socialist in content, national in form,” which meant an inevitable reorientation to the Soviet east. Jakub Berman, a Stalinist who honed his skills in Moscow and served in the Polish Politburo, said that "copying the model of the Soviet Union was obligatory in every sphere."[36]

The Soviet conquest of Poland involved the expulsion of the Nazis. Nazi invaders intended to free the country of Jews and enslave the Poles to work for German residents. They intended to replace Warsaw with a city one-twentieth its original size, Warschau, home to 100,000 Germans served by 80,000 Polish slaves in a labor camp. Plans for Warschau disappeared as Nazi defeat grew imminent; German armies burned Warsaw to the ground after the Jewish and Polish uprisings; 85 percent of buildings were destroyed. After the war, citizens engaged in spontaneous rebuilding with the removal of rubble. In 1949 the communists took political control—and control over rebuilding—as manifested in a six-year plan for reconstruction of Warsaw under Boleslaw Bierut. Socialist realist public architecture centered on highly visible buildings with important political functions erected next to new Soviet monuments. They commenced the construction of "factories of culture"—libraries, schools, and theaters to foster the appropriate political attitudes. They converted several greenbelts to industrial development.[37]

With the intensification of the cold war, socialist leaders shifted "from the utilitarian to the symbolic" in Warsaw's reconstruction. The Soviet dominance of politics, technology, and culture found full expression in the Stalin Palace of Culture and Science, built in the style of Moscow's seven postwar Stalinist skyscrapers. This was Moscow's skyline reproduced by Soviet architects under Lev Rudnev, not a "Polish" building. In fact, Polish communists did not want the Palace even as a press campaign praised the item and the contribution of 4,000 Russian workers, "brigades of enthusiasts," and "Soviet friends" who worked day and night using automated technology (from the civilized USSR, of course). The Palace occupied a 60-acre site that required the razing of 100 houses and displacement of 4,000 people in a time of housing shortage.[38] Rudnev and his colleagues built the Palace in 1953–55 as a "gift" from Stalin. They visited several Polish cities to study local architecture. Granted, some of the detailing and figures on the exterior represented Polish traditions and symbolized the tie between knowledge and labor. Yet the building looks Soviet—as well it should as a copy of the seven "wedding cake" Stalinist skyscrapers in Moscow—in its inhuman scale, overstated neoclassical style, and grotesque waste of vital resources: 32,000 cubic meters of concrete, 50,000 tons of steel, and 34 million bricks needed for reconstruction elsewhere.

The epitome of Polish socialist realist architecture and city planning was Nowa Huta, or New Steelworks. One critic called it a site of "conspicuous production" and a good example of the "Stalinist fetish for 19th century models of industrial production." This massive steel mill equaled prewar national steel production figures in its first year of operation. Party leaders and planners selected the site for Nowa Huta for three reasons. One was to force the pace of development of an agricultural region near the Vistula River. A second was to "proletarianize" Krakow, the Polish city that had offered the greatest political resistance to the communists. The third was to demonstrate to the world that COMECON, the Council of Mutual Economic Assistance established in 1948 to integrate the economies of the socialist nations, was a superior tool of East European economic integration to the Marshall Plan in Western Europe.[39] In general, however, the COMECON nations had rather autarkic economic policies until the late 1950s.

Nowa Huta was established in 1949 to support the Lenin Steelworks. The plans for Nowa Huta dated to the first postwar three-year plan in 1947. That plan focused on rebuilding the nation, so construction in Nowa Huta lagged until the six-year plan. Soviet planners were closely and directly involved in the plan during the reign of Boleslaw Bierut, a long-committed communist loyalist. Bierut first went to Moscow to be trained in the school of the Communist International in 1925. When Stalin dissolved the Polish Workers' Party in 1938 as part of the purges, Bierut was lucky to survive. He was designated head of the new Polish Workers' Party in 1943 and was head of the Polish provisional government from 1944 to 1947, and from 1947 through 1952 he was party head. Bierut was instrumental in the Soviet takeover of Poland by the communists.

Through COMECON, the USSR contributed $450 million to Nowa Huta. Soviet planners selected the site for Nowa Huta near the Vistula River, not in Silesia on the Gliwice Canal, but near Krakow to force the industrial development of the region and to assert control of an agricultural region of Poland that had remained psychologically and politically distant from socialism. Soviet engineers from Gipromez (the Metallurgical Design Office, who designed the Monchegorsk, Norilsk, and other arctic region metallurgical combines that operate to this day, with continued negative environmental impact) were critical in site selection.[40] The goal was to make nearby Krakow a "proletarian city" by accelerating the diffusion of the working class into the region. Hardy and Rainnie claim that Nowa Huta and its steelworks were indeed "a deliberate piece of social engineering."[41] A Polish-Soviet agreement included the offer of iron ore from Ukraine. Nowa Huta required the construction of an extensive transportation infrastructure: hundreds of miles of rail, the building of a new port on the Vistula to transform the river into an artery between Silesia and Nowa Huta, and the city itself—3,000 hectares crisscrossed by hundreds of kilometers of ditches where water mains and cables would be laid, plus the building of other plants needed to complete the project: factories for brick, building materials, and so on.[42] Like the streets of every socialist production city, those of Nowa Huta reflected the production ethos in their names: Six Year Plan, Lenin, December Revolution, Shock Worker, Polish-Soviet Friendship, Soviet Army, Marx, Engels, and Great Proletariat Avenues provided the framework for classical socialist realist architecture. Monumental Stalinist structures dominated every corner in Central Square. The structures were dwarfed only by the castellated gates at the entry to the steelworks.[43]

Planners anticipated spillover effects from Nowa Huta on the construction, machine tool, heavy machinery, rolling stock, automobile, tractor, and agricultural machinery industries "for the purpose of improving the welfare of the working population." The promoters referred to the significance of the foundry for the nation, but especially for Krakow with its rich cultural and folk traditions "but which was impoverished in an industrial sense." This agricultural region would change, by force of industry. The construction site "teem[ed] with workingmen in blue overalls . . . some of [whom] have come from the remotest corners of the country, but the core of labor crews is made up of former peasants of the Krakow distract," *Poland Today* reported. "The combined efforts of their hands and their brains will build a plant and city which will stand as a symbol of victory over the misery and backwardness which once marked the life of the peasant."[44]

The creation of production cities—of large-scale technological systems—had social, political, and cultural consequences that planners could not anticipate. In spite of the best efforts of political leaders, planners, scientists, and engineers, the hero cities—as a microcosm of the socialist experience—did not work out as intended. Science, including Marxist science, failed to consider the human and environmental factors adequately. Party officials and planners ran into human choices about lifestyle, reproduction, class awareness, status, and other features of human life that are hard to determine. The new towns of socialist Eastern Europe, like the new towns on which they were modeled in the USSR, attracted young people, especially peasants, those fleeing charges of being "kulaks," and militant communists. Migration from the countryside to the city burdened social services and housing, especially since planners had not planned adequately for housing and services. The younger people naturally began to court each other and start families. This made the absence of such domestic infrastructure as stores, kindergartens, and medical clinics a terrible burden, especially since the immigrants arrived in droves precisely because of the promise of new, well-furnished apartments. In Nowa Huta as late as 1970 nearly three-quarters of the citizens were of peasant origin. This new proletariat rarely encountered an easy life. They had to learn new skills on the spot, their apartments were poorly furnished or construction was not completed, and they encountered ridicule from city residents. Their factory mates, salesgirls, people in trams, and so on, disparaged them and called them names that ridiculed their peasant origins, lack of breeding, and alleged lower level of intelligence. Nowa Huta was planned for 100,000 residents, but between 1950 and 1985 it grew to 223,000 inhabitants.[45] This story of paradox—of rapid unplanned growth of a planned city—was repeated with similar disjunction between factory and home, worker and peasant throughout the socialist world.

At its height, the New Steelworks employed over 43,000 workers and produced 7 million tons of steel annually. While Europe's largest in terms of volume, the plant was not efficient, and its construction and operation consumed "vast proportions" of Polish investment funds. These funds enabled the support of a health service, vocational training center, metallurgical training school, cultural center, sports club, stadium, and two cinemas, yet all of which were totally inadequate to meet demand. The construction of housing, stores, and social services lagged considerably as it inevitably did at every socialist construction site from Nowa Huta to Novosibirsk, from Sztalinvaros to Stalingrad and Volgodonsk, and from Dimitrovgrad to Monchegorsk. Enterprise managers throughout East Central Europe generally found it necessary to secure housing budgets from the state to erect apartment buildings and attract workers. Such state-controlled infrastructure as the town's newspaper, *Budujemy Socjalizm* (*Let's Build Socialism*), and a series of propaganda films reinforced Nowa Huta's reputation as the place to live for aspiring proletarians.[46]

Nowa Huta, like other hero cities, was the focus of what might be called industrial ideological socialization. In the manner introduced at Magnitogorsk, Dnieprostroi, elsewhere in the USSR, and throughout the economies of East Central Europe, Nowa Huta sponsored a Stakhanovite movement. The Stakhanovite movement spread to polish mills at Huta Warszawa and Huta Katowice. Not all workers accepted the exhortation to overfulfill plans in the face of material and spiritual shortages. In *Man of Marble*, the Polish film director Andrzej Wajda captures a frequent response to the phenomenon: a Stakhanovite bricklayer commences a demonstration of his craft, only to discover that local workmen have heated the bricks. This scars his hands, and he can no longer demonstrate his craft. Stakhanovism did little to overcome mediocrity in industry.

In 1956 in Moscow Nikita Khrushchev delivered his so-called secret speech at the Twentieth Communist Party Congress in which he condemned the murderous excesses of Stalinism, the abandonment of "Leninist norms," and the cult of personality of Stalin. The speech led to a period called the Thaw in the USSR. The speech shocked communists the world over. At the congress Dmitri Goriunov, the editor of *Komsomolskaia Pravda*, took five nitroglycerin pills to stave off a heart attack. Bierut was being treated in Moscow for pneumonia; he read the speech, had a heart attack, and died.[47] Throughout Eastern Europe Khrushchev's speech triggered heightened expectations about a better life and led to confrontation with the governments. Popular resistance to Stalinism grew, and rebellions broke out. According to Neil Ascherson in *The Polish August*, in June 1956, 15,000 workers in Poznan at the H. Cegielski engineering plant, a major producer of engines, military equipment, and other machinery, grew so exasperated by their fruitless efforts to relax new production targets and to gain higher wages that they went out on strike. Their protests turned into a street demonstration of over 100,000 people who rioted. They engaged the security police and the army in battle, with nearly eighty people losing their lives and thousands injured and arrested. What had proletarian aesthetics wrought?

The Silver Armor of Concrete

The economic, political, and cultural choices embodied in the determination to follow the Soviet development model and embrace Soviet technological systems would have similar societal, environmental, and cultural impacts in Bulgaria, although the country was more agrarian than Poland—roughly 80 or 85 percent of the population was peasant. While the DDR had a long tradition of science and engineering, in Bulgaria it was poorly developed, and this fact necessitated dependence on Soviet expertise. The Bulgarian production city, Dimitrovgrad, immortalized in its glory days in the 1950s by socialist poets and writers,[48] was named for the Bulgarian communist leader Georgi Dimitrov, who died in 1949. Dimitrov was embalmed for display in a mausoleum in Sophia, where he lay for forty years. The mausoleum, built in six days, took weeks to destroy with dynamite and bulldozers after the fall of communism. Dimitrov's legacy lives on in the town in environmental despoliation. In "Concrete and Dreams" Peniu Penev, one of the leading popularizers of industry, praised the cement mixer for producing its "silver armor"—which also lives on in Dimitrovgrad.

Dimitrovgrad itself dates to the late 1940s when communist youths with utopian visions of a glorious, industrial socialist future gathered to create a petrochemical Magnitogorsk. They brought with them trees and shrubs to plant in the city; this greenery fails to obscure the industrial essence of the city. The communist government embraced these beginnings, immodestly seeing to it that 50,000 peasants and workers were drawn from the countryside to create a fertilizer plant (the Stalin Nitrogen Fertilizer Factory), one of the country's largest cement works, and several thermal electric power stations that power coal, copper, and chemical industries.[49] The chemical plant, still in operation, began producing nitrogen and phosphate fertilizers in 1951, later adding the production of ammonia, nitric acid, and ammonium nitrate. After the fall of communism, the facilities producing sulfuric and phosphoric acid, aniline, and nitrobenzene, the latter two carcinogenic, were shut down. In April 1990, the Ministry of Public Health declared Dimitrovgrad, along with Asenovgrad, Kurdzhali, Panagyurishte, Plovdiv, Ruse, and Vratsa, to be ecologically endangered regions and announced that residents of these regions would be given medical examinations. Forty years of proletarian aesthetics may be difficult to eliminate.[50]

The first postwar Bulgarian minister of industry, Petko Kunin, discussed the advantages of the Stalinist model of industrialization and electrification for transforming a backward country into a modern one. To build modern agriculture with machine tractor stations providing the technology and new industry operating on rich natural resources, two basic problems had to be solved. The first was the transformation of the country—as East European socialists were want to say—from an agrarian-industrial country with poorly developed industry and primitive agriculture into an industrial-agrarian society based on modern machinery. The second, taking a page out of the Leninist paradigm, was the electrification of the country, through the harnessing of the Danube and other rivers and the construction of massive centralized thermal power stations.[51]

Bulgarian communists were particularly disturbed by the backwardness and poverty of the Bulgarian countryside. The country seemed mired in the nineteenth century, with shortages of draught animals, implements, and farm machinery, let alone modern agricultural techniques. Both to extract capital from the countryside and to provide raw labor recruits for industry, they used the tried-and-true methods of collectivization and rapid training of managers, agronomists, zoologists, accountants, and other specialists. Collectivization enabled the authorities to centralize the provision of high-grade seeds, planting stock, and pedigree breeding animals. Initially, machinery came from the USSR and was then distributed to the farmers through machine tractor stations (MTSs) that, as in the Soviet Union, were also a political arm of the party. Already in 1948 seventy-one MTSs existed that promised access to nearly 3,400 tractors (vs. only thirty in 1945). Within one year (1948) they had assembled 1,100 cooperative farms out of 124,000 private farms. Dimitrov's stated goal was a "powerful fleet of large farm machines, tractors above all, and raising yields from soil with improved soil management, irrigation, electrification and fertilizers." Following Khrushchev's lead at the end of the 1950s, Bulgaria created 972 mega-farms (with an average size of 10,000 acres!) from the 3,290 existing ones. This meant the transformation of Bulgaria into an "industrial-agrarian country," with the requisite drop in the rural population from 82 percent in 1948 to 24 percent of the total population by the end of the 1970s.[52]

The size of the industrial labor force expanded rapidly, more than threefold from 1948 to 1964, with construction the largest sector owing to its centrality to the problem of building enterprises in all industries. While in 1952 there were only 657,000 people working in industry, transport, and construction, by 1965 there were 1.5 million, and the number of people in agriculture had shrunk from 2.9 million to 1.9 million. Between 1939 and 1965, electrical energy production increased 30 times, coal production 9 times, steel 81 times, and several industries (zinc, copper, chemical fertilizers) had been created anew. Cement, of course, had an honored place, with a ninefold increase.[53]

Bulgarian communist leaders might have supported factory construction, but like their fraternal brothers in Poland and Hungary, they failed on the housing front. They faced housing that was "woefully inadequate," outdated, dilapidated, and unsanitary in poorly planned towns with muddy and dusty streets. Houses were "gloomy, sunless and small." Between 1944 and 1963, 905,000 dwellings were built, of which two-thirds were in rural areas. The architecture and planning were influenced by Soviet ideas. Bulgarian architects adopted a grand scale that was intended to glorify the ordinary working man or woman. Neoclassical buildings had a "massive allure." At the end of the 1950s, as part of the short-lived de-Stalinization in society, including its construction projects, the authorities began to criticize the style as "undemocratic, pompous, too rigid, outmoded, unsanitary and out of place." Bulgaria was a land of largely single-storey housing (82%) where reinforced concrete techniques were in their infancy. To meet demand, the authorities turned to simple, mass-produced styles with little or no decoration, based on prefabricated concrete forms, yielding drab slab or tower construction growing like gray mushrooms on the outskirts of urban areas.[54] A growing number of occupants filled the average dwelling. As investment dropped, construction slowed, with the result that floor space per occupant declined and kitchens and bathrooms shrank in size.

To jump-start modern agriculture and industry, the Bulgarian government determined to build a large chemical fertilizer plant. Officials selected a site near the Marbas lignite mines, with a power plant and a cement factory nearby and relatively good rail service. The new chemical city, eventually called Dimitrovgrad, would bring together nearby villages through the process of socialist industrialization. Construction commenced in 1947, with youth brigades, the forerunners of the Bulgarian Komsomol, carrying the load. Roughly 45,000 to 50,000 youths participated in the construction through 1950. By 1951 the "Stalin" Chemical Factory had opened, followed by the "Valko Chervenko" Power Plant (named after Georgi Dimitrov's successor) and asbestos, cement, and other factories. By the 1950s the city had grown to 34,200 inhabitants (peaking in the mid-1980s at 54,000) who lived in a chemical world: Dimitrovgrad produced 50 percent of the nation's chemical fertilizers, 32 percent of its nitrogen, 24 percent of its sulfuric acid, and 18 percent of its cement. The fraternal communists—could there be any other kind?—in Moscow had supplied loans, machines, equipment, and expertise on top of the name of the chemical plant.[55]

As with the other hero cities of Eastern Europe, Dimitrovgrad was a symbol of the triumph of socialism, and at the same time it was a microcosm of the problems that socialist officials, architects, planners, and citizens faced in living and toiling with joy in spite of shortages. Rapid, almost anarchic construction of massive factories and power plants with tall chimneys that belched black smoke moved ahead, with housing construction usually an afterthought. Scaffolding rose everywhere; machines whirred, banged, and crunched; and the air smelled of petrochemicals, fresh soil, rotten garbage, and curing cement. Of course, in light of rural Bulgaria's underdeveloped industry and poorly developed labor force, the plans were not met. Workers lived in shacks that lacked basic amenities and even slept on bags filled with cement or straw. Planning and construction were "chaotic." Housing was far away from work; urban planning lacked roads, sewage systems, shops, and transport.

Dimitrovgrad symbolized the unity of heroism and discipline, industry and science, urbanization and mobilization of the masses; the new Bulgarian man (and woman, of course) would simultaneously embrace consciously and live through social and political transformation through modern socialist technology.[56] As Reid, Crowley, and others have argued, the architecture of the city was central to transformationist processes.[57] Initially, the planners had envisaged a town of small houses scattered about in groups, each with its own garden, a design reminiscent of outmoded rural towns, and failing to capture the "grandiosity of socialist architecture."[58] Extensive green regions coexisted with factories and apartment buildings, although the monumentalism of the architecture indicated simultaneously both the "triumph of socialism" and the insignificance of the worker. A revised plan of the mid-1950s settled on three- and four-storey apartment blocks concentrated in neighborhoods. According to Bulgarian planners, the modern architecture would overcome the contradiction between town and industry.[59] How many of the planners realized that Trotsky called in the 1920s for the establishment of *smychka* between town and village, between worker and peasant, through modern technology?

Having in fact alienated the peasant/worker, the political authorities had difficulties in attracting qualified workers to fill the factories, in spite of a national propaganda campaign to showcase Dimitrovgrad as a symbol of what Bulgarian socialists could accomplish in short order. Long hours, poor equipment, miserable clothing and food, even malaria (which was eradicated only in 1948) meant that workers and peasants did not rush to the site to participate. Until 1950, therefore, the construction workforce was composed of unskilled youth brigades. When others migrated to the city in search of work during forced collectivization, they were unenthusiastic and unreliable. Labor turnover was very high. The government introduced a draconian labor law to tie workers to the job; the unpopular law was revoked a year later. For their part, managers had to offer higher wages and lower norms to attract and keep workers. Gradually, the authorities introduced a system of vocational "factory schools" to improve qualifications—and worldview.[60] But many Dimitrovgrad residents could not abandon their rural roots: they established small private plots within the town; they farmed gardens, built pigsties and chicken coops, and turned public parks and courtyards into gardens.[61]

Stalin Produces Steel in the German Democratic Republic

Let us take a tour of one more production city, Stalinstadt (later Eisenhüttenstadt) in the German Democratic Republic. While Germany's industry was at a significantly higher level on the eve of World War II than that in the other socialist countries, the patterns of the city's foundation and expansion, the organization of housing, and the dissatisfaction of workers were all repeated. And while East German engineering, architectural, and other technological traditions were firmly within the western, industrial, capitalist ethos (for example, the Bauhaus school), these traditions would face eradication. Following on the heels of the formation of COMECON, and just after Polish, East German, and Soviet negotiators agreed to the creation of a "peace" border, the German Democratic Republic was established. The communist government quickly formed various ministries charged with supervising the rebuilding of the economy and creating a socialist order. The Ministry of Reconstruction was empowered by a Reconstruction Act that gave the state the power to dispose of property and land, define towns and counties, and give, withdraw, or limit property rights. As in Hungary, Bulgaria, and Poland, a production city would be a symbol of the new state.[62]

Approximately half of the industrial capacity of the Soviet zone was destroyed in war, and reconstruction of the civil economy in an agricultural region cut off from its old industrial connections created challenges. The DDR generally lacked raw materials and production capacity to produce iron and steel and had little coal. Stalinstadt would operate, therefore, on Soviet iron ore and coke from Poland. Stalinstadt represented the effective incorporation of the DDR into the Soviet sphere of influence, already effectively secured through military occupation. The promulgation of Stalinist five-year plans further guaranteed Soviet influence from ideological and economic standpoints as well. The first five-year plan (1951–55) targeted the construction at Stalinstadt of a large iron and steel combine and a cement factory, as well as a town to house the workers, officials, and bureaucrats. By 1962 the population of the city was 35,000. By 1954 there were six blast furnaces; by 1968, a cold rolling milling; in 1973, a plastic laminating plant; and by 1984, another steelworks. The number of employees grew from 6,000 in 1955 to 12,700 in 1989.[63] The quantity of toxic chemicals that filled the air also grew, but weren't the workers happy with the socialist social order? And weren't they enthused to live near massive factories?

Planners for Stalinstadt chose a site on the Oder River with access to the Oder-Spree Canal and thence into the central German waterway system, and with a number of rail connections to the rest of Germany, Poland, and Russia. They anticipated that the project would transform the agricultural region of Brandenburg into an economic powerhouse and give employment to refugees, farmers, and others. City planner Herbert Hartel envisioned the eradication of economic backwardness in seven years. The guarantee of this fact, he wrote, was that the city "was entirely conceived and executed on socialist principles."[64] These were the "Sixteen Principles of Urban Development" imported from the USSR. In spring 1950 Lothar Bolz, the minister of reconstruction, and architects Kurt Liebknecht, Walter Pisternik, and Kurt Leucht traveled to Moscow to discuss Stalin's German city. Leucht later became manager-in-general of Stalinstadt. The goal of the Moscow trip was to reorient Berlin's town planning to represent needs of the new socialist state, with Berlin to be a clear alternative to the West and an exemplar for other cities in the DDR. Planning took place within a debate and attack on constructivism, cosmopolitanism, and condemnation of Bauhaus traditions while promoting a socialist yet "national building tradition." Of course, the Bauhaus was part of the German national heritage, especially among socialist architects. But in polemics ideologues referred to it as a symbol of "American imperialism."[65]

How could architects develop national heritage while obeying socialist internationalism? In the 1930s Stalin had abandoned world revolution for "socialism in one country," with its attendant autarky, xenophobia, and militarism. If planners, ideologues, and others followed the notion of socialism in one country, then national particularities could be celebrated, while an internationalism of the proletariat was no longer possible. Similarly, a universal aesthetic language was rejected as cosmopolitan. The result, again, was an architecture that was "socialist in content and national in form." According to the sixteen principles, this meant that compact towns would be densely built, with high-rise buildings in the center of big cities. The center was defined not by trade as in bourgeois cities, but by administration and culture. A system of public spaces and hierarchies of use organized space, in theory with traffic subordinated to public life. Squares, main streets, and dominant buildings gave character. Hence, architects emphasized urbanity, not a decentralized, green utopia organized according to functional criteria, landscapes, and historical structures as was popular among "bourgeois" planners. Paradoxically, by following the sixteen principles, a city was defined by the political elite in the national government, not by local representatives or traditions.[66] Was it therefore Soviet in content and socialist in form?

In November 1950, several months after construction of iron and steel mills began, the authorities selected a location for Stalinstadt. Leucht produced a design that stressed the industrial and political significance of the city: The monumental plant entrance was the culminating point on which the town's radial and concentric streets centered. Roads, walkways, and avenues led through residential areas, all structurally oriented toward the gate. Chief designer Leucht defined the town in relation to the Stalin Iron Works, which included a town center with a large square lined by major public buildings, the biggest of which were the House of Culture and the City Hall that faced the plant's gate at the other end. The plant became "sovereign," with its gate, according to May, a "secular cathedral." Work and life, plant and town were reconciled in this plan.[67]

No less than in other East European and Soviet cities, workers were an afterthought in Stalinstadt. Housing construction lagged significantly behind demand, and while the first apartment buildings were well intended in terms of comfort, style, and quality, those intensions had to be abandoned as workers flooded into the work site and needed housing. Yet the barracks and tents of Magnitogorsk and other Soviet production cities might not suffice under the nearby gaze of the capitalist occupiers of Germany's western zone. The first residential buildings to go up in Stalinstadt in 1951 were simple, serial, unpretentious, economic, and modest as a stopgap measure. The architectural designs of the next complexes of flats became more opulent, modern, and spacious to suggest workers' palaces. They were adorned with large imposing gateways. To remove pedestrian traffic from the main streets, the flats were built around inner courtyards with park-like pedestrian avenues and such public facilities as nurseries, kindergartens, day care centers, and shopping areas at important junctions.[68] This had the effect of obscuring, if not ignoring, domesticity and had to be abandoned eventually for simple, inexpensive, mass-produced structures. Roland Adamson, who drove to Eisenhüttenstadt in 1962, remarked on the domination of the town by its mills: "The sudden appearance of the gargantuan J. V. Stalin Iron Smelting Plant . . . loom[s] up on the horizon in company with tall point blocks of residential areas and the water cooling towers of the electricity generating plant."[69] While designed so that prevailing winds carried the smoke, smog, and particulate from the plant away from residential areas, Stalinstadt residents would also live in terrible air pollution, especially when the winds failed to follow the dictates of the socialist plan. The needs of industry, not people, determined plans.

Socialist industry drew migrants like a magnet, changing the countryside rapidly from Hungary to Poland to East Germany. Stalinstadt filled with refugees, farm workers, women, and young people who came to seek employment, not necessarily to make a life. They were disappointed by the typically sluggish construction in the housing sector, since planners and builders focused on the steel mill. The workers found these buildings to be utilitarian boxes. On an early visit, party leader Walter Ulbricht recognized this problem and called for ceiling height to be raised to 3 m and the construction of four-story structures with more attractive, diverse facades. Beginning in February 1952, the government agreed that workers of the mill would be invited to discuss housing plans in detail. Yet progress remained slow: in 1952 only 360 of 905 flats were built on time, and no shops or other "social infrastructure" were completed.[70] The decision to focus on heavy industry meant the absorption of the economic resources of the new state in industry, not housing. Citizens who had lived under one failed regime had strong reservations about the new state, which seemed to ignore consumer needs. The government, already hamstrung by its own decision to focus on heavy industry, found itself further restricted by the requirement to pay reparations.[71]

Throughout the socialist world, planners turned to industrial construction techniques based on standard concrete forms to meet housing demand. The first three housing areas built in the first five-year plan for 18,000 residents were typical of the style of proletarian aesthetics: "grey-brown blocks of flats looked very depressing even in the bright sunlight but a little relief was provided by the colourful street decoration in celebration of the Youth Congress." The earliest buildings had a simpler design and silhouette than those built later, which have a "great deal of unnecessary ornament and complicated elevational treatments. In all these early housing areas the facades of the blocks facing the streets look like barrack buildings, very stern and forbidding." The inner courtyards had greenery and tidy paved areas. In the fourth housing area that followed, planners used more color and terracotta to distinguish them.[72] According to the official brochure of the town planning office: "The integration of giant industrial buildings and the city blocks of houses, as an expression of city planning, has become a real symbol of magnificent unity of purposeful effort and recreation, of work and play and of the unity of human existence in a socialized society. It gives architectural expression . . . to a society in which want and exploitation are banned forever and in which the creative power of man has opened the gateways wide to a beautiful and peaceful life."[73]

In 1954 Khrushchev proclaimed the mechanization and modernization of the construction industry through the establishment of new factories that turned out concrete forms, an industrial form that quickly spread through steelworks. This would speed apartment and other construction, yet it broke with the concept of planning oriented toward national tradition in the direction of mass needs, with mass production—and the inherently proletarian aesthetics of mass production—given priority over national style.

In Stalinstadt, in order to provide housing for increasing numbers of workers to keep up with plant expansion, the planners were forced to add these box-like complexes in rows and lines, like any tract housing. Stalinstadt's residential regions ineluctably spread toward and incorporated Furstenberg. The apartment buildings added by the 1980s (the seventh and eighth complexes) were simply industrial and noticeably worse in terms of quality. In fact, few of the central spaces and buildings of Leucht's plan were built. The planned axis of works gate cathedral and city hall never came into being. Rather, today one sees the blast furnaces along Leninallee (Magistrale) and a broad four-lane thoroughfare between the works and the town.[74]

Soviet dictator Stalin died in March 1953. Many East Germans, and especially workers who detested the high production targets set by the government, hoped that an end to Stalinism might lead to better living conditions and easing of political terror. The attempt to provide joy through steel, plastics, and other industries had not worked with the masses. They increasingly rejected the pressure to meet production targets. Rebellion broke out that spread from Berlin outward. The government, under General Secretary Walter Ulbricht, hoped to placate the masses by freezing prices and making more consumer goods available but refused to lower production targets for industry and construction. Ulbricht was a Stalinist who had served in Moscow from 1937 to 1945 to escape Hitler. On June 16, workers put down their tools, walked off their jobs, and gathered at the new parade grounds at Stalin Allee in Berlin. When party officials addressed the crowds, they were shouted down and often roughed up. The demonstrations spread to most other industrial cities the next day. Like in Hungary, workers established factory committees. Who else but workers should run socialist factories? They demanded economic and political reforms and called for Ulbricht's resignation and free elections. In Dresden the workers took over a radio station, elsewhere newspapers, and used them to demand the formation of a revolutionary government. Unable to quell the protests, the authorities relied on Soviet military units stationed in East Germany and their own police units. Over ten days of confrontations, thousands were arrested and scores were killed. Having reestablished tenuous control, and having recognized their lack of legitimacy among the masses, the party purged itself, increased surveillance, and offered modest relaxation of Stalinist economic development goals.[75] The Soviets put greater control over their military and curtailed training programs for the DDR, fearing that Soviet jets and tanks might be turned against them someday. Only after the erection of the Berlin Wall, and when the DDR seemed politically stable, would the Soviets permit an autonomous East German army to develop.

Of course, the DDR was more than Stalinstadt. Its engineering tradition could be divorced from that of Western Germany only gradually. Its scientists had been involved in creating the foundations of modern rocketry, chemistry, and physics. It remained strong in a variety of fields of modern technology, from plastics to solid-state physics to optical instruments. Its scientists included specialists thrilled at the opportunity to work under socialism, even if many scientists fled the increasingly authoritarian regime until the Berlin Wall was erected in 1961. A number of specialists have studied the interaction of technology and socialism in the DDR, pointing to this important history.[76] Here, however, the point has been to explore "grayness" and Stalinstadt as a major example of the phenomenon. When the wall fell in 1989, East Germans rushed to embrace the technological style—and, of course, the consumer culture—of West Germany. We have since discovered the tremendous human and environmental costs not only of authoritarian rule in the East but of socialist technological style. This style was evident even in such a symbol of universal modernity as nuclear power.

Stalinist Technological Style in the Energy Sector

A number of these features of Stalinist technological style prevailed in the energy sector until the fall of the Berlin Wall in 1989, thirty-six years after Stalin's death. "Grayness" in energy technologies existed both in a traditional area of that industry—coal mining and hydroelectricity, the latter an intermediate region of technological advance given its larger scale in terms of site selection and components employed—and in an entirely new area, nuclear power. In each sector, planners and engineers enthusiastically embraced the Soviet template, from training programs for workers and specialists, to research institutes that produced plans that reflected supreme confidence of the ability to rework nature so that it too operated according to plan, and to the machines, turbogenerators, and even mass-produced reactors. Because of the high cost of research and development in nuclear technology, it would have made sense for East European nations to turn to the USSR more completely in this area than in coal or hydroelectricity, but each sector rushed headlong into rudimentary designs; standardization of approaches, machinery, and equipment; and poor treatment of workers at each site.

In coal, in spite of a vision of highly productive workers pulling coal out of seams with modern pneumatic machinery, reliance on Soviet blueprints meant a low level of mechanization and emphasis on labor inputs, poor working and living conditions for the workers, extensive environmental degradation that resulted from operation of power generation systems (fossil fuel boilers, hydroelectric stations, and so on), and designs that risked sacrifices in safety for reductions in capital costs. Take, for example, the Polish bituminous coal mining industry in Silesia. Polish communist planners oversaw the nationalization of the coal industry and fostered rapid growth in the mining labor force, yet they failed to meet the targets of a three-year plan adopted in late 1946. Severe coal scarcities resulted, in part because of demand triggered by the industrialization drive and urbanization, plus coal exports at favorable prices to the USSR in a strange kind of socialist exploitation. While output per shift exceeded pre–World War II levels by 1948, it dropped back to those levels by 1953, in part owing to poor mechanization, even though the labor force continued to expand.[77]

Outdated techniques included long-wall and room-and-pillar methods with hydraulic backfilling underground, strip mining in its infancy, shortages of cutting machines and pneumatic hammers, and main haulage ways that lacked mechanized equipment. Added to this, productivity of labor in the coal industry was low because of "notoriously poor living conditions and housing, added to very low safety standards, [which] discourage the needed influx of new workers and result in a high rate of labor turnover." When the Poles sought modern equipment, they fell prey to premature obsolescence by relying on the USSR. They manufactured KW-52 and KW-57 undercutting and loading machines, copies of the Soviet-made Donbas combine. According to one observer, the machines were considered to be impressive by virtue of their size alone, but this hid the reality of their inferior quality and inefficiency; they were adapted from a Soviet model itself outdated as soon as it appeared in the 1930s. In fact, they wasted tight investment capital on the KWs in a sector of the economy "where elementary mining equipment is scarce, and repair facilities highly inadequate."[78]

With the construction of the Lenin Works in Nowa Huta and the expansion of the Kosciuszko mill and the Bierut Works in Czestochowa during the six-year plan of 1950–55, targets were fulfilled 90 percent for pig iron and 95 percent for steel and rolled products. The percentage of sheet in total production would be doubled by 1960 owing to production from the continuous wide-strip mill of the Lenin Works. In spite of all this investment and expansion, or perhaps because of it, the coefficients of productivity (average useful capacity, coefficient of utilization, dry coke consumption, and so on) were "mediocre by modern standards," with Soviet metallurgists doing better at their plants in the mid-1930s than Poles in 1955. Owing to low quality of iron ore charged, low capital, and low labor productivity, the average Polish blast furnace daily produced in the late 1950s only roughly 30 percent that of the average in the United States.[79]

Toward the end of modernization of coal mines, Polish engineers established thirty-five massive institutes that employed a total of 11,684 people, although only 850 of them were senior researchers (less than 1% of all personnel). These researchers were "blazing the trail in mining engineering." The first cutter-loader went into operation in 1945, and by 1972 there were 601 of them and ninety-four plows, most Polish built. (Soviet engineers and technology were crucial in the initial stages of mechanization.) While this may seem like great progress, keep in mind that Poland operated 544 mines in 1975. They had begun a transition to intensification of larger pits, for example, the Pniowek pit, which had a daily output of 15,000 tons of coal. All of this meant, in other words, that the massive socialist mine relied on raw human labor.[80]

The Soviet technological imprint flowed more directly into hydroelectricity and nuclear power. Although the hydroelectric potential of rivers in East Central Europe did not lend itself to the massive nature transformation projects characteristic of the former USSR, the Poles, Czechs, Bulgarians, Hungarians, and others organized hydrology institutes modeled on those in the Soviet Union to train engineers to turn what they considered wasted or useless land into productive land through hydroelectricity, irrigation, and aquaculture. In Hungary they sought radical transformation of the Tisza River and Hortobagy Plain through irrigation, reclamation, and fisheries projects. Polish engineers also aggressively pursued a series of river basin transformation projects.[81] At the peak of its nature transformation efforts at the beginning of the 1980s, the Polish "Hydroprojekt" institute maintained twenty-eight design teams with a total of over 1,000 employees. The engineers' scope of interest included water management, hydraulic engineering, steel construction, mechanical equipment, electrical installations and power generation, automation, water supply, wastewater treatment, architecture, and land development. Hydroprojekt followed the example set by the Zhuk Gidroproekt Institute in Moscow, itself an outgrowth of such nature transformation projects as the Belomor (Baltic–White Sea) Canal, the Moscow Canal, and others that relied on gulag slave labor. The projects, which engineers approached with great enthusiasm, turned out to be costly from environmental and social perspectives.

The human sources of environmental degradation and ecosystem change in Polish river basins were well known to officials and scientists, including how displacement of population from the Wisłoka River drainage area contributed to increased annual stream flow, as well as the impact of urbanization and industrialization on the Rawa River runoff in the Upper Silesian industrial region.[82] Yet they pushed onward in support of industrialization. One such project was the construction of a melioration canal connecting the Wieprz and Krzna Rivers to eliminate summer water shortages in the area of Polesie Lubelskie; by 1985, 40,000 hectares had been prepared for irrigation and eleven impoundments had been built. Yet the withdrawals from the Wieprz River, an average of 25 percent of average flow, were not well controlled and had an impact on the river ecology itself.[83]

The peaceful Soviet atom also found a home in socialist Eastern Europe. As part of the major propaganda effort to glorify peaceful programs in nuclear power, the USSR assisted the socialist nations in establishing extensive research, development, and energy production programs. The USSR promoted the military atom in East Central Europe through the Warsaw Pact Treaty organization. It promoted the peaceful atom through COMECON and the establishment of nuclear physics training and research institutes in each country. It also provided the opportunity for specialists to work in Soviet facilities, in particular at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia, where fraternal physicists gathered to do work on nuclear, high-energy, and other areas of physics. Ultimately, the USSR exported both nuclear research and power-generating reactors to Eastern Europe.

Peaceful nuclear programs in Hungary, Poland, the German Democratic

Republic (as part of Germany proper), and Czechoslovakia had prewar roots, while Bulgarian and Romanian scientists commenced research from a more embryonic stage. All programs received a significant boost from cooperation with the USSR. For the leaders in Eastern Europe, just as for Soviet leaders, modern science and technology were keys to building socialism. Scientists and engineers were considered naturally more reliable than other intellectuals, especially more so than humanists trained under the old regimes. No less than mining, metallurgy, hydrology, agronomy, or chemistry, nuclear science and technology would bring modernity to formerly agrarian societies. Nuclear research in Eastern European programs accelerated in the 1950s, especially after U.S. President Dwight David Eisenhower gave a speech at the United Nations in March 1953 calling for “Atoms for Peace.” In his speech, Eisenhower sought to diffuse the growing tension of the cold war by urging the UN to establish an organization with international control over nuclear materials and knowledge in support of peaceful applications in agriculture, industry, medicine, and energy. Eisenhower’s call led to the formation of the International Atomic Energy Agency (IAEA), which successfully operates to this day in promoting peaceful nuclear programs. Together with the Americans, the leaders of the Soviet Union and East European nations recognized the opportunity to use peaceful nuclear programs as a cold war propaganda tool. They quickly organized joint research efforts and expanded peaceful directions of study in order to demonstrate that they used the atom in the name of peace, not for military purposes as in America.

The creation of JINR was the result of domestic and international forces. JINR was built on the foundation of the Institute of Nuclear Problems, itself organized in Dubna in the late 1940s to contribute to the cold war nuclear enterprise. Another impetus was the creation of COMECON, founded in 1949 by the Soviet Union, Bulgaria, Czechoslovakia, Hungary, Poland, and Romania. COMECON was intended to ensure healthy trade among the socialist nations and to provide an alternative to the Marshall Plan, adopted by the United States to help rebuild Western Europe and to prevent socialism from spreading further. COMECON had a permanent nuclear commission called ATOMENERGO. The founding of JINR occurred after Vladimir Veksler, then of the Physics Institute of the Academy of Sciences in Moscow, conceived of the notion of the synchrophasotron to reach higher particle energies. To build a truly powerful—and much larger—machine, Veksler and his team moved to Dubna. Representatives of eleven states, mostly from Eastern Europe, then gathered in Moscow in March 1956 to sign an agreement to work at JINR in support of Atoms for Peace programs. From that time, East European physicists frequently journeyed to the JINR for fellowships, short-term research trips, and long-term collaboration. Scores of Czech, Hungarian, Polish, East German, Bulgarian, and other scientists worked together for nearly four decades on a variety of projects.

At home, the East European nuclear enterprise expanded rapidly, especially in Czechoslovakia, Hungary, and Poland, in terms of both institutes and researchers. Simultaneously, universities and Academy of Science institutes expanded nuclear physics training programs on the basis of Soviet programs and mass-produced equipment. At many institutes physicists installed U-120, U-240, and Van de Graaff particle accelerators built at the Efrimov Institute of Electrophysical Apparatus located outside of Leningrad; the Efrimov Institute built standard equipment for reactors and fusion research equipment as well. The East European research programs were vital, indigenous, and extensive, but they were tied intellectually and materially to Soviet technology.

For example, the Institute of Nuclear Physics was established in Krakow, Poland, in 1955. Researchers, under the leadership of Henryk Niewodniczanski, founder and first director of the institute, employed a U-120 Cyclotron, built in 1958, for various research projects. The Central Research Institute for Physics of the Hungarian Academy of Sciences (Központi Fizikai Kutató Intézet or KFKI), founded in 1950, grew into one of the leading European institutes of research on atomic physics, nuclear physics, cosmic rays, electromagnetic waves, spectroscopy, and radiology, expanding research after the Hungarian revolution into nuclear chemistry, electronics, reactor research, and solid-state physics using a Soviet research reactor.

Nuclear power logically followed research and development. While the climate of East European nations is not as harsh as that of many regions of the USSR, other factors played into the decision to build a series of nuclear power stations in the region. One was the absence of fossil fuel resources of high calorific value and low pollutants. A second was the need to transport oil, coal, and natural gas long distances—primarily from the USSR, which served as the major supplier of energy resources. Indeed, by Soviet standards, the countries of East Central Europe were energy poor. Third, as part of COMECON integration programs, nuclear power became almost inevitable. The leaders of East European nations indeed welcomed nuclear power as a sign of modernity and progress as they entered the second half of the twentieth century. While Czechoslovakia manufactured various parts and components for VVER reactors, and East Germany and Hungary contributed equipment, too, the lion's share of the technology came from the USSR in the form of the complete nuclear template.[84]

One technology was the pressurized water reactor, known by the Soviet acronym as VVER reactors, in 440 and later 1,000 megawatt (MW) units. The first generation was quite "gray"; those built in Bulgaria, Czechoslovakia, East Germany, and Hungary did not employ containment vessels. This meant that, had there been an accident, radioactive material could have been spread far and wide. Later, engineers built VVERs with containment vessels but sought to keep costs down through the serial production of eight 1,000 MW units annually at the Atommash factory in Volgodonsk, USSR. (Except for the DDR, most of the VVER reactors continue to operate in Eastern Europe, but with significant retrofitting of western safety, monitoring, and control equipment.)[85] Hungary had plans to buy ten units from Atommash that would have been floated through the Volga-Don Canal (itself a typically Stalinist technology), down the Don River to the Black Sea, and then up the Danube to Paks for a total capacity of 10,000 or even 12,000 MWe. At the height of their nuclear enthusiasm in the early 1970s, the countries of Eastern Europe forecast total capacity of 25,000 MW in 1985 and 177,000 MW by 2000,[86] that is, over 200 reactors.

Bulgarian leaders welcomed nuclear power to demonstrate that the former "agro-industrial" country had become "industrial." The nation built the Kozloduy Nuclear Power Station on the Danube River in northeast Bulgaria near the Romanian border. In East Germany the Central Institute for Nuclear Research in Rossendorf opened in 1956, and a research reactor commenced operation the following year. The first East German power reactor, the 70 MWe Rheinsberg PWR, was connected to the grid in 1966 and operated until 1990. The German Democratic Republic also had four VVER-440 reactors at the Greifswald nuclear power station dating to the 1970s, as well as two VVER-440 reactors at Magdeburg. In 1976 one of the Greifswald reactors nearly melted down owing to failure of a safety system. In 1974 Poland opted for four Soviet reactors, but the political crisis brought about by Solidarity and the breakup of the USSR put those nuclear dreams to an end. Under dictator Nicolae Ceausescu, Romania pursued a joint program with Canada to build the latter's CANDU natural uranium reactors. The regime discussed far-fetched plans to build as many as twenty CANDU reactors at ~650 MWe each. Taking a page out of Stalinist practices, Ceausescu ordered forced labor to work at the Cernavoda nuclear station site. Poor workmanship and faulty construction were widespread. When Ceausescu was killed in the revolution of 1989, the nuclear infrastructure of Romania disappeared with him, and only one reactor was completed.

Czechoslovakia has a long independent history of nuclear research that predated the Soviet takeover. Beginning in 1958, Czechoslovak scientists built a gas-cooled, heavy-water-moderated reactor, which had a spotty fifteen-year history and several unfortunate accidents, including one that killed two people during a refueling accident and several others that released large amounts of radioactive material. Under socialist power, before separation into the independent countries of the Czech and Slovak Republics, leaders decided to build nuclear power stations at Bohunice and Mochovce, also based on Soviet VVER models and all built largely by the Skoda Works at Plzen. The Czech Republic has four VVER-440/213 reactors in operation at Dukovany that came on line in 1985, 1986, and 1987; two VVER-1000 reactors at Temelin; and four VVER-440 reactors at Bohunice.

A second Soviet reactor is the notorious "RBMK" Chernobyl-type. Lithuanian communist leaders joyously approved the construction of two 1,500 MW units—50 percent larger than those at Chernobyl—in Visaginas at the Ignalina station. As with the VVER, this facility uses standard components, pumps, turbogenerators, and other equipment wherever possible to keep costs down, and engineers prematurely embraced those standard components. The RBMK has the advantage of on-line refueling, but the impossibility of containment. In fact, over 1,500 concrete plugs rest in the top of the reactor vessel to enable year-round refueling. Further, the RMBK is inherently unstable at low power and produces plutonium that can be used to make simple fission bombs. (As a precondition of entering the European Union, Lithuania has agreed to shut Ignalina by 2010.)[87]

Soviet-style planners imposed the Ignalina station on the nation with typical fervor. Electrical energy production stimulated industrial growth, and vice versa. Nuclear power construction stimulated more reactor construction. While at Chernobyl they dreamily envisaged ten reactors, and at Paks in Hungary up to ten others, in tiny Lithuania they planned a second large power station at Pavilosta on the Baltic Sea to ensure copious amounts of cooling water while not having to build expensive concrete cooling towers. The output of the huge Ignalina station represented an 80 percent increase over the total output of the entire nation. It enabled Lithuania to become an energy exporter, since domestic demand was nowhere near the amount produced. But Soviet planners were not satisfied. They decided to build a 1,600 MW pumped storage station at Kaisiadorys at the junction of the Streva River and Kaunas Reservoir; in periods of low demand, excess electricity will be used to pump water to an upper reservoir, and in periods of high demand, the water will be released through powerful turbogenerators. In keeping with the belief that technology was inherently safe, the construction companies for these massive hydro- and nuclear power stations employed young people with little previous training or experience, whose work was often judged "unacceptable." At Ignalina, again to save money, they designed the station without water effluent cooling towers. The station, built on the shores of Lake Druksiai, drew 300 to 400 cubic meters of water per second, or roughly 30 million cubic meters daily (perhaps 6% to 7% of the lake's volume), and dumped heated water back into the lake, contributing significantly to thermal pollution, evaporation, and ecological degradation.[88] Pity the poor fish.

Like other Soviet technologies, Ignalina was a tool of Russification. High out-migration marked rural regions during the postwar Soviet industrialization campaigns. Over ten years during construction, the percentage of Lithuanians in the surrounding region declined from 79.0 to 64.3 percent, while the percentage of Russians increased from 9.0 to 19.7 percent. The town of Visaginas, built to house plant workers and their families, was a typical Soviet settlement, designed by a group of Russian federation architects whose designs essentially rejected the notion of "socialist in content, national in form," and inhabited by Russian nuclear families—in all meanings of the term. Engineers came from other reactor facilities in the USSR. City planners chose a confluence of apartment bloc styles and sought to preserve the lakes and parks in the region, but the demands of the reactor predominated. Representatives of forty different ethnic groups joined to build the city and the reactors; many of them intermarried, with the keys to the first completed apartment going to a Lithuanian-Belorussian couple. But generally, the drawing together of different nationalities did not take place. The immigrants did not know Lithuanian customs, language, or history; the Lithuanian government succeeded only after the breakup of the USSR to require Lithuanian to be the language of operation of the nuclear power station.[89]

Proletarian Aesthetics Reprised

The workers who lived and toiled in the production cities of Eastern Europe lived a gray life of hard work and few comforts at home. Their lives mirrored the Spartan life of workers and peasants throughout the socialist world. Beyond the politics of the effort to create a strong state, ensure ideological conformity, and eliminate the remnants of capitalism, a major reason for this was the embrace of a peculiar technological style, itself the result of cost, ideological, and other considerations. The technology of concrete—and the fetishization of mass production—determined designs, rather than designs determining demand for concrete. This was most clear in the wide dissemination of the technique of large-panel construction. In the mid-1950s, as part of a drive to mechanize and automate all aspects of production, the Soviets and their fraternal brothers in Eastern Europe pursued the manufacture of prefabricated concrete forms. The ubiquitous large panel found myriad applications in housing, construction, and road building. Panels could be used as ceilings, floors, walls, and roads (when laid end to end); as walls with windows or door holes; or as sidewalks, steps, and light and power line standards. By the early 1960s, large-panel construction techniques had spread from East Germany and Hungary through Poland and Romania all the way to Siberia and back, often by East Europeans who had been "placed" in the Soviet system after the war and then returned home.[90]

One source of the techniques was the "huge and feverish process" of rebuilding that took place after the war. In the USSR, between 1946 and 1950 (the fourth five-year plan) Soviet workers built or rebuilt 100 million square meters of living space, and a similar amount was proposed for 1951 to 1955. Yet these statistics give little sense of what, by whom, by what means, and for whom the flats were built, or the fact that millions and millions of people lived in tents, barracks, communal apartments, and dug-out earthen homes. Usually only party, economic, and intellectual elites gained apartments in new buildings. P. I. Kotovodov's *Socialist Competition of Workers of Stalingrad and Minsk* (published in Minsk in 1950, in Russian) provided a sense of the apartment construction process, a process repeated in East Central Europe. The Central Administration for Construction of Minsk, Glavminskstroi, promoted a contest to build more quickly, better, and cheaper with the Stalingradstroi construction company. Glavminskstroi consisted of several poorly equipped building trusts; for example, Trust No. 1 had sixty-one lorries. The competition encouraged greater use of mechanized processes and "improved methods of bricklaying." Stakhanovites led the way, training young workers to follow their example. One Gromov, a plasterer in Minsk, wrote to the Stakhanovites in Stalingrad, "When we signed our contest [obligations] I had three trainee plasterers under me. This year I have trained six." Lectures, demonstrations, press, posters, and activism spread modern construction methods among the rank and file.[91] It would have been nice to have cranes and pile drivers.

Large-panel construction techniques determined that a few basic designs would suffice to meet burgeoning demand. Just as in the USSR in the 1920s and 1930s as urban centers swelled during the industrialization drive, so throughout Eastern Europe cities grew rapidly in the 1940s, 1950s, and 1960s. Planners' preferences in a centrally planned economy minimized consumer input into aesthetic considerations. And, to build housing rapidly, why not use inexpensive, standardized designs based on prefabricated forms that could be assembled rapidly by unskilled and illiterate workers into dwellings? This housing was proletarian in its minimal space, threadbare appointments, and shared bathrooms. It frequently incorporated the "collectivist" ethos in communal kitchens, child care facilities, and rooms for workers' clubs, but these were introduced more often to cut costs than to uphold a proletarian social ideal. The apartments and clubrooms, like the factory itself, also had a political function as the appropriate setting for the Communist Party to employ various media (radio, film, mass publications, and meetings) to educate the masses about the glories of communist construction.

To say that socialist cities resembled one another is an understatement. There were but a handful of basic apartment building styles in each country. The Soviet film *Ironiia sud'by ili s legkim parom!* captures that oneness of Soviet architectural style. The main character gets drunk and falls asleep. His friends stick him on an airplane. He awakes in Leningrad, but he thinks he is in Moscow and heads home. He ends up in a woman's apartment—he has used his key to gain entrance, and it works. He comments, "Street names are not very inventive. Which city doesn't have its First Garden street, its Second Country street, its Third Factory street? Staircases are all the same, painted with a standard, pleasant color. Standard flats are decorated with standard furniture, and the indistinguishable doors have standard locks." Upon waking from his drunk, he informs her that *she* is in the wrong apartment.[92]

Wherever they are introduced, such technologies as roads, factories, and apartment buildings both reflect and influence social choices. Or, to put it simply, technology is a social force. The decision to employ proletarian aesthetics in industry and housing simultaneously had implications for employment, quality of life, and commuting issues. First, in spite of egalitarian intentions, there were disparities in the quality of housing by region. Cities like Warsaw, Budapest, and Prague were the focus of intensive construction activity that could barely keep pace with the rebuilding effort and the growing migration of peasants into cities. Smaller cities had few resources for housing. This forced municipalities and construction trusts to build lower quality, overcrowded, and nondescript apartments. Regional disparities, like those of class, resulted from political and social concerns, not some objective determination of the one best way to allocate all resources equitably. One could achieve maximum economic growth for the entire country if the goal were to equalize output per capita. But that goal ran in the face of decisions to direct resources to areas of high resource productivity. And, of course, since a Marxist urban industrial ideology held sway, the cities received the lion's share of investment while the countryside suffered.

Second, enterprises that were ordered to expand industrial production had to attract new employees; it was easier for them to attract workers if they could offer subsidized apartments in buildings they erected and owned. The incentive therefore was speed in construction of barely functional apartments that were still better than barracks and tents that existed at many early construction sites. Yet the failure to build sufficient numbers of flats of more than two rooms meant that larger families were crammed uncomfortably into tiny living spaces. The absence of multiroom flats discouraged many families from having more children. And, of course, as noted earlier, members of the new administrative and technical elites often jumped lines in anticipation of new apartments opening up.[93] Rarely did the authorities order larger apartments to be built or the production of more consumer goods to make daily life more comfortable. Proletarian aesthetics predominated because housing, with the exception of Hungary, was largely allocated administratively according to nonmarket preferences. While new housing was available to most people at low rents in theory, bureaucratic procedures and intervention of one's place of work were required to secure an apartment.[94]

Stalinist Technology in East Central Europe

What had Stalin and his East European colleagues wrought? The large-scale technological systems that were deployed in East Central Europe reflected the crucial juncture of state power and technological choice, as well as political choices concerning distribution of goods, services, and natural resources that privileged industry over housing, steel over medicine, and cement over vegetables. That much is clear. Yet in what ways did a strong reliance on Soviet engineering practices also influence, shape, or constrain the technological choices of the other socialist nations of Eastern Europe? Owing to its military might, its central involvement in the politics of Eastern Europe, and its prevailing direct and indirect control over technological choices in its client states, the USSR was able to exert considerable influence over technological style that was manifested in a variety of ways and over a variety of technologies.

Each socialist nation had its own technological style as a result of national political, economic, and social differences. Engineering designs reflected not only natural constraints but political realities and choices. Consider, for example, Hecht's concept of "technopolitics" to explain how two different reactor designs developed in postwar France.[95] Physical constants place limits on technological choice. In construction, for example, strength, stability, reliability, weight, density, and other factors are universal values that limit choice of materials and how they are employed and constitute a complex decision matrix that includes cost, safety, stability, and so on. Yet political, economic, and ideological desiderata also shape technological choice. Soviet and East European planners seem to have had a particular fascination with mass production, with concrete, and with the design of more rudimentary technologies, with minimal attention to environmental concerns or worker safety. The result is precisely the "grayness" I have attempted to describe, even if we find only slightly different shades of gray. This discussion of hero cities indicates the importance of the interaction of local, national, and geopolitical (read Soviet) factors in the determination of those shades. By shades of gray I mean how these factors shaped technological systems, and how they differed from country to country. One could also find shades of gray in various energy, metallurgical, construction, and other technological systems that arose in Eastern Europe under socialism. Hero cities seem ready-made for this investigation: the Soviet impact is prominent in the planning process, the organization and layout of the cities, the architecture, and the training, employment, housing, feeding, and education of all residents. The hero cities also present compact cases from the points of view of history, geography, and sources for their study.

The new socialist regimes in East Central Europe turned to rapid industrialization reminiscent of the Soviet experience. After the end of World War II, with the installation of socialist governments, these nations—Poland, Bulgaria, Czechoslovakia, Hungary, Romania, and the German Democratic Republic—embarked on rapid industrialization and collectivization of agriculture. Leaders, planners, and engineers pursued industrialization through large-scale technological systems—new coal mines and steel mills, electrical energy generating plants, and entire production cities. In spite of the rhetoric of the glories of socialism, workers lived and toiled in dangerous conditions, factories polluted extensively, and housing was uninspired. The nations adjusted their programs in one way or the other, tinkering with production targets, factory blueprints, and urban layouts, but they seem to have learned little about the human and environmental costs of the Stalinist program, or learned about them later and still did relatively little to alter investment policies, pollution regulation practices, or industrial designs. Perhaps the political goal of establishing Marxian societies that were at least in a rhetorical sense "proletarian" gave little leeway to political leaders, planners, or engineers in their effort to transform their societies from capitalist, highly agrarian ones to socialist industrial ones.

How did economic desiderata contribute to technological style in East Central Europe? Three major forces seem to be at work here. The first was the requisite centrally planned economy with its alleged hyper-rational planning of production and distribution of resources. Paradoxically, instead of rationality, planners—and consumers—encountered bottlenecks at every step that went beyond simple explanations of resource constraints and geography. Instead of having pride in labor, the result was low-quality goods and services of an often irrational mix that left proletarian consumers dissatisfied and facing shortages. The absence of flexibility in the planning system contributed to decisions to adopt standard, rudimentary systems. Managers and engineers sought to take advantage of modern automated systems and mass-produced components to keep costs down. But in East Central Europe all of this waylaid innovation, as did pressures on engineers and managers to meet targets that had the rule of law. Engineers and managers therefore found it safer to choose simple designs and then avoided innovations precisely to ensure that they received performance bonuses and avoided punishment for failure.

Another economic factor was a fascination with mass production that rivaled Fordist attitudes in the West. I sense the roots of this fascination in the effort to be egalitarian (no worker should have it better than another worker, no concrete should be better than any other), to cut costs, and to take advantage of modern production processes, as well as fear of managers and engineers of missing targets. But we must also consider the importance of the example of technology in leading capitalist countries, in particular in the United States, and ask whether East European leaders shared the view of leading Soviet politicians that the assembly line would liberate industrial and agricultural workers. The Fordist assembly line is deskilling and inhumane, a fact that workers under socialism and capitalism both recognized long before their bosses did. Or, perhaps socialist bosses indeed understood that they desired socialist workers to be cogs in a machine, not independent thinkers.

The emphasis on heavy industry and on rebuilding as rapidly as possible from the devastation of World War II also contributed to gray technological style. Rebuilding from the war devastation contributed to the decision to adopt streamlined projects and ultimately to employ industrial mass production construction techniques rather than other more aesthetically pleasing and comprehensive designs. In what ways were economic choices, paradoxically, resource intensive or inefficient, while their adherents claimed them to be rational and efficient? How did autarkic economic relations contribute to technological choice? No doubt, cold war ideological competition between the United States and the USSR, between NATO and the Warsaw pact, also played a role, but we need to consider this further. More concretely, what was the relationship among top party officials, city and plant managers, and engineers concerning all of these issues? In what ways did ideological mandates influence technological choice and shape industrial designs? How did they shape the training of scientists and engineers? What was the impact on universities and research institutes? Which presocialist indigenous engineering traditions, national institutions, and styles found expression in the newly socialist countries? The notions of grayness and proletarian aesthetics go some way toward answering these questions.

Ideology also contributed to the phenomenon of gigantomania at the urban centers and factories that served them. Armed with simple tools and exposed to the elements, tens of thousands of peasants cum workers toiled not only to build the factory or urban center or canal at hand, not only to create a site of great ideological significance for indicating the glories of state socialism, but also to master the tenets of Marxism-Leninism, atheism, central planning, selflessness, collectivism, and allegiance to the party and its five-year plans. At hero projects throughout Eastern Europe divisions of workers were assembled whose every movement was scrutinized to ensure that they remained in lockstep with plans. They built factories, government buildings, and edifices that glorified state power.

Large-scale technological systems, as Thomas Hughes and others have argued, are not merely artifacts, but a series of interrelated processes and technologies and the governmental, scientific, engineering, communications, and financial institutions that contribute to innovation and diffusion.[96] Connected with engineering practices—and the technologies in which they were embodied—are important economic, social, and ideological considerations. This discussion of hero cities enables us to see that they are, somewhat tautologically, a huge agglomeration of technologies. Hence, gigantomania not only concerns the search for economies of scale, but grows out of ideological and political considerations. These include the desire to demonstrate state power through the construction of important artifacts, for example, various nations' space programs or hydroelectric power stations; consider Soviet and American competition over the Kuibyshev and Grand Coulee dams or the race to be the first to the moon. In the socialist nations, grayness paradoxically grew out of a conscious desire to compete with the West, to demonstrate the superiority of socialist technological systems, and to gather, train, and transform citizens into conscious proletarians efficiently.

Stalinism in its economic, political, and technological forms had a clear impact beyond Soviet borders. A number of scholars have written about ideological interference in science and engineering; about the persistent impact of the administrative, financial, and political controls over science and engineering in the decades after Stalin's death; and about the technological style that prevailed in industry in the USSR owing to resource constraints, economic desiderata, and other factors. Yet several issues remain incompletely explored, especially in socialist Eastern Europe, and especially concerning the history of science and technology. What of the Stalinist legacy in hero cities, in technological design, in engineering education, and in social policy? After Stalin's death, and especially after worker rebellions in the DDR, Poland, Czechoslovakia, and Hungary during the next three years over the inappropriateness of the Stalinist development model, communist leaders were compelled to reconsider investment priorities and the place of big technological systems in their plans. Yet the physical structures remained, as did the political, economic, and engineering decisions they reflected, and they would have an influence on the quality of life and the environment in East Central Europe into the twenty-first century.

Mikhail Grigorevich Rojter (1916–93), “Concrete Pourers at the Bratsk Hydropower Station,” 1960, etching. Socialist workers, without helmets or steel-toed shoes, poured concrete from one end of the socialist world to the other, from the Bratsk station on the Angara River in Siberia to North Korea, where it seemed it was easier to find concrete than food. Courtesy of the Allan Gamborg Gallery, Moscow, Russia.

FROM *KIMCHI* TO CONCRETE

The North Korean Experiment

> If *kimchi* is made tasty and sold at a low price, who will go to the trouble of lugging around heavy earthenware jars to pickle vegetables? Dried radish slices, red pepper leaves, sesame leaves and so forth should also be processed well; more tasty bean paste and hot bean paste should be made and sold in greater quantities. This will make our life much easier and facilitate the apartment-style living.
>
> At present we raise tens of thousands of ducks on our stock farms. Therefore, we should pay deep attention to the processing of duck.
>
> KIM IL SUNG

Large-scale hydroelectric, earthmoving, concrete-pouring, and other projects that transform both nature and society; daring achievements of proletarian heroes against all odds, including internal and external enemies as identified by vanguard communists; mass, forced migrations of peasants together with other elements mistrusted because of outmoded worldview; extraction of investment capital from the countryside to build up heavy industry but inadequate support for social overhead capital, schools, stores, and housing; manifestations of pseudoscientific tendencies under the pressure of ideology—all of these things describe some of the most disturbing aspects of the Stalin period in the USSR. Do they not also describe the Democratic People's Republic of Korea under Kim Il Sung and Kim Jong Il? Kim Il Sung would say that North Korean development focused not just on heavy industry, but on light industry as well, and especially on the quality of life of the worker and peasant, providing them with kimchi, bean paste, and ducks and building a modern socialist society.

In the mid-1950s Kim Il Sung seemed poised to pursue industrialization and collectivization of agriculture while also devoting attention and resources to the consumer sector. Nikita Khrushchev provided an example. Khrushchev had abandoned the Stalinist program of unrelenting investment in heavy industry and incessant exhortation to fight internal and external enemies. He began to empty the gulag labor camps, simultaneously ordering "rehabilitations" (many of them posthumous) for the victims of the Stalinist terror. Of course, Khrushchev maintained the unassailable position of the Communist Party, of planners' preferences and the centrally planned economy, and while reining in the secret police he had no intention of disbanding the KGB.

In his speeches and programs of the 1950s, Kim Il Sung indicated a certain affinity with the Soviet approach. He spoke of the importance of rebuilding houses destroyed during the Korean War, providing clothing and other basic necessities to the people while simultaneously building industry and mechanizing agriculture. North Korea joined COMECON, the Council for Mutual Economic Assistance established by Stalin in 1949 as an alternative of sorts to the Marshall Program to rebuild Western Europe. North Korea entered the international scientific arena, sending dozens of novice nuclear scientists to the Joint Institute for Nuclear Research, in Dubna, Russia, beginning in 1956 for training and, with technology provided by the USSR, bringing on line its first experimental reactor at Yongbyon in 1963 for peaceful purposes.[1] Initially foregoing autarky, Kim Il Sung declared, "We should introduce all the technology superior to ours, regardless of the country it comes from."[2]

Yet by the 1960s, Kim Il Sung and the Korean Workers' Party had embarked on a policy of self-help and autarky under the banner of "Juche" ideology that led to virtual isolation. Kim Il Sung identified renegades within the party, attacked those who hoped for more balanced economic growth, and even rejected Soviet guidance and assistance in a number of spheres. He wearied of Soviet heavy-handedness in COMECON, through which Moscow insisted on providing finished goods to North Korea at terms that were not always favorable in exchange for raw materials. Regarding *Juche*, Kim Il Sung said, "We formulated our policies independently by creatively applying the Marxist-Leninist principles to the specific realities of Korea and enlisted the inexhaustible creative potentials of our industrious and talented people and the rich domestic natural resources in the carrying out of the policies."[3] He meant to go it alone and build a new kind of socialism.

With the Korean Peninsula we face the risk, as in the Soviet case, of claiming some kind of geographic determinism in shaping the face of technology. Recall how Trotsky believed that Russia's backwardness had much to do with its vast spaces and difficult climate, and that only modern technology would bridge the gap between countryside and city, not to mention protect the youthful proletarian republic against the advanced capitalist powers. The northern half of the Korean Peninsula is colder, more mountainous, and has richer deposits of mineral wealth, while roughly the southern half has a milder climate, more forest, and more arable land. The effort in the north to build industry *and* agriculture after the Korean War therefore was handicapped from the start by climate and resource distribution that favored industry but made agriculture costly and risky. Riverine water resources were limited by both total annual flow and great seasonal fluctuations. This led to the promulgation of large-scale national irrigation systems, stepped reservoirs along rivers, and hundreds of other impoundments to establish collectivized agriculture, while serving all important industry with water and hydroelectricity. But the headlong pursuit of *Juche* socialism through big technology resulted not from geography but from Kim Il Sung's cult of personality that set a course of Stalinist, autarkic economic development.

Judging by the rhetoric of officials from the United States, North Korea was an evil regime. Its leaders sought weapons of mass destruction, starved its people, and threatened stability in the Far East. Isolated from the outside world, its closest allies, such as China, might only periodically exert a calming influence on it. So autarkic was North Korea that study of its political, economic, and social systems—and especially its strategic technologies—is possible only with great difficulty, and many of the conclusions that we draw must be based not only on limited information but also therefore on our own preconceptions. And yet sufficient material exists for an evaluation of the genesis and place of large-scale technological systems in North Korea. The Foreign Languages Publishing House in Pyongyang published scores and scores of editions of Kim Il Sung's works, official party transcripts, and planning documents that enable this evaluation. These primary sources reveal the government's abandonment of any pretense to develop consumer society (here, metaphorically, kimchi, a traditional dish of fermented and often spicy vegetables), a focus on big industry, and a hubristic belief in the ability of the masses of workers to transform nature under the proper guidance of the Korean Workers' Party. In its autarkic economic development policies, in the genesis and diffusion of technology, in the formation of a cult of personality and cult of the Communist Party, and in its incessant ideological pronouncements, North Korea was the epitome of Stalinism. In its devotion to large-scale technology based on rudimentary systems and in its determination to pursue metallurgical, mining, chemical, and military industry, North Korea produced typically socialist technologies.

Stalinism and North Korea

Engineers and scientists in North Korea, laboring under difficult work conditions with significant resource constraints, denied regular access to the international scientific community, and trained within a closed political system, have produced Stalinist technologies, more Stalinist than those developed in the USSR under Joseph Stalin. Although Stalin died in 1953, remnants of his system and the kinds of thinking he promoted persisted, not only in the former USSR, where de-Stalinization that commenced under Khrushchev was only partly successful, not only in the hero cities of Eastern Europe, but especially in North Korea. Under Kim Il Sung ("Great Leader," 1912–94) and Kim Jong Il, his son ("Dear Leader," 1941–, a specialist in North Korean socialist realist art, literature, and especially film), the government pursued a strictly Stalinist program. This meant that, like the USSR in the 1930s and 1940s, the government introduced a centrally planned economy that emphasized the development of heavy industry at the expense of other sectors. Agriculture was violently collectivized. Owing to the absence of economic incentives to encourage performance, the government turned to both coercive measures and exhortations. This exhortation involved various campaigns and programs, some indigenous, some modeled on Soviet Stakhanovism, that is, highlighting the achievement of higher than planned norms of productivity for a worker or brigade of workers as an example for other workers to follow. Constantly invoking campaigns to increase industrial production and raising the specter of hostile encirclement by the United States, South Korea, and Japan, Great Leader and Dear Leader promoted autarkic economic, scientific, and engineering institutions.

Stalinist regimes produced technologies noteworthy for great scale that dwarfed human sensibilities and aesthetics. Economic imperatives led to the adoption of large-scale, resource-intensive, symbolically important, yet highly irrational projects. The power stations, transport and communications infrastructure, factories, and so on, reflected the tendency of the state to collect power in centrally controlled institutions and bureaucracies to administer factories, things, peoples, and technologies. The technologies served first of all state economic development programs and reflected planners' preferences; hence, they were designed with insufficient attention to safety and environmental concerns, for example, various redundancies to protect the worker or filters to lessen pollution. Any regulation either served those industries to be regulated or was ignored.

In Stalinist regimes like North Korea, officials see nature as real, knowable, and important to the state; pre-socialist nature itself is capricious and mysterious, while Stalinist nature is rational and planned. The major tool to exert control over society and nature is the Communist Party, with its insistent vision of the future and its science and technology purged of bourgeois thinking and personnel. They are the bulwark against assault from dangerous, hated outsiders. They are symbols of national achievement and of the advantages of the socialist system over the capitalist one. While socialist technologies share this last feature—ideological significance—with capitalist ones, they are different in one important regard. Stalinist science and technology are decidedly transformationist, tools to change a backward, agrarian nation into a modern industrial power and to change the peasant, the religious middle class urbanite, and others into conscious materialist citizens.

Political desiderata reinforce these tendencies by preventing public input in the technology assessment process. A one-party regime insists on allegiance to its development programs. Engineers and scientists who question the pace, scale, or costs of those programs face hostile scrutiny or perhaps worse. A secret police with great power to surveil seeks to uncover dangers—both domestic and international—that threaten the regime, while absence of open media means that no engineers, let alone citizens, have channels to question the programs. This also leads to extra-scientific censorship of results and extensive ideological interference.[4] State planning ensures dedication to state goals and emphasizes applied science at the expense of basic research. The resulting closed research and development (R and D) system restricts expert and citizen input into determination of safety and efficacy. Technology remains only a symbol of modernity and a panacea, never a potential danger.

What is an authoritarian regime? Beyond the monopoly on power usually manifest in one-party rule, a charismatic leader or tiny clique presides at the top of the party, with unquestioned and arbitrary personal power. Members of the ruling elite share a fiery commitment to transform society. One of the tools they use is a monistic belief system that encourages the individual to identify with state goals. This belief system, which includes mythical notions of right and wrong, justice and retribution, nationalism, fatherland and/or motherland, and love for the leader, is disseminated through centrally controlled media. The system appeals to instinct as opposed to reason, although claiming the latter. The state employs secret police who use terror, coercion, and violence to reach its aims. It alleges the presence of internal and external enemies to mobilize the masses. Unlike such authoritarian systems as Nazi Germany or Peronist Argentina, Stalinist regimes have eliminated private property; the state in the name of the working class owns all property. Following the Soviet example, North Korean communists embraced centrally planned economies and a command approach to ensure resource allocation based on planners', not consumers', preferences. They pursued autarkic economic development. They employed various campaigns of exhortation and coercion to increase productivity of workers in the absence of material incentives.

In terms of technology, several features distinguish Stalinist and other authoritarian regimes from other systems. Tautologically the state is the prime mover in technological development. In order to achieve the goals of economic self-sufficiency and military might, the state harnesses the efforts of engineers and scientists to its programs. State officials, guided by heroic ideology, determine what areas merit study. In exchange for funding, experts are held accountable to produce results, and failure to meet targets may trigger personal reprisals. A highly centralized and bureaucratized system of funding and monitoring ensures accountability. Since the state is the prime mover, its projects acquire significant momentum that carries beyond the completion of the initial goal. Bureaucracies everywhere seem to take on a life of their own, becoming institutions in search of a mission. The large-scale technological systems themselves acquire nearly unstopped momentum, moving ahead in spite of geological and technical obstacles, garnering vast armies of workers, and starving other projects of support. Even those intended to satisfy the public need for food and shelter acquire "gigantomania": public housing, subway systems, and government buildings have a depersonalizing scale. Their "ideological skins" are thick, overpowering, and intimidating. The gigantic structures reflect the effort of officials and engineers alike publicly to demonstrate the strength, glory, and legitimacy of the regime, and as such they become symbols of the present and the future.[5]

The centralization of science policy in Stalinist regimes enables one institution or approach to gain unassailable power to define orthodoxy. Owing to this momentum, it is more difficult to derail economically unfeasible and environmentally dangerous projects than in pluralist regimes. Occasionally "quack" scientists such as Trofim Lysenko, whose rejection of modern genetics destroyed the nascent field in the USSR, and with it the careers and lives of many respected scholars, and in North Korea Ri Sung Gi, a talented organic chemist, gain authority over entire fields of research and with it resources and censorship powers.

Great Leader Rebuilds after the War

Korean communist leaders logically pursued the Stalinist development model of collectivization of agriculture and breakneck industrialization. The Soviet Army occupied the Korean Peninsula when the Japanese moved out after their defeat in World War II. The Japanese government had pushed industrialization in colonial Korea in the 1930s and 1940s to expand the industrial base of the country in preparation for its war in Asia and the Pacific. The northern parts of Korea were the focus of the effort because of rich ore and mineral deposits, as well as coal and hydroelectric potential to power the effort. The north had higher growth of industry in the late 1940s compared to the south, in part because 75 percent of heavy industry was located in the north. Direct Soviet guidance and Japanese detainees were crucial to the postwar reconstruction effort. Soviet Red Army leaders picked a young guerrilla leader, Kim Il Sung, to be the communist leader.

Kim Il Sung joined the communist movement in the 1930s and led a division of a Chinese-sponsored anti-Japanese army working against colonial occupation. He and his division escaped to Khabarovsk and Stalin's protection at the beginning of World War II. Here, he and other Korean guerillas received training, and on returning to Korea in 1945, like Trotsky before him, he immediately set to the organization of a military force, the North Korean People's Army, with Stalin providing armaments, tanks, trucks, and even jets. The communists established the Democratic People's Republic of Korea in 1948 in the face of growing evidence that peaceful unification of the north and south would be impossible. In 1950 war broke out over efforts of the north to unite with the south under Kim's army, with Soviet and Chinese support, and U.S. efforts to prevent the spread of communism (the "domino theory"), with British and even UN support.

When Japan withdrew after the war, more than 1,000 factories were nationalized under the communists. Some small-scale business activity was permitted, and the number of private manufacturers grew until the Korean War. Foreign experts contributed to industrialization. Over 400 Japanese engineers were detained in North Korea, and Soviet experts soon joined them in factories, mines, hospitals, planning offices, and other workplaces to teach industrial management. When Japanese engineers were finally repatriated, Soviet engineers filled their places. They conducted technical education to improve skills of workers in operation of machines. In some factories the number of specialists and skilled workers grew from one thirty-fifth to one-tenth of the labor force in a few years.

But all in all, the quality of production fell significantly even if output increased, and electrical power, coal, steel, and chemical fertilizer production ultimately fell before the war.[6] This left communist leaders feeling vulnerable.

Kim Il Sung repeatedly stated the goals of the Korean Workers' Party to eliminate colonial dependence, backwardness, and lopsidedness in industry and to develop heavy industry with light industry simultaneously, providing the machine tools to get at natural resources and process them.[7] The rebuilding effort had begun to gather momentum when the Korean War broke out. U.S. bombers leveled Pyongyang and also strategic sites in the countryside. As late as May 1953, the Air Force set out to destroy irrigation dams in the north, releasing floods that wiped out roads, railroad tracks, and thousands of acres of rice fields. The Koreans quickly repaired the damage, but they had to reduce the water levels to prevent flooding in case of another attack, and this reduced the water available to the remaining rice crops. The bombers also destroyed the Soopoong Hydroelectric Power Station, later rebuilt and expanded by the late 1950s to have the greatest capacity of any Asian station. Unfortunately, the reservoir was rarely filled to capacity, and this limited output. The bombing also destroyed industry, fields, and educational, public health, and cultural facilities. Factory buildings, machinery, raw materials, and technical knowledge were destroyed. Elected American officials and military men even spoke of using hydrogen bombs against Korea. It was logical in this environment of war and threats for North Korea to rely on Soviet aid and to emulate the USSR in many ways (planning, party structure, the creation of an Academy of Sciences, and reform of the educational system). China also contributed directly to the postwar reconstruction through millions of man-hours to build and rebuild bridges, reservoirs, dikes, and the like.[8]

The subsequent division of the country at the thirty-eighth parallel and the establishment of a demilitarized zone, of course, created grave obstacles to the overall political, economic, and cultural development of the Korean Peninsula, making it, in the words of communist leaders, "impossible to utilize rationally the rich resources of the northern and southern parts of our country in the production and construction and to use them in a unified way for the wellbeing of the entire people of North and South Korea."[9] For his entire rule, Kim Il Sung therefore sought to turn his state into a military machine ultimately to conquer the south, but more immediately to repel attacks from such "imperialist aggressors" as the United States. He pursued large-scale industrial, energy, public water works, and other projects both for strategic and economic reasons and as monuments to his rule. Because of his unequivocal power and that of the Communist Party, no one was in a position to question the human and environmental costs of the projects.

In pursuit of these goals, North Korean specialists often turned to reverse engineering, although not entirely successfully, when they could not rely on extensive indigenous industry and trade. In one case, having been refused a license to build Soviet tractors, North Korean managers and engineers set up a factory on their own based on copies. They produced a prototype with great fanfare and only one problem—it went only backward; they quickly solved this minor detail. They copied electric locomotives (based on a Czech engine), trucks (based on old U.S. "Diamond T" trucks that made their way to Korea by way of lend-lease to the USSR during the war), and even sewing thread. When they imported or otherwise acquired new technologies, they preferred to import from the West rather than import old-fashioned machines and equipment from socialist countries.[10]

The cold war tensions between the socialist camp and the capitalist work of course led to a determined effort to build up the metallurgical industry for steels, chemicals for fertilizers and artificial fabrics, building materials industry for cement, and machine building. Machine building, Kim Il Sung asserted, was at the core of heavy industry and "the basis for technical progress." This sector of the economy had to supply electrical machines, mining equipment, farm machinery, vessels, processing machines, and spare parts.[11] He noted, "Our revolution does not permit us to slow down the rate of growth of industrial production." The nation had to overcome technological backwardness as a result of Japanese imperialism; they could advance no further on the basis of old technology.[12]

Following the Soviet example, North Korea immediately ordered the collectivization of agriculture at the end of the war. Kim Il Sung praised the peasants for providing food during the war, plowing fields with oxen whose backs were camouflaged and sowing seeds at night to avoid bombing. But the collectivization effort was as brutal as Stalin's campaign had been in 1929–34. Kim sought to attract peasants to the farms by providing seeds, fertilizers, and equipment. By the end of 1956, 80 percent of the land had been collectivized. The process ended in August 1958, with more than 13,300 cooperatives having been formed. All aspects of farming, from planting and harvest to retail services and marketing, ran through cooperatives under the control of local party committees. The government required self-sufficiency in production. This meant a life of sacrifice among the peasantry to support the military and heavy industry, allowing mobilization of resources for a constant battle. Self-sufficiency of agriculture would occur through the state-sponsored transformation of nature.

De Rigueur Planning and Heavy Industry

The Stalinist system relied on central planning and planners' preferences. The plan would, according to officials, overcome the irrationality inherent in capitalism, but North Korean economic irrationality had its own special flavor. Korea launched two one-year plans (1947, 1948), two two-year plans (1949, 1951), a three-year plan (1954–56), a five-year plan (1957–1961), and then moved to seven-year plans (the first in 1961), all based on rapid state investment in capital construction for big technology in industry, agriculture, construction, and transport, followed by smaller amounts and increments in scientific research, health, housing, and social overhead capital, and even a decline in education and culture.[13] Long-term plans, they learned, were rational plans. In March 1958, while celebrating the early fulfillment of the five-year plan, Kim Il Sung said, "We have already experimented with a one-year plan, a two-year plan and a three-year plan, and today we are discussing our five-year plan and carrying it out." A one-year plan envisaged small-scale short-term construction. But a five-year plan envisaged "magnificent, large-scale construction over a long period."[14]

Officials adopted the longer and longer plans to complete "socialist construction" and "socialist rehabilitation" of the nation after the war, with heavy industry gaining the lion's share of investment. In words and documents, agriculture and the consumer sector would also be resurrected. The Three-Year Plan for Postwar Rehabilitation and Development of the National Economy (1954–56), adopted to reach 1949 production levels, reminded citizens, for example, that "machines do not provide food."[15] Unfortunately for planners, they were unable to count on rapid increases in production of electrical energy, the typical technological panacea in socialist regimes, because it remained to build large thermal power stations to be powered by plentiful coal or hydroelectric stations, both of which required years to come on line.[16] "Rehabilitation and construction" of industry and the simultaneous attempt to build roads, bridges, reservoirs, and housing consumed immense resources and generated bottlenecks of supply, dearth of building materials, and labor shortages. In an April 1955 speech, Great Leader drew particular attention to the Anju irrigation project that envisaged the excavation of hundreds of kilometers of waterways including tributaries. On top of this massive project, to reconstruct factories, railroads, and bridges, they needed to resurrect cement production and the timber industry. All this required the mobilization of manpower, which Kim Il Sung assured his audience was a simple matter of organization. For example, he claimed that if organized properly, the mobilization of raftsmen in rural areas for work in lumbering activities would not result in idle crop land due to labor shortages.[17]

And what of capital, building materials, and so on? Where would the iron and steel, coal, machinery, chemical fertilizers, cement, and bricks all come from? At the Third Congress of the Workers' Party of Korea in April 1956, Great Leader reported that the three-year plan had already been fulfilled in most targets areas, with great strides in rebuilding the economy, with industrial and consumer goods production nearing 1949 levels, with expansion of cultivated areas, and so on.[18] But there could be no rest. He called for further rapid growth of heavy industry as the basis of the socialist economy: metallurgy (the Songjin Steel Works, the Kim Chaek Iron Works), mining (for example, the Kapsan Copper Mine), machine tools, construction and transportation equipment (mining and drilling machines, cranes, concrete mixers, excavators, railway coaches, and locomotives), shipbuilding, electrical power production and electrical motors, and building materials.[19] More coal was needed to free up timber for construction and to serve such new, massive factories as the Hwanghae Iron Works served by the Chondong Mine.[20]

In 1957, the party adopted a five-year plan "to complete the building of the foundations of socialism in our country." In good socialist fashion North Korea fulfilled this plan in two and a half years. Kim Il Sung observed that "socialist relations of production came to hold undivided sway in the towns and countryside, and the base of heavy industry with light-industry as its core, and the base of light industry were laid."[21] The emphasis, he insisted, was on heavy industry, not for the sake of heavy industry, but for the people. Still, the major achievements of the plan in electrical energy, coal, pig iron, steel, fertilizer, and machine building all indicated that heavy industry was the primary interest of party leaders.[22]

To keep his people's attention focused on the plan and not on their continued material deprivations, Kim Il Sung repeatedly—and understandably—reminded Koreans about the great losses they had experienced under Japanese colonial rule and during the Korean War. They had had a very hard life with a precipitous drop in their standard of living. They had lost most of their furniture and household goods, their clothes and homes. At the second Supreme People's Assembly in September 1957, he repeated his frequent observation that "towns and farm villages had been reduced to heaps of ashes, all branches of the national economy had been totally destroyed, and the popular masses had been deprived of the basis of subsistence."[23] But with the successful completion of the five-year plan, he was ready in June 1958 to announce that from those ashes "the towns and villages . . . have been rebuilt with a new look, and the material and cultural life of the people has markedly improved."[24]

Soviet technical influence included scientific management that reflected Taylorist language and concepts. The North Koreans published hundreds of Russian-language books in translation to encourage scientific methods to establish norms of production. Yet in 1956, when North Korea announced that its three-year plan had been achieved, they embarked on a five-year plan (1957–61) that would reach production norms not through new management techniques but through various campaigns. These campaigns or competitions made up for lack of skilled engineers and workers, lack of materiel, and decreasing foreign aid. As a result, self-reliance became a key, along with scientific management techniques and ways to rationalize industrial organization.[25]

Ultimately, in the early 1960s, a managerial reform succeeded. Kim Il Sung, as was his wont, visited the Taean Electrical Machinery Factory on December 6, 1961, to give "on-the-spot guidance." He referred to Korea's great industrial achievements, but the need to link planning, production leadership, and technical leadership "organically." The resulting Taean Management System served as the basis of economic management of the economy into the twenty-first century. Great Leader had chosen to link management and technical expertise to increase production. This signified that the economy had recovered sufficiently from the Korean War to try a new approach. The new approach went beyond urging people to work harder or emphasizing self-reliance. In the Taean Management System the chief engineer would be subordinated to the factory manager in an effort to bridge the gulf between administrative and technical issues and put management on a scientific footing.[26]

With the five-year plan for creation of heavy industry including machine tools successfully achieved, the party established more ambitious targets for the seven-year plan (1961–67): an "all-around technical reconstruction and cultural revolution." No longer was transformation of the productive relations sufficient; "socialist industrialization" was required. All branches of the economy were to be equipped with modern technique.[27] Reminiscent of Stalin's Great Break that included rapid industrialization, Kim Il Sung called for increasing outputs or production in electrical energy, coal, iron, steel, and electrical motors two and a half to three and a half times; generators nearly thirtyfold; turbines over 100 times; tractors to 17,000 units annually by 1967 or fivefold; and synthetic resins over 60 times (based, as seen below, on a scientifically feasible but industrially unproven yet party-endorsed process).[28] Ten new major mines would open; this required the development of tunneling and drilling equipment, in which the North Koreans eventually excelled—they built hundreds of kilometers of tunnels deep underground and through mountains for irrigation, hydroelectric, transport, and military projects. But expanded mining operations required the manufacture of iron and concrete props, owing to a shortage of prop timber, and did little to put food on the worker's or peasant's table.[29] Of course, establishment of a new prefabricated concrete parts industry with annual output of nearly 2 million cubic meters would follow.[30]

Industrial development was the sine qua non of the North Korean (and of virtually all Stalinist) centralized command economies. State-owned industry was responsible for 90 percent of production. Prices, wages, trade, budget, and banking all fell under state control. Like its Soviet counterpart, Gosplan, the Korean State Planning Committee established all aspects of planning, from inputs to prices and outputs; planners' preferences prevailed. Nearly all goods were distributed through state-operated or cooperative stores. Under communist leadership the nation transformed rapidly from an agrarian economy (fishing, forest products, and farming) to an industrial one. The North Korean economy grew faster than the South Korean one into the early 1960s by focusing on development of an independent economy, yet taking advantage of extensive aid from the USSR and East European nations. When Moscow cut aid to the country to punish it for a turn toward China, the leaders sharply curtailed their involvement in COMECON and embarked on an extensive foreign borrowing program to push modernization, even though they lacked sellable goods to pay off the loans, and the nation eventually defaulted on billions of dollars of loans. Even with a precipitous fall in the pace of growth, annual growth of output remained above 10 percent through the mid-1970s. Industry's share of national output also was very high, at the expense of agriculture; today's endemic famines are no accident. The second seven-year plan (1978–84) saw increases in output in electrical energy of 78 percent, in coal of 50 percent, in steel of 85 percent, and in cement of 78 percent. Mining and metallurgy have grown on the backs of workers.[31]

The fulfillment of plans ahead of schedule is difficult to verify because of the paucity of reliable statistics, but the North Korean economic achievements are remarkable given the state of the economy in 1935, 1945, or 1955. The extension of the first seven-year plan (1961–67) into a de facto ten-year plan completed in 1970 indicated the challenges Korea faced in rebuilding from war and transforming into a socialist economy, although in November 1970 Kim claimed that the nation was no longer "industrial-agricultural" but "socialist industrial." Still, targets for electricity, steel, chemical fertilizers, cement, and textiles had not been reached.[32] Annual new year's messages set tones for policies and goals, especially for seven-year plans. Following the example of the USSR, which sought to encourage innovation in industry through exhortation, in 1983 Kim Il Sung called for "speeding up" the introduction of advances into production.[33]

Socialist Specialists Produce Socialist Technology

The socialist polity thrives on a variety of class-based tensions. Leaders maintain that they inevitably move toward classless society. However, the experience in Stalinist USSR in the 1930s, the fraternal socialist states of East Central Europe in the late 1940s and 1950s, and the People's Republic of China during the Cultural Revolution of the 1960s indicates constant mistrust of potential enemies of the working class both within and outside the country. Intellectuals, even those trained entirely within the socialist system of education, fell under scrutiny. Communist parties feared their potential independence and dissidence, their special expertise that gave them greater access to the policy process than other groups, and their belonging to such strongly international endeavors as science, technology, art, literature, and music. Dissidents and other critics of the polity and economy in the USSR, Eastern Europe, and China were likely to come from the intelligentsia; Andrei Sakharov and Fang Li Zhe represented precisely this danger to communist leaders. The show trials of experts in the USSR and East Central Europe and the expulsion of intellectuals to the countryside to learn from the peasants in China indicate the extent of fear of individuals who were essential to the future of their countries.[34] While workers on the shop floor and peasants in the field might suggest new ways to organize labor and other innovations, the labors of scientists and engineers in research institutes and universities surely were crucial to technological advance. In North Korea, too, party leaders worried about the potential autonomy of intellectuals.

North Korean leaders have embraced science and technology strictly for their utilitarian functions and used them to promote autarky and self-reliance through rational management of natural and technological resources. Japanese colonization delayed creation of modern universities and research institutes. Yet no sooner had the communists taken power than in September 1946 the Kim Il Sung State University opened. In education and the sciences, North Korean communists followed the Soviet model. Over the next few years the government established a series of commissions that considered how to develop science and technology in the country. In 1952, even during the Korean War, the government founded an Academy of Sciences. Like its Soviet counterpart, the Academy stressed the political reliability of its members. Its social science and humanities institutes, which focused on party history, Marxist philosophy, and other ideological concerns, fared better than institutes of science and engineering, which required extensive expenditures for equipment, chemicals, and so on. A State Committee for Science and Technology, also resembling a Soviet bureaucracy of the same name, followed in July 1962 to boost innovation in heavy industry. While a number of lucky young scientists studied at Moscow and Leningrad State Universities, and others at Chinese facilities, autarkic relations prevented thousands of deserving specialists from developing skills abroad. Party officials touted the establishment of universal education and the expansion of a study-while-work system with evening schools, correspondence courses, and factory and communist colleges.

In the 1950s and 1960s Korean leaders claimed that they had expanded their pool of "technicians and experts" from very few to hundreds of thousands, although the question of quality remained given the rapid transformation of individuals with rudimentary schooling into technical experts.[35] In part they accomplished this by establishing compulsory six-year education in 1956 and extending it to tenth grade in 1958. As Kim Il Sung explained, "Far more cadres in science and technology should be trained and the general cultural level of all working people should be raised rapidly. That is why the state even envisages the introduction of compulsory junior middle school education . . . while further developing middle and higher-level technical education . . . Our educational work should be closely linked with production, and the keynote should be to arm the working people with advanced technology and scientific knowledge and train them to be competent socialist builders."[36]

Simultaneously, the government created a new system of technical education; during the five-year plan, more than 135,000 engineers, specialists, and technicians were trained. The government also introduced the "factory college" so that workers could study while continuing to be engaged in production. Communist colleges were established in the capital of each province, which, according to the Central Committee, trained "a new type of intelligentsia from the workers [who] could closely link production and education, theory and practice."[37] By the mid-1960s party officials claimed that the nation had 290,000 technicians and experts; this suggests overcounting or perhaps inclusion among "technicians" individuals who were test-tube washers, high school teachers, and others, and of course quantity does not imply quality.

During the founding years of the nation, Great Leader rhetorically adopted a Leninist attitude to specialists. Old-line intellectuals were to be "educated and revolutionized . . . to serve the people and display their talents and skills." They would be "steeled in struggle and remolded into Red intellectuals."[38] In a mirror image of the experience in the USSR and the East European socialist countries, many Korean revolutionaries apparently had a hostile attitude toward bourgeois experts, while many citizens apparently stood in awe of science and therefore did not trust themselves to take the lead in suggesting innovations. In a speech at a provincial party committee meeting in March of 1958, Kim Il Sung urged a careful approach to this situation. He urged an end to "narrow-minded attitudes" toward intellectuals. "The working class should look to the intellectuals for their knowledge and techniques, and the latter should look to the former for their revolutionary spirit, strong organization and immense fidelity to the Party, thus uniting and cooperating with each other in the struggle for communism."[39] He called for a symbiotic working relationship between the intellectuals and the workers. This was needed because of disparate shortfalls in qualified persons and modern materials. At a January 1958 meeting of activists of the Ministry of Light Industry, he noted, "We were short of well-trained technical personnel and had no equipment, too."[40] This meant that Kim Il Sung was aware of not only bottlenecks in the economy and lags in technology because of the ongoing effort to develop heavy industry, light industry, and agriculture simultaneously, but also shortfalls in the training of skilled and reliable experts.

Yet the experts alone could not provide the innovative impulse needed to advance the economy. Simple workers and peasants would be encouraged to contribute through a variety of campaigns. Kim Il Sung reminded his audiences that the country had "worked wonders by mobilizing the forces of all the people in our extensive building of local industries, the let-one-machine tool-make-machine tools movement, etc." An ongoing technological revolution would succeed based on the drive of the Korean Workers' Party and a movement of the entire people. He urged everyone to participate "in this honorable and worthy revolutionary task." He demanded doing away "with all of the mysteries shrouding technology" that arose from having long lived in a backward state. Kim pointed out that under socialism "mystery-mongering has been dealt heavy blows."[41] Unfortunately, the attitude that the people could contribute significantly to modern science and technology created a fertile ground for pseudoscience to develop. If Stalin could endorse the Lamarckian theories of a simple peasant, Trofim Lysenko, with great damage to the development of genetics in the USSR, then similar dangers existed in North Korea.

Kim Il Sung urged constant reeducation of the intellectuals, retraining them, keeping them actively involved, putting them into factories, all the while training new cadres.[42] A bad tendency was "that of ignoring or underestimating science." Kim Il Sung warned that "like the mystery-mongering, this, too, holds back our technological development. Machinery itself is a product of the development of science; the technical revolution is inconceivable without science."[43] The solution was "strengthening the creative cooperation between the workers who operate the machines and the technicians who have scientific knowledge." The workers could offer the "new and valuable" experiences of everyday work. They always "racked their brains" to produce more with less effort. However, given that they knew only the machines they themselves operated, and knew them experientially and not theoretically, how might their knowledge be incorporated broadly into production? Kim Il Sung concluded, "The technological revolution will go forward successfully only when the workers and technicians help each other and learn from each other, when experience and science go hand in hand. It is wrong for the workers to refuse the help of science on the pretext of opposing mysticism; it is just as wrong for technicians to get swelled heads, as if they alone were learned, and refuse to accept what is new from the experience of the workers."[44]

Officials frequently announced that the majority of old intellectuals had come over to the people. Yet in practice North Korean officials adopted a hard line toward scientists and engineers, requiring their allegiance to projects that had immediate economic impact, secured national defense, and demonstrated the glory of Great Leader. Trained within a closed system that encouraged allegiance to *Juche* ideology, how could it be otherwise? Warning signs of this attitude toward specialists were present from the first one-, two-, and three-year plans, in which it was clear that so-called ivory-tower reasoning—an inadequate effort to focus research on the needs of the masses—would not be tolerated. The president of the Academy of Sciences pointed out that "scientists should not waste their energy and time doing research on useless, fantastic subjects. Rather they should concentrate on the problems which are vital to our national economy today and require an immediate solution . . . Our country does not have many scientists. It is important to solve the burning questions of the present, instead of going in for 'far-reaching projects.' "[45]

The North Korean Academy of Sciences has gone through numerous reorganizations of its various agencies, bureaus, and offices, reorganizations that reflect dissatisfaction with the performance of R and D. In the country's three-, five-, and seven-year plans, R and D in heavy industry, metallurgy, electronics, heat engineering, material science, and much later biology had a central place. Yet even the motivational "February 17 Fast Combat Unit of Scientists and Engineers," intended to promote engineering consultation and innovation in factories, performed dismally owing to inadequate funding. The theoretical sciences, including mathematics and physics, may have outperformed the others in this environment since they needed less equipment.[46] Leaders of the Korean Workers' Party believed that *Juche* ideology would overcome all of these problems, but they underestimated the importance of international contacts to ensure the vitality of the scientific enterprise.

Juche and Technology

North Korean technological style developed its distinctive simplicity and awkward reliability because of the headlong pursuit of autarky and self-sufficiency. Great Leader offered the following watchwords: "*Juche* in ideology, independence in politics, self-reliance in the economy and self-defense in our national defense—these have been the invariable lines of our Party."[47] Party officials insisted that *Juche* did not hamper innovation, but fostered independent thinking. They understandably defended the need to develop their own processes and techniques. They could learn from the varied experiences of communists and workers around the world. But that experience came from the different conditions and specific features of each country. The more countries embarked on revolution and socialist construction, the more diverse and valuable experiences would be created. They believed that the decision whether to introduce the experience of a fraternal party had to be judged according to its own actual conditions and needs. No one could be allowed to interfere. Experience, they said, must be tested in practice, not mechanically copied—even as they mechanically copied western technology.[48]

During his concluding speech at a plenary meeting of the Central Committee of the Workers' Party of Korea in August 1960, Kim claimed that a technical revolution had fully emancipated the people from past oppression and exploitation.[49] Against all odds—and in spite of the attitudes of skeptics abroad and renegades within the party—they had committed to learning and mastering many things in the technical sphere and had shown themselves fully capable. When the leaders first suggested manufacturing tractors, some people had "misgivings" and showed a "lack of confidence." Yet, Kim Il Sung observed, "People who had never ridden in a car before are now capable of producing so many automobiles. The manufacture of excavators also seemed beyond us at first, but, on producing them, we found that they were, after all, nothing but big mechanical shovels."[50]

The North Koreans hubristically claimed successes in pursuing their own path of industrialization. *Juche* ideology—which meant that a developing country must rely on its own resources—grew out of these successes and out of the cult of Kim Il Sung. As a tool of foreign policy, *Juche* was aimed to attract the interest of other developing countries, although it claimed always to be Marxist-Leninist.[51] This was a sharp break with the experience of the USSR, whose leaders recognized the need to extract leading technology from the advanced capitalist nations for application in socialist productive relations. The North Koreans called for revolution in productive relations with the assumption that this would lead to the creation of technologies of socialism. Yet since *Juche* required discipline, devotion, unquestioned hard work, and indeed militarization of labor, it also undoubtedly limited significantly personal and intellectual freedom. It handicapped innovative impulses while creating an attitude of self-contentment and superiority. The North Korean Workers' Party would celebrate the launching of a 20,000-ton ship when South Korean shipbuilders were simultaneously launching 200,000-ton ships and shifting industry from Europe to Asia. According to a Swedish diplomat, this "do-it-yourself ideology" knew no bounds and was constantly indoctrinated into citizens so that they realized that every town was newly built, that the country was self-sufficient in food, that education and health care existed for all, that the countryside was electrified, and that captains of ships at sea might themselves operate on sick members of their crews, inspired by the thoughts of Kim Il Sung.[52]

Did *Juche* promote independence, initiative, and creativity? *Juche* forced fierce independence to be sure, but also foolish insistence that indigenous ideas were always better. One Swedish engineer explained to Korean colleagues as an example that a 12 horsepower engine could power three drills at 4 horsepower each, but no more. They insisted on four units, and he eventually realized that he must let them try—and fail—on their own. The Koreans pursued reverse engineering, which led them apparently to the systematic theft of all sorts of things, even door hardware, from foreign embassies in the attempt to manufacture those items in local industry.[53] In the spirit of self-reliance they imported only what they thought was necessary to copy, but when it came to more complicated production processes they were not successful in timely start-up or operation. They did not comprehend that a technology is not a disembodied thing-in-itself, but usually a series of technologies, techniques, and attitudes about efficiency and labor tied into one. Yet they stubbornly persisted in pursuing their own tack in the face of failure even when repeated experience indicated otherwise.[54]

Sungwoo Kim writes that *Juche* "mandates autarky through maximum reliance upon indigenous resources and technologies."[55] Like monthly and annual "storming" to meet targets in the USSR, *Juche* was coupled with a constant emphasis on speed and exhortation of the workers and farmers to improvise as best they could with crude local technology and materials in lieu of scientific methods. This often had great consequences down the road—missed production targets, cost overruns, environmentally suspect impacts—and there was no one to blame because Great Leader and Dear Leader were infallible.

Juche in part grew out of ideological conflicts between the USSR and the People's Republic of China and conflicts between China and North Korea over cultural revolution. North Korea sought in foreign policy not to take sides in the developing Sino-Soviet dispute of the late 1950s. Kim Il Sung began to proselytize *Juche* in this environment, taking its other meanings beyond self-sufficiency to sovereignty and autonomy. *Juche* also reflected rising tensions between the working people and intellectuals. Kim Il Sung encouraged the intellectuals to join with the working masses in the innovation process. Having gained authority to make suggestions—and tacit permission to criticize the organization of the economy—the intellectuals thus became a point of concern. Kim Il Sung was not an intellectual, having finished only middle school. In this atmosphere, while encouraging self-sufficiency, Kim Il Sung also began to attack leading intellectuals. Not only western literature but even some classics of Marxism-Leninism were viewed as incommensurate with *Juche*, with Kim Il Sung's teachings on *Juche* replacing instruction on dialectical materialism. Gulag-like labor camps and prisons in North Korea have become home to suspected dissidents.

The foundation of Kim Il Sung's socialism, *Juche*, has remained a central feature of Korean daily life, labor, industry, science, and technology. *Juche* socialism required the assembling of mass armies of laborers to work with rudimentary tools owing to the underproduction of even such simple technologies as tractors, excavators, and bulldozers. *Juche* socialism required military and economic independence, isolation, and the development of racially pure, indigenous technology. *Juche* is truly "socialism in one country." The 1992 revision of the constitution deleted references to Marxist-Leninist ideologies, while *Juche* became the "guiding principle" of the Korean Workers' Party. Kim Jong Il criticized leaders of reform in other countries who had turned from socialism and embraced materialism as "renegades."[56]

Stalinist Agriculture in North Korea

Since investment for industrial self-sufficiency would be drawn from the countryside, and because of the belief that large-scale agriculture is more efficient than small house holdings, the party pursued collectivization. In this regard again Kim Il Sung was a Stalinist par excellence. Like Stalin, he pursued economic autarky, rapid industrialization, and war against the countryside to create a socialist fortress. Projects that seemed to serve the people or the consumer sector often were propaganda ploys, or even shams, perhaps a Pyongyang, if not Potemkin, village. For example, Kim Il Sung's land reform of 1946 to break up large farms and distribute holdings to landless peasants and small tenants was only a short-term effort to attract southern sympathizers, stockpile grain, and repair the post–World War II economy in preparation for a future war of liberation. In the short term, agricultural production recovered from the war, and heavy industry developed. But this was a prelude to the "war of fatherland liberation," the Korean War.[57]

Kim Il Sung pursued "cooperativization" (as translated by North Korean sources) with purpose and certainty. He proudly proclaimed that the nation's achievements in agriculture had proven foreign doubters wrong: even without modern farm machinery, cooperativization proceeded quickly. Kim Il Sung explained that the nation could not wait for the day when industry could mass-produce modern farm equipment. Rather, cooperativization was possible, and urgently needed, on the basis of transformation of outmoded production relations when sufficient revolutionary force has been gathered "even though modern farm machines may be nearly non-existent."[58] Whether the official state agricultural production targets were outlandish or reports of overfulfillment were accurate is not the crucial point. Rather, we should recognize the impatience of communist leaders over transformation of "feudal" agriculture into modern socialist agriculture that would produce surpluses for urban inhabitants and export markets, as well as investment for industry.

While ultimately exploiting the countryside through extraction of resources, lack of investment, and starvation of the peasantry, at least in word the Korean Workers' Party addressed the need to establish a healthy connection between the cities and countryside, or *smychka* as Trotsky and others called it. Kim Il Sung criticized the disjunction under capitalism between cities and the countryside, where lifestyle in the latter became desolate and living standards fell. But the communists, he declared, would eliminate this gap, create proportionality between the lives of peasants and workers, and not permit disparity to exist between rural and urban construction.[59]

Kim Il Sung painted a rosy picture of agricultural development. He frequently spoke about the diversification of crops, vast increases in grain harvests, and the development of food processing industry that would facilitate "apartment-style" living. Perhaps he assumed that the Korean Workers' Party had allocated sufficient resources to the program for collectivization of agriculture so that there was absolutely no danger of the mass starvation that struck Ukraine in the 1930s under Stalin. Kim never referred to the errors of Stalinist agricultural policy in any of his speeches. But he may have had that experience in mind when, in the 1960s, he discussed how his policies would "cooperativize" agriculture while increasing production substantially. Cooperativization would be based on industrialization of crop production, including expansion of grain and paddy rice through extensive application of chemical fertilizers, pesticides, and herbicides. Sown areas of grains would grow from 2.28 million to 2.52 million jungbo (a little less than a hectare), and even maize to 1 million jungbo in a few years. Breeding stock would double in number.[60]

The fascination with increases in corn production seems to mirror that of Nikita Khrushchev—corn grew higher than an elephant's eye after he visited Iowa in 1959; he had already called for an Iowa-like corn belt to be planted in Russia in a February 1955 speech.[61] Apparently, the policy to plant corn did not consider soils, climate, or terrain adequately. In pursuit of corn at any cost, the system of exhortation, reward, and punishment led party officials to pursue extremely high density planting and heavy applications of chemicals. The area of arable land planted in corn increased from 10 percent in 1953 to 35 or 40 percent in the 1990s, but maize production remained low, and widespread soil acidification resulted from overuse of chemicals.

Rather than *smychka*, in North Korea deep contradictions arose between the city and the countryside, between the promise of mechanization and the reliance on labor, between rhetoric and reality. Kim Il Sung called for a technological revolution in the countryside based on a fourfold program of mechanization, electrification, chemicalization, and large-scale irrigation.[62] He touted this as "an all people movement to remake nature on a large scale, to facilitate the use of tractors and other machines and the application of modern chemicals." Kim Il Sung indicated that by 1961 over 90 percent of the countryside had been electrified and over 800,000 jungbo of land were irrigated, 7 times the level before the revolution.[63] Might the nation produce sufficient numbers of tractors in the proper assortment, smaller ones for mountainous regions and larger ones in lowland fields, and through irrigation and electrification achieve unheard-of successes in agricultural output?

Kim Il Sung followed up his call for technical revolution with his "Theses on the Socialist Agrarian Question in Our Country" in 1964 on the need for technical and vocational progress in the countryside to strengthen collectivist forms of ownership and management. To succeed, this required the establishment of agricultural research and extension services to get that knowledge to the farmers. In his "Theses," Kim Il Sung repeated the demand that more tractors be produced, but owing to military buildup, the resources for this task were not available. In addition, the personnel at the agricultural research and extension services were forced by *Juche* methods to ignore accepted international practice in modern agronomy that required soil science, hybridization, and other studies. Instead, Kim Il Sung stressed autarkic self-reliance in agriculture, reliance on the "creativity of the masses . . . based on concepts of ideology, technology and culture," not on capital inputs. "Do yourself, do without, work around shortages and be inventive," the Great Leader instructed.[64] Yet people were arrested, interned, and beaten for planting corn in ways other than the Great Leader insisted.[65]

Juche socialism resulted in agriculture being not only self-sufficient but also labor-intensive, insufficiently mechanized, and tied to harsh methods that destroyed land in search of harvest at any cost. In 1968 in the entire nation there were but 20,000 tractors (vs. over 1 million in the United States—in 1929).[66] Perhaps because of the repeated failures of agriculture to perform at hoped-for levels, in the 1970s Kim Il Sung took personal interest in his "Theses." He ordered in 1972 that production of tractors increase to 30,000 units for the year, and that rice planters, harvesters, thrashers, and other machines be manufactured; the entire stock of tractors on farms in 1972 was only 30,000. The number of tractors in fact doubled in two years. In addition, there were significant investments in chemical fertilizers with the Namhung Youth Chemical Complex, an entirely imported facility. These two programs raised agricultural production somewhat, with grain leading the way. Yet the demands of the military always took precedence, and only direct intervention of Kim Il Sung could secure capital or labor inputs for agriculture when they were needed. Tractor production continued to lag, so that at the turn of the twenty-first century the nation had only 75,000 tractors. To make matters worse, the size of cooperative farms tended to be too small for tractors that at 25 horsepower or more dominated production, while shortages of fuel and spare parts limited their use.

In the 1970s and 1980s North Korean agricultural policies were directed toward solving endemic food shortages through another campaign of the "four improvements." Extensive reclamation projects—irrigation, terracing, draining—increased the area of arable land. Improvement of infrastructure and rural living conditions and expansion of grain production were intended to establish self-sufficiency. Double-cropping and better varieties would raise production. Yet overuse of land and excessive application of fertilizers exacerbated the damage from natural disasters. Floods in 1995 caused widespread landslides in the terraced fields constructed in nationwide programs. Three hundred thousand hectares of land were inundated. After floods receded, 100,000 hectares remained covered in sand and gravel. As a solution, the government determined to abandon cooperative management, with cooperatives already under state control, for highly centralized state control.

Ultimately, it was impossible for peasants to be inventive and productive in the face of persistent shortages. The agricultural, forestry, and fisheries sectors of the economy declined in their share of investment and output. Roads, machinery, and other forms of infrastructure were inadequate to the tasks of farming. The share of the labor force engaged in agriculture also dropped from 57.6 percent in the 1960s to 34.4 percent in 1989, still a large number considering how poorly agriculture performed. One would expect a decline in the size of the peasant population, given a socialist regime's allegiance to industrial development and the proletariat.

Kim Il Sung traveled hundreds of thousands of kilometers through the countryside to exhort the peasants to produce crops and see with his own eyes the success of his brilliant program. How did he miss seeing 600,000 North Koreans (according to some estimates 2 million) who starved owing to the inhuman and failed policies of hyper-industrialization and cooperativization? Government policies permitted ownership of small family plots of 160 square meters, as well as a few pigs, chickens, fruit trees, and beehives. It allowed peasants to sell surplus at markets. Peasants had no surpluses, but starved. Vegetable farms, fruit production and storage, rice cultivation, fish farms, and soil and plant experimental stations all lagged.[67] By 1979 the country's leaders had recognized that stunted growth among children was a result of pervasive malnutrition. Kim Il Sung's response was a campaign to plant runner beans around the fences of houses to avoid using up farmland. The beans would provide protein. The campaign made clear that "the people were on their own for survival, dwarfed growth and all."[68]

The collapse of the Soviet Union, a series of disastrous floods, reduction of investment to the agricultural sector, shortfalls of machinery, equipment, and seeds, incompetence, and cruelty all contributed to the famine. One North Korean resident recalled, "We used to live off from what we got through the Public Distribution System (PDS) without the Non-Public Distribution Management patches of land for growing crops for individual use. When the Public Distribution System suddenly stopped [in 1995], we even made porridge by cooking with the goosefoot plants for pigs and the fistful of powdered corn cob. People ate more grass than rice. More people died every year. That's when the Republic began to see an increase in the number of thieves. When you planted potatoes or corn in your backyard and woke up the next day, you would find nothing there."[69] As in Stalinist systems generally, the periphery and the countryside served the center at great expense, including human expense.

Nature Transformation, Autarky, and Applied Science in North Korea

Perhaps captured by the aura of the massive projects completed under Soviet power and the claims of reclamation engineers in the USSR—the Kuibyshev Hydroelectric Power Station on the Volga River, the Volga-Don Canal, the planting of thousands of kilometers of forest defense belts—Kim Il Sung saw water melioration projects as essential to the construction of a socialist economy in the Democratic People's Republic of Korea. If, in 1948, at Stalin's request, the Communist Party of the Soviet Union had unanimously passed an audacious project for the very "Transformation of Nature" itself, would Kim Il Sung be any less bold? Kim Il Sung called for "irrigation projects on a large scale and . . . river improvement and dyke projects for the protection of land." He promised that the state would invest heavily in these projects, while "funds from the cooperatives and peasants themselves should be widely used for smaller projects."[70] Irrigation demanded pumps, transformers, generators, and motors that the country formerly imported "so we could not make decisions on our own and had to consult with those who were going to supply us." With the creation of a machine-building industry, "now we have our say, and we have the right to decide" which pumps to use and how to use them.[71]

Initially the projects lacked Stalinist scale. In August 1962 Kim Il Sung toured rural areas for about a week, during which time he called for continued efforts to build up local industry, not focusing exclusively on large factories. This would avoid problems of transport and more rapidly meet local demand, at the same time ensuring incentives to peasants to produce. He suggested a kind of Korean "machine in the garden," with factories built at sites according to specific features of geography. "What a splendid job it is to build factories and develop industry in all parts of our country with its beautiful mountains and rivers!" he declared.[72] Of course, decentralization of production also served defense purposes by requiring foreign aggressors to seek out dispersed strategic sites.[73]

Ultimately, like the Stalinist USSR and National Socialist Germany, North Korea set out to transform nature in service of the state. North Korea embarked on aggressive, in many cases far-fetched, and ultimately unsuccessful projects to change nature itself given the failure to get industry or agriculture to perform well. The understandable rationale for large-scale irrigation projects was to preclude agricultural failure from drought and, through river improvements and reservoirs, to store water and prevent floods.[74] One of the nature transformation projects involved terraced fields to cultivate much of the country's slopes of hills and lower mountainsides. The effort to increase the amount of arable land by 10 percent resulted instead in extensive deforestation and heavy erosion, and production increased very little because of the inability of the soils to hold moisture and fertilizer. Fruit and vegetable plots located in narrow, high mountain valleys were rife for washout during heavy rain. Just as with Stalin's Belomor (Baltic–White Sea) Canal, huge armies of poorly equipped laborers, many of them no doubt slave laborers, were mobilized to transform nature. In one case, according to the party newspapers, 100,000 hectares were brought under irrigation in only twenty days in 1977. The laborers "dug 42,000 wells and pools and drove pipes into the ground" to irrigate an additional 100,000 hectares in another twenty days. "The organizational capability of our people is tremendous," Kim Il Sung declared.[75]

In addition to irrigation and reclamation, engineers turned to hydroelectricity. This would secure self-sufficiency in energy production. But because of an inadequate scientific foundation to the projects that formed the core of the electrification program, frequent changes in direction of the projects, and a fascination with gigantomania without the requisite resources, energy capacity and production have never met the government's plans. Scientists have had to show allegiance to bold, far-fetched projects and to withhold their independent expertise on project feasibility and the expected human and environmental costs. This meant that officials pushed ahead without considering those costs. They set forth plans to build hydroelectric power stations at seemingly every neck of every valley. This followed a pattern in the USSR where hydrologists studied the vast network of rivers from the European West to the Far East with the goal of building dozens of hydroelectric stations.[76] At least the USSR had extensive coal and oil reserves to develop simultaneously.

As noted, the Japanese occupiers built the Soopoong Hydroelectric Station in 1943, the largest in Asia at the time (700 MW), and several other projects. Virtually all stations were destroyed during World War II and then largely rebuilt with Soviet aid. Several rivers could serve as sites for more stations, especially the Yalu River. But the Yalu, as the border with China, would require joint management and participation with China. Indeed, the Ubong Hydroelectric Power Station (400 MW) on the Yalu River, begun under Japanese occupation, was completed only in 1970, owing to tensions of the Sino-Soviet split that spilled over into Sino-Korean relations.[77]

Kim Il Sung endorsed major hydroelectricity projects on the Orangchon, Nam, Ryesong, and Yonghung Rivers that included aqueduct tunnels to take advantage of deep slope and enormous head possible in mountains. By 1962 specialists had apparently completed surveys of North Korea's hydroelectric resources, nine-tenths of those available on the entire Korean Peninsula. The surveys indicated 200 suitable spots for dams on sixty-four rivers with capacity potential of 8 million kW capacity, with the Yalu River offering the Supung (700 MW), Hochungang (338 MW), Changjin (326 MW), and Punjongang (201 MW). The rated megawatts for these projects indicate that North Korea had yet to standardize production of turbogenerators in 100 MW, 200 MW, or larger that might be used at any site. And, if the three- and five-year plans were intended to expand hydroelectricity production and facilitate transmission with lines and transformer networks of 1,300 kilometers,[78] this indicated quite a modest network considering the huge quantities of electricity to be generated. Production would far outstrip distribution capacity and demand. Visionary plans were rarely rational plans.

Tunnels were to be built deep underground through almost inaccessible mountains to divert river and stream flow to the steep slopes. Yet even using military transports and helicopters, it was hard to get cement trucks and other equipment to the sites in the mountains. Elite Army engineers planned the Kumgangsan Power Station to divert three rivers originating in Mt. Kumgang from draining into the West Sea toward a new delta in the East Sea. The project included a 300-meter waterfall collected in four reservoirs and descended through seven interconnected tunnels that required boring through granite. The engineers failed to measure up to the those of the U.S. Army Corps of Engineers, whose multibillion dollar projects would frequently suffer from cost overruns but would meet targets. Planned at 810 MW, Kumgang operates at only 100 MW. It diverted resources from other projects that also fell far short of their targets, and it appears that extensive repairs have already had to be completed, including crude concrete rewrapping. In spite of being a campaign priority, modern technology lags even in this area of the economy. To illuminate what they have achieved, the North Koreans have had to turn to floating wheel turbines and dirt and wood hydroelectric dams that harkened to a previous era.[79]

Mirroring Stalin's 1948 plan to transform nature, North Korean leaders advanced the West Sea Barrage, which would have created the longest dam in the world at 8 kilometers long, cutting across rough sea at the Taedong River estuary. The project was important for its potential to serve the leaders, the party elite, and the urban residents of Pyongyang at the expense of the peasants. The project created a huge reservoir of nearly 400 cubic kilometers capacity and required the excavation of 15 million cubic meters of earth, the transport of 16 million cubic meters of gravel, and the pouring of 2 million cubic meters of concrete. Three divisions of the army soldiers were conscripted to the project, which cost, according to some estimates, 9 percent of GNP. Planners touted its contribution to irrigation, but they overestimated this contribution. The goal was to create new tidelands and irrigate them. When proposed in 1961, Kim declared that 50,000 hectares of tidal flats would be reclaimed. In a few years, planners revised the forecast downward to 30,000 hectares. Another project, approved at 100,000 hectares, resulted in irrigation of only 34,000 hectares.

Bulldozers, excavators, tractors, trucks, rail cars, barges, cement, fuel, logs, and iron were requisitioned, yet all were in short supply owing to endemic bottlenecks in the economy that plagued this project no less than mines, steel mills, and hydroelectric projects. In essence, the country relied only on labor inputs; capital was tight.

Constant failure was no obstacle to other, more ambitious plans. The fourth plenary session of the Central Committee in 1981 approved "nature-remaking programs" to solve persistent food problems. The engineers designed dikes to close the mouths of bays, built embankments, and reclaimed five tidal flats in the 1980s and 1990s. With over 70 percent of precipitation in July and August, and hence the desirability of huge water storage capacity, North Korea had to turn to irrigation, reclamation, and storage through canals, pumping stations, and reservoirs. When irrigation systems were built into the mountainous regions, the process accelerated erosion and triggered mudslides into reservoirs. According to some estimates, the Korean laborers constructed 80,000 artificial lakes, 1,700 reservoirs, 25,210 pumping stations, 124,000 groundwater facilities, and 40,000 kilometers of flumes. The reservoirs were poorly if rapidly built, using earth and stone piled haphazardly, leaving them vulnerable to saturation and flood. A number disappeared in flood waters in the 1990s. When Kim Il Sung died in 1994, government reclamation projects were at least 280,000 hectares behind goals of reclamation of 300,000 hectares of tidelands and 200,000 hectares of unused lands.[80]

Finding trouble in bending nature through "splendid projects" centered on irrigation powered by hydroelectricity, Kim Il Sung and his planners therefore turned to thermal power generation, a reasonable idea owing to the country's anthracite reserves. Yet the effort to supply thermal stations triggered a persistent coal shortage because of technologically backward mining techniques that could hardly meet targets in any hour, let alone any month. Miners used outdated blasting to break up coal seams, not machines that could do 50 times the work that were widely available in other countries. Not only machines were lacking. Said Kim Il Sung in 1982, "If the workers of the Anju Area Coal Mining Complex are merely supplied with safety lamps and hand tools, they will most likely be able to double the present output of coal." That is, miners had rudimentary tools and inadequate safety equipment. The Anju fields were also plagued by flooding and inadequate efforts to build drainage tunnels since the goal was immediate extraction.[81]

Dear Leader, Kim Jong Il, has followed in his father's impressive footsteps, by redoubling efforts to build hydroelectric power stations. Even in the face of famine, he discovered investment capital to return to several of the rivers his father had visited, with the hope of adding additional power stations. In February 2005, according to the Korean Central News Agency, General Secretary Kim Jong Il "gave field guidance to the newly built Orangchon Power Station No. 1 and the Jangyonho Fish Farm." The report noted that Kim Jong Il "acquainted himself in detail with the construction of the power station." He expressed "great satisfaction" over the plant's rational design and high quality and "over the fact that the people of the province have built a modern power station." Visiting the construction site, he "called upon the members of the youth shock brigade and other builders to speed up the construction of the dam with the same vim and vigor with which they built the power station No. 1 in a brief span of time and thus complete the remaining project ahead of schedule." Kim Jong Il then gave "guidance" at the nearby Jangyonho Fish Farm. The report concluded, "He learned in detail how fishes are bred on the farm, going round fish ponds, spawning rooms and various other places of the farm. He set forth highly important tasks which would serve as guidelines for conducting fish breeding as a widespread mass movement."[82] Not quite the same guidance as his father gave for bean paste or ducks, but piscine guidance nonetheless, and a mass movement at that.

North Korean Stakhanovism: The Chollima Movement

In the face of daunting technological obstacles, unwillingness to trust experts completely, and centralized planning mechanisms that created bottlenecks and shortages, only exhortation of workers provided any hope of increasing the pace of nature transformation, agricultural production, industrial growth, and expansion of mines. Korean Stakhanovism—the imported Soviet technique of identifying leading workers to establish new norms for production with old tools—proved successful at raising output and ensuring allegiance to the cause in a symbolic rather than an absolute fashion. Stakhanov was the Don Basin miner who established superhuman norms for the mining of coal seams and was held up as an example in many other sectors of the economy. In the absence of material incentives or higher salaries, exhortation to fulfill individual norms and establish new standards became the rule, spreading from mining and metallurgy eventually into all sectors of the Soviet economy: fisheries, forestry, road grading, and teaching.

North Korean Stakhanovism was called the Chollima Movement, named after a Legendary Flying Horse. The Chollima Movement was launched at the Chollima Kangson Steel Works in December 1956 to stimulate worker enthusiasm and initiative and to spur workers to carry out socialist industrialization to repel such imperialist nations as the United States. In orchestrated visits that were hardly as spontaneous as press reports indicated, Kim Il Sung himself dropped in for visits to such facilities as the Kangson and the Hwanghae Iron Works to "rouse . . . the workers to a [sic] heroic exploits in their labour struggle." During his visit to the Chollima mill, the workers vowed to produce 90,000 tons of rolled steel at a mill with a capacity of 60,000 tons, and then they turned out the miracle of 120,000 tons in response to the Leader's appeal "Let us dash forward at the speed of Chollima!"[83] The frenzy of smelting spawned the Chollima Work Team Movement to encourage workers to establish and surpass targets in all fields of the economy.

North Korea had resorted to other campaigns standard in socialist systems to increase output in the absence of inputs. The so-called socialist competition was extended to agriculture in March 1961.[84] Socialist competitions have a Soviet legacy dating to the 1930s, when they were introduced to motivate workers to achieve targets. According to the socialist obligation, which the worker "voluntarily" and "willingly" embraced, the worker declared the goal of reaching such and such a target in competition with other workers at other enterprises. In the absence of incentives of wages or goods or other rewards, the government had to resort to titles, badges, or flags. Practically everyone got an award at some point, so the honorary titles became meaningless. In North Korea this led to the proliferation of categories and titles, for example, People's Hero, Class I, II, III,[85] and so on.

The Chollima Movement accelerated apparently in response to the People's Republic of China's Great Leap Forward (1958–60) of simultaneous industrialization and collectivization. It created similar difficulties of short supplies, bottlenecks, and all too often shoddy construction. Because of the absence of capital inputs (and incentives, as noted), the Chollima Movement relied on mass meetings and coveted titles to encourage labor. This provoked tension among workers; model workers were often ostracized because other workers accused them of forcing everyone to work harder. Authorities turned to model brigades to involve more laborers and ease the tension. The Chollima Movement involved 438,000 people by 1960. By August 1961, 2 million people were engaged in the movement in nearly 5,000 work teams and work shops, including 125,028 people who earned the title of Chollima, and fifty-five work teams with nearly 1,500 laborers who were honored with the title of "Twice Chollima."[86] In 1963 over 3 million people were engaged in Korean Stakhanovism, with hundreds of thousands of workers receiving Chollima medals. Some observers noted that the movement would have "built-in tendencies" to exaggerate output and cause disproportionate growth among different sectors.[87]

The Chollima Movement involved unquestioned enthusiasm for big technology, new norms, and self-proclaimed grandiosity of turning wastelands into a socialist industrial garden. As workers achieved each new unfathomable target, the leaders established still higher targets to ensure "strenuous effort and energetic struggle" to increase outputs and to fight complacency.[88] As Kim Il Sung noted in 1961, "Our heroic working class built in less than a year 300,000–400,000 ton capacity furnaces, laid in seventy-five days over eighty kilometers long broad gauge railway and set up in a little over one year a huge, up-to-date vinalon factory." He noted that "the grandiose high tide of socialist construction and the Chollima movement" were natural outcomes of the revolution. It had become a mass movement that encouraged "labor enthusiasm," while overcoming such "hindrances" as capital shortages through "incessant enhancement of political and ideological consciousness of the masses."[89] Chollima would encourage the creative cooperation of the "broad working masses and peasants with scientists and technicians" to develop indigenous science and technique with "incessant technical innovations" and always increased tempos.[90]

North Korean leadership responded to any hesitation among critics within the party or elsewhere by storming ahead with indignation. Kim Il Sung constantly cajoled local party leaders to do what they could to raise production. He promised in return the rewards of a life of plenty. He said, "Instead of 3,800,000 tons we must raise the grain output to at least five million tons, and even up to the six million or seven-million-ton mark. Only this will enable everyone in the northern half to live on rice, as we say. If we reach a point in which we can eat rice and meat soup, wear fine clothes and live in tile-roofed houses, that is, paradise."[91]

Campaigns like Chollima reflected an epidemic of dysfunction in the centrally planned economy. The "one-machine-tool-makes-another" campaign of 1959 was an emergency measure to double the number of machine tools by encouraging workers to find ways to put sweat, metal, and ingenuity together. More than 13,000 new tools were produced in this way, but indications are that quality, precision, and reliability were not features of these machines. Another campaign, the "production innovator," resembled the Stakhanovite movement in encouraging overfulfillment of norms.[92] The Taean Management System found fertile ground in this environment in the effort to rationalize leadership, material supply, and worker welfare. As noted, the chief engineer was subordinate to the factory manager. Reliance on such nonmaterial incentives as mass movements, competitions, and political exhortation also was evident in the Chongsan-ri; the "Pyongyang speed," "Kangson speed," and "Let's Fulfill the Plan as a Present to the Fifth Congress" mass production campaigns; and the "carrying-one-more-load," "run while carrying loads on head and back," and "watching the early star" movements, all of which sought to promote self-sufficiency and autarky in the absence of domestic capital inputs or technology from abroad.[93] The campaigns led neither to paradise nor to the harvest of more rice.

Socialist realism in the sphere of art reflected all of these campaigns in the economic sphere. In keeping with the socialist experience, the North Koreans promoted socialist realist art to inculcate values of selflessness, self-reliance, communalism, and the like. *Juche* guided this art in stressing themes that indicated the power, independence, and glory of the Korean worker. Art served the people through such themes as loyalty to the task at hand, pride in country, love of the Great Leader, victory over enemies, and control over nature. Posters, paintings, and murals blanketed walls everywhere. As in the Soviet Union, all artists and writers in North Korea were members of the artists' and writers' unions, from which they received salaries. They were required to produce works of art according to plans, not necessarily according to artistic inspiration. Leading officials of the unions ensured that works met standards for socialist realism, and they ostracized those who did not comply. Of course, abstract art was forbidden.[94]

Socialist realist art, theater, and music failed to inspire because of its superficiality, its simple-mindedness, its thematic messages limited to the successful fulfillment of the plan, industrial production, or agricultural bounty, and its depictions of life as struggle between good and evil with no shades in between, for example, between the proletarian Korean and the American missionary. Han Sorya, the chairman of the Writers' Union, a protégé of Kim Il Sung, and later minister of education, was a kind of "curator of the personality cult" through his literature.[95] In addition, placards, posters, monuments, and postage stamps commemorate the glories of socialist industry and of the constant struggle against imperialist aggression. Issued on the tenth anniversary of the People's

Army in 1958, stamps included a ten-won denomination with a soldier, flag, and the Hwanghae Iron Works in the background. In 1961 the government issued a series of stamps of different denominations in honor of the targets of the first seven-year plan, in which cogwheels figured prominently at textile, agricultural, power station, and other settings.

During the de-Stalinization thaw, abstract art reappeared in many forums in the Soviet Union. Like Kim Il Sung, Nikita Khrushchev detested abstract art. Realizing this, several conservative members of the Central Committee arranged for Khrushchev to visit a new exhibition of abstract paintings at a gallery in Moscow in 1962. Taking in a few of the paintings, Khrushchev turned beet red and then berated the artist in front of the crowd: "You ought to be ashamed of yourself. You ought to be taken out into a field of nettles, have your pants pulled off, and be forced to sit down." No North Korean artist risked Kim Il Sung's wrath. The punishment might have been to sit in kimchi.

Urban and Infrastructural Technologies of State Power

There is less evidence among the North Koreans of blind love for prefabricated concrete structures than among Soviet and East European communists. Still, in his speech at the third session of the second supreme people's assembly in June 1958, Kim Il Sung announced that mass production techniques would be applied to building new modern houses on a large scale (with, of course, nursery schools, kindergartens, clinics, and laundries also to be erected), all on the basis of "assembly-line methods" and "mechanization" of construction. The workers themselves, heeding this announcement, pledged to increase threefold their construction of houses in the current year.[96] Kim Il Sung was also enamored of bricks, although he worried about shortages as demand for them increased, even with 700 to 800 million bricks produced annually. Just before the war, they decided to build a brickyard at Kangnam. But as skilled workers had been scattered across the land by war, political disarray, and family disintegration, there was no one to build it properly. The remaining workers erected a chimney that drew poorly. It was destroyed by enemy bombing and then rebuilt again. Kim Il Sung recalled, "It was not easy even to make a brick; we did not know how to build a smokestack; and as we did not know how to make an estimate of the number of bricks needed, we were obliged to resort to a crude method of reckoning." Seven years later Kim Il Sung claimed that calculations of how many bricks and blocks were needed had replaced crude reckoning.[97]

Simple smokestacks were not the only problem. In spite of their importance to state goals, the development of transportation and communications infrastructure lagged in the workers' paradise. Expenditures for roads, railroads, shipping, and air travel are usually intended to support state efforts to industrialize and build military might. Yet rural transportation infrastructure lags significantly behind needs, especially in socialist systems, even though without good roads the farmers encounter great difficulties in meeting planting, harvesting, refrigeration, and delivery targets. Dirt and gravel roads—muddy and impassible much of the year—predominate in Russia, North Korea, and other industrial nations to this day; asphalt is a dream of local residents and traffic planners. In spite of the rhetoric of the decentralization of investment, the crucial place of agriculture in the socialist future, and the call for local industry, the Great Leader's capital city of Pyongyang swallowed capital and labor inputs, including brick, asphalt, and concrete by the mouthful. By 1974 most villages still resembled traditional peasant settlements, while Pyongyang was "an enormous 1950s sprawling European city suburb. By the late 1980s the Koreans were completing a new housing area with thirty-storey buildings along a six-km motorway. They had built a large triumphal arch which spanned a five-lane road in the city center," and a colossal *Juche* tower to honor the leader's seventieth birthday that included as many stones as days he had lived.[98] One massive thirteen-lane highway runs from high-rise apartments in one suburb to the downtown.

Authoritarian regimes tend to be superb developers of public transportation systems. These systems are a necessity in the absence of extensive highways and roads or a large number of private automobile owners, and they make a great deal of economic and environmental sense wherever they are properly designed and introduced. Combined with subways and comprehensive tram, trolley-bus, and bus lines, they enable workers to commute large distances at relatively high speed and at low cost. The systems also often serve the function of display value, that is, the ideological goal of demonstrating the superiority of the authoritarian regime over other regimes. For example, the metro stations in the USSR built under Stalin were works of art, self-proclaimed "palaces" constructed out of marble and other expensive materials and filled with murals that depicted historical events and moments of indoctrination, for example, the happy worker building communism.

The North Korean transport system has been limited in effectiveness because of the simultaneous construction of related but unnecessary facilities. Kim Il Sung determined to build sports and cultural facilities in Pyongyang that glorified his enlightened rule, replete with glorious thoroughfares and modern subway. In 1989, to rival the Seoul Olympics when efforts to cohost the games failed, Kim Il Sung ordered the construction of Youth and Kwangbok Streets for the World Festival of Youth and Students. Laborers built 260 major facilities in two years. They completed the Pyongyang-Kaesong Expressway, an unnecessary extravagance given this bicycle and train society. Youth Street was for sports and culture; Kwangbok Street was for apartments and shopping. Twelve athletic facilities aligned Youth Street, including the 150,000-seat Rungnado Stadium, a 4,000-seat table tennis arena, a 20,000-square-meter swimming pool, and several hotels, including the worthless Ryugyong, a 105-storey, 300-meter-tall unfinished structure. Kwangbok Street has a subway, high rises, and apartments.[99]

The two-line Pyongyang Subway also was a monument to modern socialism and the cult of personality of North Korean leaders. The stations feature murals and bronze reliefs, like those of Soviet metro stations, that glorify communist construction, the innovativeness of the people, and, of course, Kim Il Sung. The two lines, the Chollima Line and the Hyoksin Line, comprise seventeen stations over 34 kilometers. The stations are named Comrade, Victory, Construction, and so on, not after neighborhoods. The lines are deep underground, perhaps the deepest in the world at 130 meters. Western intelligence observers say they are linked to military facilities. Platform entrances hardened by tons of concrete and zinc to withstand a nuclear explosion bear this out.[100] And, in keeping with North Korean technological style, several stations have been closed for weeks at a time because of flooding.

Otherwise, transportation has lagged significantly behind economic needs. Inadequate infrastructure, especially in interior agricultural regions, made it difficult to harvest and move agricultural products. Refrigeration also lagged. Much of the transport system was rebuilt after the Korean War, yet in 1990 there were only 5,000 kilometers of railroad, most of it along the coasts, quite a small amount given the fact that 90 percent of all freight was hauled by rail. Efforts at electrification, containerization, and modernization of rail transport have been slow. There are roughly 23,000 to 30,000 kilometers of roads, very few of them paved, most of them gravel, crushed stone, and dirt. Vehicles mostly serve the military; rural bus service is spotty, slow, and uncomfortable, although most cities have bus and tram service.

Kim Il Sung purged a so-called antiparty group in the late 1950s as a sign of dissatisfaction with de-Stalinization.[101] The burgeoning cult of personality of Kim Il Sung indicated just one measure of rejection of de-Stalinization. Another was the continued embrace of large-scale technologies whose ideological significance often surpassed social function, for example, the construction of buildings with massive edifices to signify state power: the Tower of the *Juche* Idea, dozens of statues of Kim Il Sung at least 20 meters high, and later Kim Il Sung's grotesquely expansive mausoleum.

The North Korean state, like the Nazi and Soviet governments, uses its complete control over the media for propaganda purposes. As might be expected, very few homes and apartments have telephone service. The Propaganda and Agitation Department of the Korean Workers' Party uses approximately two dozen AM and ten FM stations and eleven television stations to carry official broadcasts. The government has mounted public loudspeakers everywhere to carry its messages.

Pseudoscience Korean Style

Autarky, centralization, and the primacy of ideology made a Lysenkoist-type figure a possibility in North Korea. In the 1960s Dr. Bong Han Kim advanced a theory that demonstrated the independent existence of a life force crucial to oriental medicine. Party technocrats embraced the theory as a major scientific achievement that reflected *Juche* socialism and enabled national self-reliance. The technocrats supported this theory with financing and institutional backing and made possible experimental verification of Bong Han theory as a "communist science." This led Bong Han theory to become an academic discipline as a part of oriental medicine, but also increasingly ideological, less empirical, and ultimately incorrect.[102] It should be mentioned that a number of specialists in the area of homeopathic and other alternative medicines claim that Bong Han theory held great promise and was rejected by westerners simply because of its North Korean origins. On the other hand, claims that it would cure diseases considered incurable by western doctors have not been proven.

Given poor funding of R and D and the short rein given scientists to embark on new projects, it is not surprising that North Korean specialists have few indigenous discoveries or applications that resulted from *Juche*, or self-reliant science. Another pseudoscientific effort in North Korea involved the costly and ultimately unsuccessful effort to create a cotton and nylon substitute in organic chemistry. Cotton will not grow well in Korea, so vinalon, a nylon-like chemical fiber developed from limestone and coal, both of which are plentiful in Korea, was a welcome substitute with a variety of applications. Vinalon was also Korean in genesis, and this secured its favor among leaders. The factories to manufacture it received significant investments, while other factories struggled to keep rudimentary machinery functioning. The stress on raw materials for fibers reflected needs of industry, military, and the civilian sector. The country slowly built or rebuilt a number of textile mills and silk mills. Yet demand grew and grew. The party therefore marshaled its "meager" resources to push the chemical industry to produce artificial fibers. This led to the construction of the Sunchon Vinalon Complex to produce the nylon-like fiber.[103]

Ri Sung Gi, a chemist who had studied in Japan, synthesized the fiber in 1939. Communist leaders invited Dr. Ri to the north from Seoul National University where he had settled. They offered him a spacious, well-equipped laboratory in Hamhung, a major city of the chemical industry, and a position as branch president of the National Academy of Sciences. Having seen his discovery ignored in the south, he relocated—or as the South Koreans say, "defected." The Sunchon Vinalon Complex was completed in May 1961 and opened with great fanfare, having gained Great Leader's attention and support. The 500,000 square meter factory consisted of thirty large structures, 15,000 machines and installations, and 500 kilometers of conduit and piping. "Our working people have miraculously finished this gigantic project by their own techniques and efforts in a little over one year," Great Leader observed.[104]

Another plant nearby was launched in 1986 to produce 100,000 metric tons of vinalon annually, plus methanol, vinyl chloride, sodium carbonate, nitrogenous fertilizers, and other products with consumer applications to improve people's standard of living. However, this facility has not met output targets, like the first factory produces an inferior product, was never fully completed, and has experienced a series of explosions.[105] Still, party officials frequently referred to the factory as demonstration of the success of *Juche* ideology. For his efforts, Ri received a Lenin Prize in 1962 and in 1965 was appointed head of the North Korean Atomic Energy Research Institute. Western specialists believe that the vinalon facility and perhaps several other plants that produce vinalon are also involved in the production of chemical weapons.

The Kims' Nuclear and Missile Programs

Given its autarkic economy, its leaders' willingness to sacrifice the public good in the pursuit of state technological programs, and its deep, some would say reasonable fear of attack from the United States, it is not surprising that North Korea has pursued nuclear and missile brinkmanship. North Korea's nuclear and missile programs give western policy makers greater worry. The tests of seven missiles in June 2006 flabbergasted Japanese and angered western leaders even if the tests were unsuccessful. What might be accomplished through diplomacy to slow North Korea's nuclear and missile ambitions and to encourage the nation to follow international regimes is not my major concern here. Rather, I pursue the question, what is Stalinist about North Korean missiles and reactors?

First, like the program of Cuba or Argentina, nuclear and space sciences serve to augment the country's self-image as a modern power. But unlike Cuba or Argentina, North Korea has produced nuclear devices for defensive purposes. The extensive nuclear program began in 1955 when scientists from the Korean Academy of Sciences participated in a major conference on the peaceful uses of atomic energy in Moscow. In 1956 government officials signed a number of bilateral agreements with the USSR and new ones in 1959 and also with China. The USSR agreed to set up a research facility near Yongbyon and support curriculum development at Kim Il Sung University. Soviet specialists provided a standard IRT-2000 experimental reactor at Yongbyon that commenced operation in 1967; Korean officials placed the reactor under IAEA controls from July 1977. In the mid-1970s, as cold war tensions simmered, the nation began to expand these facilities, for example, by building an indigenously designed, graphite-moderated, gas-cooled 30 MW reactor whose functions included plutonium production. The reactor began operation in 1987. North Korea then added fuel processing and other facilities enabling scientists to complete the fuel cycle. Scientists at the Laser Research Institute may be involved in a uranium enrichment program.[106]

Western students often have a difficult time understanding North Korea's bellicosity. North Korea justifies its military programs because of a long history of violent foreign intervention. China dominated what is now Korea for centuries. Japan exploited Korea from 1910 until 1945, expropriating half of the rice production and placing women into sex slavery. The Treaty of Portsmouth (New Hampshire), which ended the Russo-Japanese War in 1905, gave Japan "paramount political, military and economic interests" in Korea, which it used to develop industry in the northeast corner of the Korean Peninsula. Kim Jong Il claims to have defied the legacy of his father only once, in 1991, when he hesitated to divert government resources from the military to raise the standard of living of the people. With the fall of the Berlin Wall in 1989, the disintegration of the Soviet Union, the expectation of the United States that North Korea would follow along the clear and well-illuminated road to democracy, and the

Gulf War against Iraq in 1991, Kim Il Sung anticipated a U.S. attack on his country. North Korea's former allies had looked the other way; subsidized oil imports from Russia dropped 50 percent. The USSR had once before turned away from North Korea when it sought closer relations with China. Kim Il Sung admitted that "North Korean guns are so outdated that few are computer-operated," but that Korea was capable of both defending its own borders and "stinging US soil like a scorpion" with ICMBs targeted at New York, Chicago, and Washington.[107] Kim Jong Il therefore justified continued efforts to develop ICBMs, nuclear weapons, and other military hardware, no matter the costs. National mobilization, the creation of a fortress nation, and modernization of the defense industry all remained priorities.

Through reverse engineering and outright purchase, North Korea has developed an extensive missile program. The missiles are based on Chinese and Soviet models, often acquired through such third countries as Egypt, Iran, Syria, and Libya. Korea has missile-testing grounds on the eastern coast north of Wnsan, has produced a ballistic missile with a range of 900 kilometers, and soon will have an intercontinental ballistic missile with a range of 6,000 kilometers. Although struggling to feed its people, the country deployed tanks, artillery, mortars, rocket launchers, and surface-to-surface missiles and sought missile and nuclear technologies, the former of which it acquired through Egypt (scud missiles) and reverse engineering. The country's scientists extended the range of the Rodong-1 scud missile to 1,000 kilometers and eventually designed Taepondong multiple-engine missiles with ranges of 4,000 km. The first launch of a Taepondong missile in August 1998 reminded South Korea, Japan, and the United States that the fortress state remained capable of military strikes even as the economy struggled. The state combined these military achievements with *Juche* to deify Kim Il Sung, who, as a god on earth, had protected the nation from invasion. The government glorified the sacrifice of the masses, in face of their starvation, as part of the struggle in the "Arduous March" to reunification with the south, which they undertook while they sang "Song of General Kim Jong Il."[108]

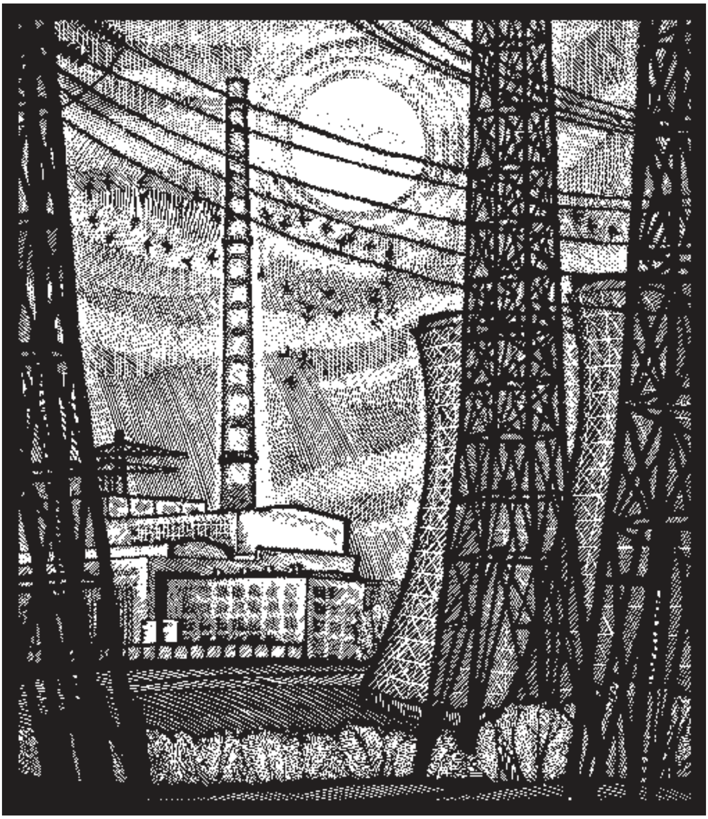
Will There Be *Kimchi*?

The song of the Great Leader and the Dear Leader consists of dozens of verses in a technological hymn. As this brief review of the history of several large-scale technological systems indicates, the genesis of industrial, agricultural, communications and transport, geoengineering, and military technologies in North

Korea reflects political, economic, and *Juche* ideological desiderata. Those desiderata include the Stalinist pursuit of collectivization of agriculture, rapid industrialization, and bold nature transformation projects. Because of the heavily centralized planning system that arose under Soviet influence, the projects acquired substantial momentum. Exclusion of public concerns, including those of engineers and scientists themselves, about environmental and social costs of development projects grew out of a closed, highly secretive one-party, charismatic political system. An overriding emphasis on applied science, on the allegiance of scientists and engineers to the masses in ways determined by officials of the Korean Workers' Party, and on military research and development also shaped Korean large-scale technological systems.

North Korea's autarkic industrial and technological policy reflects the presence of a command economy, emphasis on heavy industry, and *Juche* socialism. State ownership of the means of production, including the scientific research and development apparatus, ensured an orientation toward industry and such large-scale nature transformation projects as dams and irrigation systems. The Academy and State Committee for Science and Technology shaped the North Korean engineering sciences by administration fiat from above, not demand of the enterprises, and certainly not consumer demand. This approach has worked more successfully in missile development, nuclear energy, computer software, large-scale construction, and other campaign efforts than it has in innovation generally or civilian technologies. And having adopted self-reliance, the establishment no longer has access to turnkey plants or other sources of learning from abroad.[109]

Planners' preferences, autarky, and Kim Il Sung's cult of personality determined that North Korean development favored such heavy industry as construction, chemical fertilizers and fuels, mining, and metallurgy. Plans failed to include adequate resources for agriculture or consumer goods. And like other authoritarian political systems, its closed nature has engendered pseudoscientific efforts à la Lysenko to accelerate industrial production and modernize agriculture but has not ensured rational use of resources. Indeed, whether it be vinalon, which seems to be without counterpart elsewhere, or the massive, costly, environmentally dangerous dam, canal, and other nature transformation projects, North Korean science and technology seem rarely to have served those whom rhetoric proclaims to serve: the poor peasant and worker. For Stalinist technology is technology for the state, not for the citizen. Kim Il Sung promised bean paste, kimchi, and ducks. He could not even deliver tractors.



Masabikh Akhunov (1928–2008), “The Novovorenezh Nuclear Power Plant,” 1983, linocut. Nuclear power assumed central importance to the effort to provide more and more electrical power to the socialist state, in part through the serial production of nuclear power stations and their installation in reactor “parks,” here at Novovorenezh, Russia. Perhaps as a sign of continuity with the Soviet era, Russian engineers today are building floating nuclear power stations. Courtesy of the Allan Gamborg Gallery, Moscow, Russia.

CHAPTER FOUR

FLOATING REACTORS

Nuclear Hubris after the Fall of Communism

Through swamps and bog, over rivers and creeks, along disheveled farmlands and denuded forest, past sleepy, decrepit towns, the two-lane road from Arkhangelsk runs along the White Sea shoreline west toward the port city of Severodvinsk, where it ends amid massive shipbuilding factories that have employed the city's residents since its founding at the height of Stalin's great terror. In 1936, in anticipation of war with Hitler, Stalin ordered the Gulag administration to establish a shipyard on the White Sea, removed from foreign attack and isolated from domestic awareness and foreign espionage. Tens of thousands of gulag prisoners, their guards, and engineers arrived by railway in Isagorka, on the left bank of the Northern Dvina River, and then built a railroad to the site of the future shipyard. Arkhangelsk, with the only shipyards outside of Leningrad, lay on the right bank, but would not have a railroad station until the early 1970s.

The gulag prisoners of Iagrinlag (Iagry Island Camp) lived in tents or drafty barracks, exposed to vermin and rats, bitter cold in the winter, mud, and ravenous mosquitoes in the summer; the prisoners set immediately to building warships. At the dawn of the atomic age, Severodvinsk workers were instructed to produce nuclear submarines, eventually turning out nearly 200 of them, powered by a total of 400 reactors, including the *Kursk*, the largest attack submarine in the world that tragically sank in 2002, killing all men aboard, taking its reactors to the bottom of the White Sea, and reminding all Russian citizens, including President Vladimir Putin, of the challenges of remaining, or becoming again, a superpower with modern space and nuclear programs.

In spite of the military significance of Severodvinsk, the road from Arkhangelsk was paved only in 1968 and until quite recently lay in disrepair, overwhelmed by potholes, lacking guardrails, and poorly plowed in the winter, a technology totally incongruous with the economic, military, and geopolitical significance of Severodvinsk for the nation's leaders. Of course, the major reason for the poverty of the road was to ensure that Severodvinsk—one of roughly forty closed military cities established during the cold war with a total of perhaps 2 million residents whose lives were anonymous even to close relatives—remained closed to outsiders and to discourage insiders from leaving. In 2006, after years of lobbying, the town fathers, engineers, and businessmen succeeded in pressuring the federal and Arkhangelsk provincial governments to allocate funds to modernize the highway in support of growing market opportunities for the shipyards that have begun the long process of converting military production to such civilian enterprises as home and office furniture, oil drilling platforms, and yachts. And floating nuclear power stations.

Floating nuclear power stations (or PAES in their Russian acronym) will consist of two compact pressurized water reactors at 60 to 80 MW of power, enough to support a town of 200,000 people with all of its electricity needs. The PAES could also produce a combination of electricity and steam for industry, home heating, or even water desalination; the Moroccan government wants to buy floating reactors to turn ocean into drinking water. Namibian officials may also acquire a floating reactor. Sergei Kirienko, head of Russia's atomic energy agency, Rosatom, remarked on a visit to Namibia, "Today Russia is present on all continents in the sphere of atomic energy but we had left out Africa. Here there is a big potential market and we must be successful in this market." As for floating reactors for Namibia, "We are ready to build one," Mr Kirienko said.[1] Namibia has apparently agreed to work with Russia to develop its uranium reserves.

The reactors with their biological shielding will float on a large barge, along with a building holding the control room, computer facilities, housing for workers, and a small cafeteria and kitchen. According to plans, the first floating reactor will float out of Severodvinsk shipyards for local operation by 2010. The authorities of Rosatom will be happy to order another dozen PAES to be constructed for sale, to be towed and moored in any estuary, tidal basin, bay, or river at home or abroad for international customers. The PAES designers claim that they are "100% safe," capable of taking a direct hit from an airplane and still maintaining reactor integrity, hence the interest of the governments of China, Morocco, Indonesia, and others in purchasing them for the modest fee of $120 million. Yet PAES utilize uranium enriched 4 times higher than the amount normally used in reactors and hence could be converted to bomb use much more easily, and they will have only the barge and shielding as protection from a torpedo or bomb from underwater, let alone from waves, while land-based reactors have multimeter-thick concrete walls—and are stationary.[2] Still, Minister Kirienko touted the advantages of floating reactors at a press conference: "Floating NPPs [nuclear power plants] work on 12%–14% enriched uranium. Everything lower than 20% is low enriched uranium and is not subject to nonproliferation restrictions. That's why we can freely use such plants everywhere in the world. But before exporting a product one should test it at home. That's why we are building the first such plant in Severodvinsk. We need a finished product so potential buyers could come and see it. We are also planning to produce a plant with a capacity of less than 10 MW. You don't need to refuel it: you fuel it once and it works for 25–30 years."[3] Even throwaway reactors?

From generation to generation, from old engineers and reactor operators to younger ones, unbridled nuclear enthusiasm persists in Rosatom's extensive programs to rejuvenate the peaceful nuclear atom. This enthusiasm extends from floating reactors to factories capable of mass-producing reactors, all part of an official goal of building 100 reactors over the next twenty years, a pace never before even distantly achieved anywhere in the world. The programs raise significant questions about whether Russia or any nation should embark on nuclear renewal before issues of reactor safety and location and the disposition of nuclear waste are resolved. But Rosatom will go ahead absent public discussion, issuing glossy publications and superficial public pronouncements about the glories of the peaceful atom. The publications reflect a shocking continuity in the hubris of Soviet and Russian nuclear engineers who only a generation before presented the world with Chernobyl, and they indicate that the current-day Russian leaders share their predecessors' aspirations for great power status and empire that are symbolically displayed by reactors, rockets, and other big technologies.[4]

Floating reactors reveal continuity with the very recent Soviet technological past in a variety of ways that go far beyond reliance on designs that evolved from closed nuclear facilities of the cold war 1950s and 1960s. Nuclear reactor technology including the fuel cycle continues to tie Russia with the former Soviet republics and with the former socialist nations of East Central Europe. They rely on Rosatom for expertise, components, and nuclear fuel. Russian leaders see nuclear technology as a tool of foreign policy, as their Soviet forebears did, and hope to use it to transform economic connections into political relations. In addition, the Russian government through Rosatom remains the main engine of development of this sector of the economy, as it does for space, nanotechnology, and other cutting-edge areas of scientific prestige and economic-military potential.[5] Following the Soviet tradition, in pushing nuclear technology, the federal government has emasculated local and regional opposition, raided and closed a number of environmental NGOs for specious reasons, and weakened regulatory agencies concerned with nuclear safety issues from siting and design to licensing. The intractable problem of nuclear waste, the displacement of people, the hubris of engineers—these aspects of the "peaceful atom" remain constant across borders and through time.

Floating reactors reveal the contradictory essence of Russian technological style: the ability of the nation's engineers to design rocket ships and submarines, yet difficulties in building safe roads; the construction of an industrial superpower in one generation under Stalin, yet challenges in meeting consumer demands and maintaining infrastructure into the twenty-first century; and the continued crucial role of the state, and the political oligarchy at the top of that state, to command immense resources of engineering expertise, capital, labor, and time, while interfering with innovation in the private sector. The Russian government remains uncomfortable with civic culture and strives to silence public dissent for its big science and military programs. As for President Putin, and now apparently for President Medvedev, following in the footsteps of Peter the Great and Stalin, the crucial ingredient in the development of floating reactors may be the simple desire to maintain Russia's coveted position as a world power. And as for Lenin and other Russian leaders, electricity, in this case powered by reactors, remains a panacea for economic development and international political aspirations.[6] Are floating reactors a part of a nuclear GOELRO?[7]

Technology and the Assimilation of the Russian North

In 1694, the twenty-two-year-old Peter the Great, who assembled Russia's first great navy to conduct a successful war with Sweden, ordered a dockyard built at Arkhangelsk and personally constructed a large ship there.[8] The White Sea was a logical choice for a shipyard. Although frozen up to five months out of the year, the sea is protected by the Kola Peninsula from northern attack and is only 600 miles north of St. Petersburg and Moscow. Few people have settled in the Arkhangelsk region because of its dense forests and unforgiving climate, with winter temperatures reaching –40°C, and in the summer with thick clouds of mosquitoes and swarming flies that generate fondness for the winter. Peasants gathered bees and honey, trapped animals, and fished. Since agriculture was poorly developed, serfdom never fully took hold, while modest and labor-intensive forestry, fishery, and mining enterprises grew up and collapsed with great frequency.

Russian leaders long sought to establish political and military control over the Far North, its people and resources, and since the cold war have seen nuclear power as a key to that control. After the revolution, the Bolsheviks redoubled efforts to subjugate the Arctic. They were especially concerned with securing the region since British and American soldiers were bivouacked in Arkhangelsk at the end of World War I in a failed effort to keep Russia in the war after the fall of the Provincial Government. They were also wary of Arkhangelsk's citizens since a government independent from Moscow was temporarily established in the region. When Stalin came to power, he accelerated the pace of conquest using trails, roads, and railroads to penetrate the region and relied heavily on gulag prisoners to carry out the work. Like Peter, Stalin grasped the importance of a navy, and he ordered prisoners to build shipyards and vessels. They first called the gulag shipbuilding town "Molotovsk" in honor of Vyacheslav Molotov, Stalin's right-hand man, signatory of the infamous Nazi-Soviet Non-Aggression Pact of 1939 that permitted Hitler and Stalin to avoid war for two years while dividing Eastern Europe among themselves. Several hundred thousand prisoners, some requisitioned from the nearby Solovetskii labor camp located in a former monastery on an island in the White Sea, the Bolsheviks' first major prison labor camp, were assembled to transform the swamps, bogs, and estuaries into a naval yard.

The Soviet dream of opening the Far North using modern technology—and slave labor—expanded rapidly in the 1930s. Stalin harnessed the Gulag to serve state economic programs through a wealthy and powerful organization called Glavsevmorput (the Administration of the Northern Sea Route), whose network of labor camps extended from Arkhangelsk to Nakhodka on the Pacific.[9] The directors of Glavsevmorput learned their methods from the construction of the Belomor (White Sea–Baltic) Canal, a murderous slave labor project that was glorified in the press and in the publications of playwright Maxim Gorky in a paean to forced political reeducation of mistrusted bourgeois elements into reliable workers.[10] Yet the project failed on all counts, with tens of thousands of prisoners dying from exposure to the elements while armed only with pickaxes, shovels, and wheelbarrows, and with the canal being built too narrow and shallow to handle modern ships and leaking through porous walls and basin. Will floating reactors suffer from technological defects as well?

Many of the major early Soviet construction organizations were subordinated to the secret police apparatus and its ever-growing system of labor camps, the Gulag (State Administration of Prisons). Beginning with the construction of the Belomor Canal in the early 1930s, the system rapidly expanded north and east. It may be that the roots of the employment of prisoners in economic tasks can be found in the party's determination to "militarize labor" under Trotsky during War Communism to raise production through coercion of laborers, since capital stock had been destroyed or fallen into disrepair, and certainly that which remained was outdated. War Communism also saw detachments of loyal communist workers and Red Army soldiers sent into the countryside to requisition grain at the point of a gun. Gulag prisoners worked primarily in road and railroad construction, mining and metallurgy, and forestry. As a rule they were poorly equipped, poorly dressed, and poorly fed. The projects were seen by party officials as a cheap way to subjugate nature while simultaneously reeducating both political prisoners and common criminals. In the northern district alone (today's Arkhangelsk, Murmansk, and Karelian Provinces) the Gulag involved hundreds of thousands of prisoners interned in a variety of camps. The archival materials reveal the entire lack of concern for prisoners, whether kulaks, political prisoners, Estonians and other Balts, or Poles and Germans after the war. The camp authorities frequently reported injuries, illness, high absenteeism, and tardiness among their charges.[11]

In spite of the slave labor, or perhaps because of it, Severodvinsk long suffered from inattention to communal services. The prisoners frequently mishandled equipment. Four German presses purchased at 1.3 million rubles in 1936 and eleven derrick cranes rusted in the open air waiting for proper installation. This may be because of failed literacy campaigns that left many of the workers unable to follow let alone read instructions. The town lagged in electricity production through the 1960s and did not install an extensive telephone network until later. Molotovsk's crucial significance for the Soviet defense industry did not translate into the provision of rudimentary technologies of housing, schooling, and everyday life. Teachers worked in drafty, damp, and overcrowded temporary wooden structures. City planners had not provided for hospitals or beds, for laundries or public baths. Muddy thoroughfares flooded every spring and fall and lacked street lights. The sewage and water supply systems had failed, with water treatment unable to stem the spread of infection through the pipes. Houses, too, had begun to collapse from the inside out, as had sidewalks into the swampy soil. Passenger trains in the region were woefully inadequate to the task, from the miserable waiting rooms, to the platforms built too low, to the filth and garbage that accumulated in the wagons. In the early 1950s, even with thousands of prisoners, housing construction could not close the gap with demand, nor could they produce enough bricks to abandon the wooden structures. The town fathers repeatedly requested additional slave laborers for the local labor camp, Iagrinlag, in 1954–55 even as the camps were beginning to empty.[12]

Indigenous People and Nuclear Power from the Arctic to the Pacific

Nuclear technologies have required great sacrifice on the part of local people wherever they are installed, and other local people often suffer direct health consequences of uranium mining and nuclear testing. In the process of establishing various military and later military nuclear facilities, the authorities expelled indigenous northern peoples from their homelands, particularly the Komi and Nenets in Arkhangelsk Province, including from the islands of Novaia Zemlia, where the Soviet armed forces conducted hundreds of nuclear tests. These people suffered the same fate as Bikini islanders in the South Pacific, who, at the hands of the United States Army and Navy, were moved from their atolls. The Bikini atoll was turned into a testing area to demonstrate the dangers of nuclear weapons; military planners moved ahead with the confused assumption that, on seeing the violent power of nuclear bombs, the USSR and other nations would do as the United States insisted to prevent proliferation, while allowing the United States to remain the only nation with nuclear weapons.

This attitude, in other forms and under other presidential administrations, has seen more countries join the nuclear club every decade.

U.S. officials promised the Bikinians cleaner, better, and more modern houses on other islands and a return to their homes after a prompt and courteous cleanup. Many Bikinians, abruptly separated from their lifestyle, suffered from malnutrition, and decades and hundreds of millions of dollars later the Bikini atolls remain highly radioactive, unfit for habitation, not surprisingly after twenty-three nuclear bombs were detonated in the area.[13] Along the Columbia River in Washington State, Indians face uncertain long-term health prospects given their ingestion of radioisotopes in salmon that is a major part of their diet.[14] Apache and Navaho Indians who mined uranium have higher rates of lung and other cancers, and they face renewed pressure to seek ore in their lands for rejuvenated nuclear programs in the twenty-first century, while other Indians have considered opening nuclear waste facilities on their land to generate income for communities that face some of the highest unemployment rates and worst public health problems in the United States.[15] Many of the data related to such nuclear safety issues as exposure of miners were classified during the cold war. When any government denies access to information in the name of national security, as the Russians and Americans continue to do in some cases, it suggests that the label is applied not for security reasons alone but to hide moral failings and liability.

Forced accommodation of the indigenous people of the former Soviet Union to modern technology was similarly unforgiving. The Chukchi, Nenets, and other minority nationalities in the empire have never evinced respect for the imposition of modern technology into their lives.[16] In the Kurasawa film *Dersu Uzala*, based on a 1923 book by Vladimir Arsenev of the same name, Dersu, a Goldi hunter aware of the spirits of animals in the forest, saves a turn-of-the-century Tsarist officer and his surveying crew from ignorance, frigid cold, and hunger as they chart the immense resources of the Far East. When Dersu loses his eyesight, he accepts the captain's invitation to live with him in the city. But he cannot tolerate urban smells, noises, and moods. Dersu dies, heartbroken over the transformation of Siberia into a Russian frontier. Stalin forced indigenous people in the Far North and Far East to modernize, driving them into collective reindeer farms beginning in the 1930s. Their homelands were expropriated during the cold war for nuclear testing and military bases. Soviet officials proudly claimed that the 14,000 Chukchi of the northeastern Arctic, who served as the butt of Soviet anecdotes for their alleged backwardness, benefited directly from the peaceful atom: in the 1970s, the Russian modernizers built the forerunner of PAES in Bilibino, Chukotia, a station consisting of four reactors, each at 12 MW, to power "boiler houses" that supported Moscow's gold and tin mining enterprises in the region. While not strictly portable, the reactors were constructed of components and prefabricated forms and shipped by boat and rail for assembly over a foundation anchored into shale and permafrost. Locally generated electricity was a vast improvement over past efforts to bring electricity—and economic development—to the region since long-distance power line poles and towers sank, broke, or rotted into the swampy tundra. The authorities reported that the Chukchi were pleased with the reactors, referring to them happily as "a big fireplace."

The Nenets suffered the fate of the Bikinians. They were removed from Novaia Zemlia, which became a site for scores of nuclear explosions, many of them atmospheric, and a dumping ground for haphazard disposal of waste, with carcasses of reactor cores and other highly radioactive waste littering the landscape. In one test in 1973, many people were likely killed when an underground explosion ejected 80 million cubic meters of earth into a nearby valley and formed a new lake. In the late 1990s Rosatom commenced new excavations to turn Novaia Zemlia into one of Russia's main radioactive waste repositories, including the final resting place for 300 reactors from 190 submarines.[17] But the authorities may have abandoned the plan, perhaps to resume nuclear testing some day on the site. Officials determined that it was "inexpedient" to build on Novaia Zemlia—because of global warming. They anticipated a swamp instead of permafrost and encountered higher costs than initially estimated. They have fixed instead on a site for a repository in the granite of the Kola Peninsula,[18] near Komi and Saami lands.

Beyond Floating Reactors

Rosatom's plans for nuclear renewal go far beyond floating reactors. Its engineers seek to build reactors throughout the nation, particularly in the European part. At one time, they had their hearts set on a spot on the Arkhangelsk-Severodvinsk road for the construction of two 600 MW new-generation pressurized water reactors: the sleepy town of Rikasikha.[19] During World War II a camp to train Nenets and Komi to serve in the Red Army in the war against Hitler, Rikasikha now reflects all of the contradictions of contemporary Russian society: it consists of muddy roads, small farms held together by old peasants, a few dachas for wealthier Severodvinskians, and a modern chicken and egg farm. Known otherwise only for the presence of a police control point on the road, Rikasikha grew out of the Molotovsk Railroad, itself part of the Gulag. Rosatom planned to commence construction of the reactors, estimated at $700 million each, in 2008, but scientists at the Institute of the Ecological Problems of the North detected the possibility of seismic activity at 8.0 on the Richter scale.

Where they will be built now is anyone's guess, although they will be built in the region. Nuclear reactors have the blessings of Arkhangelsk and Severodvinsk officials because they will help wean Archangelsk Province from its reliance on two ancient fossil fuel cogeneration plants, or "TETs," that produce steam heat and electricity. The construction will keep skilled workers from Severodvinsk doing what they do best: erecting steel girders; running conduit, piping, and wiring; and loading nuclear fuel. In winters past school children endured bitterly cold classrooms and listened to their teachers dressed in coats, hats, and gloves as fuel shortages at the inefficient TETs have left many neighborhoods without heat.

Possible locations for additional reactors are on the Kola Peninsula, across the White Sea from Arkhangelsk, at the Kola Nuclear Power Station at Poliarnye Zori, consisting of four 440 MW pressurized water reactors, or perhaps somewhere in Karelia. The Karelian and Murmansk plans worry local residents who still suffer from "radiophobia" because of the Chernobyl disaster, while Rosatom insists that the reactors will be safe and an important component of a modernized electrical energy generating system to power further regional economic development, including the operation of gas and oil pipelines across the Kola Peninsula to Murmansk and the shipping by tanker to European and perhaps North American clients.

To demonstrate how consonant plans for expansion of the nuclear enterprise are with fragile arctic (and other) ecosystems, the Kola Power Station personnel established a pond fishing operation in the warmed effluent waters of the station. The cooling water reenters the nearby lake from which it was initially drawn at 5°C higher temperature; this keeps proximate waters year round warm enough to raise trout and sturgeon from fingerlings. The trout are already being sold, while sturgeon production remains in experimental stages. Discussion of the practice of pond fisheries using nuclear effluent appeared in *Atomnaia Energiia*, the Soviet journal of atomic energy in the 1970s.

Given President Putin's unwavering support for nuclear power, Rosatom recognizes no need for humility in its plans. Similar to Lenin's plan to build communist society through a state electrification program, and Stalin's even hungrier pursuit of electricity, President Putin has encouraged Rosatom to rejuvenate its civilian nuclear power programs rapidly. Toward that end, the Putin administration has cavalierly dismissed public concerns about nuclear power dating to the Chernobyl disaster in 1986. One of Putin's first acts as president was to eliminate the federal environmental protection agency, moving enforcement responsibilities to regional officials, but providing them with neither the budgets nor the manpower to uphold essentially inadequate laws. Simultaneously, the Russian nuclear regulatory body, Gosatomnadzor, lost many of its investigative and enforcement capabilities in the name of rejuvenation of the atom. The Federal Service of Public Safety, the direct descendent of the KGB, has intensified xenophobic scrutiny of NGOs, especially those allegedly with foreign ties, effectively halting public opposition to a variety of ecologically suspect projects, including nuclear power stations and dams.

In June 2006, on the eve of the G8 Summit in St. Petersburg where British, French, American, Japanese, and Russian adherents discussed the future of nuclear power, Putin sadly announced that the share of electrical energy produced in Russia by nuclear power was a miserly 16 percent (vs. 20 percent in the United States, and 80 percent in France and Hungary—and Vermont) and dropping. He urged Rosatom to increase the share to at least 25 percent by 2030.[20] While scaled back several times since the mid-1990s when first announced, Rosatom's bold new plans to build dozens of nuclear power stations west of the Urals in European Russia will require that four or five reactors come on line almost every year, with the time needed from the start of construction through testing, loading, and full power for any one reactor no more than a handful of years, much more quickly than ever before achieved in world experience.[21] Deputy Minister of Rosatom, Bulat Nigmatulin, saw no impossibility here, announcing plans to double the output of nuclear power stations by 2015. Sergei Kirienko, the head of Rosatom, his predecessor deposed after a series of questionable business dealings that benefited him and his wife, followed by declaring that Russia will build forty stations at home in the next two decades and sixty abroad—100 reactors in twenty years on the basis of a standard model. A 2007 press release that refers to twenty-six new stations by 2020 casts some doubt over whether Rosatom will succeed in its 100-reactor target by 2030,[22] but Kirienko remains confident. At a press conference he announced, "In 2012 we are supposed to start commissioning two units a year. Now we have twelve constructions in Russia and abroad. By 2020 we are to build twenty-six new nuclear power units against just thirty-one units built throughout the Soviet period. 2020 is not the end of the program. We are not going to stop but will be increasing the pace."[23]

At a 2006 Kremlin press conference with President Putin, Rosatom head Sergei Kirienko touted the role of nuclear power in safely producing energy during a very cold snap that winter in the country's heartland. He promised bigger things: Rosatom's reactors would produce 25 percent of the country's electrical energy by 2030. He referred then to the restoration of "the full technological cycle," by which he meant resurrecting all aspects of the nuclear industry and reestablishing important technological processes lost in the different republics after the collapse of the Soviet Union—uranium mining enterprises in Kazakhstan, machine-building enterprises in Ukraine, and so on, that would "restore the technological chain that the Soviet nuclear industry had developed. The system operated as a unified chain and was probably the most effective in the world." This would enable Rosatom to compete effectively on world markets to build at least forty and perhaps as many as sixty new reactors abroad, especially "in the Asia-Pacific region and in Europe."[24] Technology thus would be a foundation of reestablished ties with former Soviet republics and become again a major tool of foreign trade for Russia. Kirienko later pointed to another important continuity in the minds of officials, saying that "nuclear power stations have provided the country with more than 14 billion kilowatt hours. This is a record both for the Soviet Union and for Russia."[25]

Nuclear engineers throughout the world argue that they have mastered civilian reactor technology over a half century of experience and will reduce construction costs and time by adopting techniques typical in any industry: the use of standard components, many of them mass-produced, and rapid assembly by a well-equipped, well-educated workforce trained to avoid errors in the field. In Russia they have, after all, built and still operate thirty-one civilian power-generating reactors at ten stations (the United States has 103 reactors at sixty-seven sites), and pressurized water reactors of Soviet design and construction continue to supply power reliably in the Czech Republic, Slovakia, Hungary, and Bulgaria (but not in Eastern Germany, where Soviet-era reactors were mothballed immediately after unification).

Russian leaders hope that nuclear technology will enable them to reestablish strong economic relations outside of the USSR—with former COMECON countries, for example, Bulgaria. Kremlin talks in 2008 between President Vladimir Putin and Bulgarian President Georgi Parvanov considered such areas of bilateral cooperation as transport, investment, the military, and the energy sector. In addition to hopes for a new gas pipeline to bring Russian gas to Europe, the leaders talked about a newly signed general contract for construction of at least two VVER-1000 reactors at the Belen nuclear power plant in Bulgaria.[26] Construction on up to six VVER-1000 reactors produced through Atommash for the Belen station on the Danube River, downstream from the Hungarian Paks nuclear power facility, began in 1981 but was abandoned 40 percent complete in 1990 after the collapse of the USSR. New reactors have gained importance to both countries in the twenty-first century.[27] Bulgaria's other Soviet-era station, Kozloduy, has six reactors on its site, but only two of them are in operation. Units one through four (VVER-440s) were shut down as part of the agreement of Bulgaria to enter the European Union since they could not be safely retrofitted to meet international standards, while units five and six (VVER-1000s) continue to operate. Unfortunately, many observers worry that the Belen reactors have been reborn too quickly, without adequate study of seismic conditions, without involvement in the public about safety issues, and with other problems that suggest how Soviet-era attitudes about technology assessment continue to accompany post-Soviet reactors and other technologies. The matter of cost, at perhaps $6 billion or more for each Rosatom reactor, also may delay further construction. (See chapter 2 for more discussion of the place of Soviet nuclear technology in East Central Europe.)

Russian engineers have long pursued cost-savings measures in nuclear power, first by establishing reactor "parks" where up to ten massive reactors shared basic equipment in standard factory buildings ever to expand capacity. Locating them in these parks, in the case of Chernobyl near a nature preserve, reflected their belief in the safe coincidence of big technology and nature. They planned to build another six reactors at Chernobyl beyond the four in operation when the disastrous explosion on April 26, 1986, required the evacuation of 135,000 people, the creation of a huge exclusion zone, and the construction of a frail and failing sarcophagus to entomb the reactor and halted the further development of the inherently unstable Chernobyl-type channel-graphite reactor, only in part because of the absence of a containment vessel. Soviet engineers favored this kind of reactor because of its relatively low capital costs per megawatt of capacity compared to reactors of other designs, its plutonium production capacity, the ability to refuel it during power generation, and the ease of expanding to bigger units, even to a monstrous size of 2,400 MW, 2 times larger than any reactor ever before built. (The European Union prodded Ukraine to close the last operating reactor at Chernobyl, no. 3, in 2000, with the promise of credits and assistance in building a new sarcophagus to entomb the old one; only in 2006 did the European governments and United States finally agree to provide that financing, perhaps as much as $750 million.)

Two half-completed cooling towers at Chernobyl stand as ghostly reminders of failed nuclear policies. Yet engineers and reactor operators, young and old, Soviet and post-Soviet, celebrate their faith in nuclear power and Chernobyl-type reactors every July on a glade near a freshwater lake in western Lithuania, not far from the Ignalina Nuclear Power Station, the site of the two largest Chernobyl-type reactors ever built and the only ones outside of Russia and Ukraine, at the Dysnai Festival. To the consternation of the operators, Lithuania has agreed to shut down Ignalina as a precondition to join the European Union. The shutdown will have a significant impact on the country's economy since the nation generates not just electricity but significant income from the sale of electricity east into the Russian grid. The operators find little solace in the promise to replace Ignalina with reactors acceptable to the EU from the point of view of safety and stability. In the interim, the residents of Visaginas, like Severodvinsk a town built to support nuclear reactors, a colony largely of Russians who moved here in the 1970s and 1980s from stations in Russia and Ukraine, as far away as Bilibino, will find unemployment and dislocation from careers supporting the peaceful atom.

But at the annual Dysnai Festival employees from the atomic empire of the former Soviet Union gather to sing, dance, perform skits, and eat shashlyk (a marinated shish kabob), all to celebrate the glories of nuclear power. Using their skills as electricians, plumbers, and carpenters comfortable with steam and electricity, they build a sauna in the woods, construct a stage on which to perform skits in homage of the peaceful atom, and tap into overhead power lines to illuminate the festival. The festival, established and run by former Communist Youth League members, demonstrates the widespread faith that engineers trained within the Soviet system continue to have that the peaceful atom of mass-produced floating and stationary reactors has a promising future.

The Soviet Legacy of Mobile and Mass-produced Nuclear Power Stations

The premature rush to standardization of scores of reactors has roots in the pressurized water reactor of Soviet design, the VVER, and the Atommash Factory in Volgodonsk on the Volga River. Barges play a role in this reactor, too.

The strangely intriguing idea of a reactor factory on the Volga grew out of Stalin's grandiose 1948 Plan for the Transformation of Nature, according to which the Volga and Don Rivers would be engineered through dams, reservoirs, and canals to heed five-year plans like clockwork while providing electricity, water, and an integrated transport system to the nation. Atommash arose near the Tsimlianskoe Reservoir on the Central Volga near the Volga-Don Canal. À la Henry Ford, engineers planned annually to build and ship eight massive, serially produced reactor vessels and associated equipment by barge for assembly at reactor parks in the USSR and Eastern Europe. Hungarian officials envisioned ordering ten of the 1,000 MW units from Atommash, which would then be floated through the Don-Volga Canal, down the Don, into the Black Sea, up the Danube through Bulgaria to Paks, Hungary, for installation. Atommash produced only three reactors before a wall in the main foundry collapsed owing to poor design and construction. In March of 2001, federal emergency management agency officials denied reports that there had been a radioactive discharge at the nearby Rostov nuclear power plant. Officials admitted that there had been a leak in the first loop of a steam generator that was immediately fixed and that radiation remained inside the reactor, while conditions at the station and in the area around the station remained normal.[28] Shortly thereafter, President Putin showed the government's faith in nuclear power when he joined Rosatom officials in April 2001 to christen the Volgodonsk reactor, the first reactor to come on line since the fall of the USSR, which had been manufactured locally at Atommash. Construction is well under way on a second reactor at Volgodonsk, and some engineers hope that Atommash will again begin spitting out scores of reactors in the near future.

This atomic enthusiasm is represented in the artifacts of the Soviet era still operating within major cities in the former Soviet Union. Fifty experimental reactors and critical assemblies that date to the early nuclear age—and their waste—fill scientific research institutes across Russia, many within the limits of major cities like Moscow and Kyiv. Rosatom also operates breeder reactors, a technology of proliferation that generates additional plutonium to load another reactor—or to be extracted for a bomb. The breeder reactor employs a liquid metal, usually sodium, as a coolant. The water used to produce steam and the liquid metal are an explosive mix: after a series of setbacks including sodium fires and leaks, the BN-600 breeder reactor came on line eleven years after plan. In spite of this delay, Rosatom now insists that the next breeder, the BN-800 (that is, 800 MW) will operate by 2012, and the BN-1800—the largest reactor ever built—will be producing plutonium and power by 2020 and then, in the words of Rosatom officials, "enter into serial production as a competitive commercial energy block."[29]

Russian engineers have their greatest experience with "transportable" reactors. They deployed over 500 units in submarines, icebreakers, and freighters between 1955 and 2004, two-thirds of them in the Northern Fleet served by Severodvinsk and Murmansk. Based on these reactors, Rosatom, Rikhasikha, Arkhangelsk, Severodvinsk, and other officials logically think of floating reactors as a relatively simple technology with clear civilian applications that can be serially produced. In spite of scores of accidents, several of them major involving submarines, sodium fires at breeder reactors, failed pumps, and the Chernobyl disaster, engineers have maintained their hubris and have embarked on a plan to build at least a dozen PAES in the next decade.

The design of portable, floating, and other nuclear "engines" dates to the late 1940s and includes not only nuclear submarines but models for use on land and in the air. Engineers owe much of their inspiration for these engines to Igor Kurchatov, the head of the Soviet atom bomb project. Bombs in hand, Kurchatov turned to such peaceful applications as peaceful nuclear explosions (PNEs), over 120 of them, to dig canals, create dams, fabricate underground storage caverns for industrial wastes, and put out oil well fires. Until the Limited Test Ban Treaty of 1963 prohibited atmospheric tests and any venting of radioactive gases from an underground test, PNEs had great support among hubristic engineers. The tests continued until late in the Soviet period, the United States ceasing its PNE program after sixty-seven attempts in 1968 because of the impossibility of preventing venting and other repeated technical failures.[30] Yet in 2007, specialists at the Kola Scientific Center expressed some hope for rejuvenation of PNEs, recalling wistfully a twin PNE only 10 kilometers from Kirovsk that in 1983 generated a shock wave to pulverize ore for mining. Nuclear geoengineering remains a fantasy of Soviet and post-Soviet—and no doubt American—specialists.

Yet Kurchatov's love was reactors. He encouraged research on fusion with reactors based on principals of the physics of the sun. He supported the investigations of Igor Tamm, a future Nobel laureate in physics, and Andrei Sakharov, father of the Soviet atomic bomb, but better known for his selfless fight for human rights in the Brezhnev era, his Nobel peace prize, his exile and isolation in the city of Gorky, and his return to Moscow at Mikhail Gorbachev's invitation where he became the conscience of perestroika. Less well known, Sakharov favored nuclear power to solve the world's energy problems and proposed building reactors underground to be safe from terrorist attack and protect the environs from an explosion.[31] Tamm and Sakharov proposed a donut-shaped or torroidal layout ("tokamak" reactor) of electromagnets to contain a superheated plasma of deuterium and tritium that would be fused into helium-4, releasing a tremendous amount of energy. The tokamak remains the most promising alternative among fusion reactors and the focus of the ongoing multimillion dollar joint ITER effort of Russia, Japan, the European Union, and the United States. Kurchatov secured the release of classified results from the tokamak program in anticipation of the first Geneva conference on the peaceful uses of nuclear energy in 1955. The breadth of Soviet programs simultaneously intrigued and bothered American delegates to Geneva, who thought that they themselves were no doubt well ahead of the Soviets in all areas. After the initial shock, they welcomed the knowledge that their Soviet colleagues shared their views of the promise of peaceful nuclear programs.

The Soviet press savored achievements in nuclear power, food irradiation, agriculture, and industry that generated suggestions from ordinary citizens. Among scores of letters, Kurchatov received one from a provincial peasant who suggested portable nuclear generators for use on the farm. Kurchatov asked his staff to write polite responses to the people whose ideas he found far-fetched, as if his ideas proposed nothing out of the ordinary.[32] He provided the foundation for the Severodvinsk floating reactors a half century earlier in his plans for portable reactors, some of which might move about on tank treads, others by flatbed railway car, still others dropped from airplane by parachute in component parts into remote locations for assembly on site. One rationale for portable reactors derives from nuclear fuel, whose volume is significantly smaller than the amount of fossil fuel needed to produce a like amount of energy, which does not need oxygen for combustion, and which operates in Arctic temperatures while diesel engines are difficult to operate let alone start in winter. The transport of oil, gasoline, and diesel fuel into remote taiga or tundra was also costly.

Kurchatov imagined workers deployed by parachute into the Arctic along with reactor units and other equipment, assembling them quickly and producing electrical energy and heat to power new settlements such as that at Bilibino for the Chukchi. In his view, atomic energy would power communism itself, a society founded on copious quantities of electrical energy and easy access to resources. Unlike Stalin's gulag system with Arctic prisoners poorly equipped and dressed, the workers of the Khrushchev era and beyond would toil effortlessly with the assistance of the atom. Soviet engineers built a series of experimental portable reactors toward these ends, including a crawling atomic power plant, the TES-3, at the closed city of Obninsk, in Kaluga Province about 100 miles southwest of Moscow, the birthplace of the peaceful atom in 1954 with a modest 5,000 kW reactor first contributing electricity for a civilian grid. This reactor produced steam heat for Obninsk until a few years ago, with the occasional water leak in the reactor hall quickly sopped up by babushki armed with mops and pails. Physicists hoped to have the TES-3 operational in time to ship to Brussels for the 1958 World's Fair, but they decided against it. An Obninsk physicist told me with a light smile, "We were worried about irradiating the Queen of Belgium." Still, the atom figured mightily in Soviet exhibitions at the Fair.

The organizers of the U.S. exhibit at Brussels on the theme "Unfinished Business" planned to include several panels on desegregation. This infuriated southern congressmen, who cut funding for the budget, and the Soviets gladly took over the freed-up area in the International Science Exposition to expand their displays of achievements both in space—*Sputnik* had shocked the world in 1957—and with the peaceful atom. Combining cosmic and atomic hubris, the Soviets ultimately launched over thirty nuclear-powered satellites, most of which are still in orbit, but two of which fell to earth, one breaking up over Canada, the other over Australia, spreading radioactive debris over hundreds of square miles. The advantage of the nuclear satellites was energy levels dozens of times higher than possible with solar panels. The disadvantage was the possibility of the spread of radioactivity throughout the environment if the rocket blew up on launch or if the satellite fell to earth.

Beyond space reactors and submarines, the prototype for floating reactors was the *Lenin*, a nuclear icebreaker launched in 1958. Dry-docked in Murmansk, it will soon be moved closer to the town center to serve as a museum and information center to remind citizens of their great nuclear heritage. The *Lenin*'s elegant interior of polished wood handrails, door frames, cabinets, and library and its sauna, pool, dining room, cafeteria, and elegant quarters for sailors—as in submarines, the quarters had to calm sailors who might be onboard for months without respite—suggested the domestication of the peaceful atom. Yet the aesthetics and craftsmanship did not extend to the reactor itself. On two occasions, after refueling, the authorities ordered the jettisoning of the reactor vessel into the Arctic Ocean for disposal, an act that gave rise to an apocryphal story that a reactor had melted down, burned through the hull of the vessel, and deposited itself on the ocean floor. Engineers subsequently deployed floating reactors in a half-dozen freighters and icebreakers to serve the northern sea route from Murmansk and Arkhangelsk and Norilsk to Dudinka and Vladivostok. To meet local energy shortfalls and keep soldiers and workers busy, in 1997 engineers proposed using the idle nuclear cruiser *Ural* with two 170 MW reactors to supply the Kamchatka Peninsula, which faced an unusually cruel winter and economic depression.

Kurchatov Institute engineers still share the atomic father's certainty that nuclear power is the power of the north. One engineer commented as follows:

> All of our vast [natural] resources get very expensive as soon as we start developing them with the use of gas and masut [black oil] technologies. I have traveled the North and I have seen lots of desolated villages and empty casks, while, for example, in Bilibino, I have seen greenhouses with tomatoes and cucumbers. I believe that in the nuclear power sector we must build whatever will give us some energy, otherwise, we will face a terrible fuel crisis. We may use not only KLT-40 but even smaller plants, for example, on Kamchatka . . . Nuclear energy is so effective that it allows us to forget about waste for 15–30 years and we get relaxed. I am very happy that we are building something. Of course, we could have cheaper projects but this is the only thing we can build for the time being. Floating [reactors have] excellent export prospects but I hope that the for-export plants will be less expensive.[33]

Nuclear engineers in the United States entertained similarly fantastic visions for nuclear engines. Lyell Borst, who moved from Oak Ridge National Laboratory to the University of Utah to Brookhaven National Laboratory, and his research team received tens of millions of dollars from the Atomic Energy Commission to design a nuclear locomotive that could run for a year without refueling. Military researchers and their private contractors spent billions of dollars to develop nuclear rocket ships and airplanes, the latter to stay aloft and safe from Soviet attack for months at a time.[34] The challenges of excessive weight, strength of the landing gear and wings, shielding of pilots against radiation, and fear that a reactor might crash into someone's backyard eventually derailed the program, but not before Air Force brass suggested using less shielding, to lighten the jet, and compensated by raising the level of exposure to radiation considered safe for airmen and shortening tours of airborne duty. Physicists at the Idaho Reactor Testing Station conceived of several experiments to test the viability of atomic jets: they loaded reactors—not operating—onto planes and flew them over the state to gauge the safety of takeoff and landing. The United States also built one commercial nuclear ship, USS *Savannah*, but abandoned it as costly, dangerous to bring into populated harbors in case of an accident, and of uncertain value.

Nuclear Renewal—and Nuclear Waste—in the Twenty-First Century

Kurchatov's dreams of a peaceful domesticated atom in the form of a truly mobile reactor may soon be realized, half a century later, in the boatyards of Sevmash, the Northern Shipbuilding Enterprise, in Severodvinsk. Sevmash, one of five major nuclear shipbuilding yards in Russia dating to the cold war, occupies 750 acres or 1.25 square miles, consists of 100 departments, and employs 25,000 workers. It manufactures household furniture, veneer and solid wood cabinets, windows and doors made mostly from pine, and yachts. Sevmash produced 45 surface ships, 163 submarines (of which 128 were nuclear), 100 tugboats, pontoons, barges, and fishing vessels. With the nearby Zvezdochka shipyard, itself a massive facility, Sevmash now dismantles nuclear submarines and handles the removal, storage, and disposal of spent fuel and the reactor vessel as part of the START agreement to reduce the number of strategic nuclear weapons.

Simultaneously building down from the cold war and building up peaceful nuclear applications, the headlong rush into floating reactors and other such twenty-first-century nuclear technologies ignores persistent perils, one of which is the legacy of nuclear waste dating to the dawn of the nuclear age, which challenges all of the nuclear powers, especially the United States and Russia, to find solutions. Specialists at the Bellona Foundation in Norway have calculated that the majority of Russia's waste is military in origin, consisting of 177 million tons of ore, work clothes, lab equipment, packaging, building materials, and so on, some 158 million tons of which is uranium tailings held in 274 different facilities, 50 percent of which are still in operation, and only 70 percent of which are securely shielded from the environment; and 465 million cubic meters of liquid radioactive waste at ninety-seven shallow lakes and ponds with a surface area of nearly 50 square miles, enough to cover a major city, and another 50 million cubic meters safely isolated—or one ton of solid waste and two and a half cubic meters of liquid radioactive waste for each Russian citizen.[35]

High- and low-level, liquid and solid radioactive waste accumulated in astounding quantities in connection with the complex effort to separate the fissile and non-fissile isotopes of uranium from each other, which differ in weight only by the number of neutrons in each nucleus, a process that uses massive industrial facilities and employs thousands of electromagnets, filters, and centrifuges arranged in series that stretch miles in length. The formerly secret facilities initially served as icons of technological achievement but now symbolize the mundane industrial processes of serial production of weapons of mass destruction and grave environmental costs: Oak Ridge, Tennessee; Puducah, Kentucky; Krasnoiarsk and Tomsk, Russia; and many others. Another source of the fissile material used in nuclear bombs is plutonium production reactors that harness a chain reaction to transmute the non-fissile isotope of uranium into fissile plutonium. The fuel rods are then moved from the production reactors to concrete canyons where acids attack the steel alloy cladding of the rods, and the plutonium is separated from the dangerous brew of radioisotopes and steel. The first production reactors, many of which operated until the 1980s in the United States and 1990s in Russia, used "once through" cooling: engineers simply pumped water from a nearby river into the reactor, to tame the high temperatures of the chain reaction in the core, and poured the warm, radioactive effluent back into the river. The reason for these simple designs was to maximize production and lower costs. The engineers postponed any determination to handle waste properly, storing it temporarily in tanks and ponds that began to leach radioactivity into the groundwater almost immediately and has continued to do so for the past fifty years.

The most notorious of these facilities are the Maiak plant in Cheliabinsk (now Ozersk), Russia, and the plant in Hanford, Washington. At Maiak, phenomenal levels of radioactivity leaked into the environment, and at least two major accidents spread waste over thousands of square miles and required the evacuation of thousands of residents (see chapter 5), although Rosatom officials today minimize the risk. Radioisotopes from Hanford have entered the Columbia River, and Indians who rely on salmon for their diet have ingested isotopes with them. The Bush administration cut funding for cleanup at Hanford by hundreds of millions of dollars, seeing the necessary process of cleanup as too costly and not as pressing as Washington State residents do, and proposing further hundred million dollar cuts in post-Bush budgets.[36]

The disposition of spent fuel in Russia similarly remains an unsolved problem, but with an added twist: in 2001 the Russian parliament passed at his urging, and President Putin signed, legislation enabling Rosatom to import spent nuclear fuel. Ministry personnel estimated that receipts might top $30 billion, which they would apply to the tasks of upgrading safety, inventory, and control systems, and especially toward remediation of the frightening legacy of nuclear waste. The Russian waste program permits used fuel rods from nuclear power stations in fourteen countries in Europe and Asia to be imported for storage, but not permanent disposal, and returned after fifty years. About 14,000 tons of an estimated 200,000 tons of the world's used fuel rods are currently stored in Russia; Russia might import another 20,000 tons of waste. About $10 billion of the $30 billion revenue expected over the next ten years has been earmarked for "special ecological programs for the rehabilitation of radioactively polluted regions," according to the bill. The remaining $21 billion, a vast sum considering that Russia's 2001 federal budget totaled $60 billion, will be considered a general source of funds, but many observers believe that it will likely be used by Rosatom to retool and embark on an aggressive new nuclear power program. Further, $10 billion is wholly inadequate to clean up the Soviet Union's nuclear legacy or ensure safety in planned reactors. And since building a single reactor—based on current French experience—costs more than $5 billion, there is ample reason to anticipate that MinAtom officials will seek to divert funds from cleanup to construction.[37] Import has begun, although at a level much lower than anticipated.

At stations in Russia and elsewhere so-called temporary storage facilities for spent fuel rods are full or nearly full, with the rods stored both in basins of borated water, to keep them stable and cool, and increasingly in steel-lined concrete casks (dry cask storage) above ground. Whether in basins or in dry casks above ground, the fuel assemblies make inviting targets for terrorists. Russia's pressurized water reactors produce 39 tons annually, and its Chernobyl-type reactors produce almost 60 tons annually. In all, by 2030 there may be 50,000 tons of spent nuclear fuel in Russia, virtually all in temporary storage facilities at reactor sites.[38] Given the presence of thousands of these rods in temporary storage, is Rosatom prepared to import more?

The uncertainties facing nuclear renewal in Russia should remind us that those uncertainties face other nations. In the United States, spent fuel—60,000 tons of it—has accumulated at over 100 nuclear power plants across the nation, currently at 2,000 tons annually; 161 million Americans live within 75 miles of one of these sites. Stored in basins and in concrete casks spread across huge parking lots above ground, the fuel serves as a reminder of the failure of engineers to manage waste safely. At the recently decommissioned Maine Yankee power station,[39] located on a scenic inlet of the Sheepscot River, two miles from the Atlantic Ocean, and just outside of Wiscassett, the self-proclaimed "prettiest little town in Maine," one such lot sits in the open sky under the constant watch of armed guards, surrounded by a fence, surveilled by cameras. The reactor vessel, the jackhammered reinforced concrete from the distinctive dome, and other building materials were loaded onto a barge and shipped to Barnwell, South Carolina, for burial several years ago, but the fuel remains, waiting for a repository to open, the vigilant guards ably monitoring the casks twenty-four hours a day, as I discovered when I took the wrong turn out of the plant after a site visit and found myself meekly facing assault rifles. On an August day, tourist traffic backs up for miles in each direction along Route 1 through Wiscassett, vulnerable should an accident involving a small plane or a terrorist attack rupture casks and eject radioactive debris into the environs. Soon there will be fifty such nuclear fuel parking lots in the United States.

In 2005 the National Academy of Sciences in Washington, D.C., released a report criticizing the U.S. Nuclear Regulatory Commission and nuclear industry for inadequate attention to the danger of terrorist attack, especially on the spent fuel, whether in casks or in basins. The report took issue with Bush administration contentions that the pools were safe, as well as with the decision of the NRC to classify sections of the report allegedly for security reasons, but in fact to prevent publication of sections of the report that pointed out the dangers, a conclusion that differed with the administration's pro-nuclear stance.[40]

Spent nuclear fuel has overwhelmed power plants throughout European Russia as well. The Leningrad Atomic Energy Station (LAES) in Sosnovy Bor, a town of 60,000 inhabitants created to serve four Chernobyl-type reactors in the 1960s, suggests the worn metaphor of the machine in the garden. The reactors sit among pine trees, together with 25,000 spent fuel rods, some fifteen to twenty-five years old, whose zirconium cladding has begun to corrode, in basins a stone's throw from the Gulf of Finland, with its currents and tides leading to the Baltic and Scandinavian states. Station managers have elected therefore to build carbon dioxide–cooled dry concrete casks for above-ground storage of spent fuel such as those becoming standard as pools fill up at nuclear reactors in the United States. This will require removing the fuel rods from the pools and cutting them to size to fit in the casks. Sawing the rods into pieces could create severe environmental and safety problems. Sergei Kharitonov, a former LAES employee who worked in building 428, the site of the cooling pools, said, "Sawing these rods will release two decades of contamination." He continued, "These things contain uranium 235 and 238 and weapons grade plutonium. If handled improperly, it could be a catastrophe. It possesses dangers to the workers themselves, and an ecological emergency for the surrounding area."[41]

The LAES was the first Chernobyl-type reactor; Chernobyl was considered the best operating and most modern RBMK facility until the disastrous explosion of April 1986. At LAES construction began in 1967; unit 1 came on line in 1973 and unit 2 in 1975. The two newest reactors, which were brought into operation in 1979 and 1981, are second-generation RBMK-1000 (megawatt electric) reactors, considered safer than the first-generation reactors, but still of the Chernobyl design. Each RBMK-1000 has 1,661 fuel assemblies that consist of eighteen fuel pins containing uranium enriched to 2.4 percent. The RMBK has the advantage that when fuel assemblies fail, or in order to refuel, the operation can be conducted without shutting down the reactor. These reactors were used for the production of plutonium for nuclear weapons in the Soviet Union.

LAES station director, Mikhail Orlov, announced in November 2001 that the service life of the first and second units of the Leningrad nuclear power plant could be extended for a decade without any safety risk. Work has already begun to upgrade safety; $700 million was to have been invested by 2005,[42] but I can find no confirmation of such an investment. Around the world, nuclear power station operators and owners have asked to extend operating licenses decades beyond the initial estimates of station lifetimes. The tremendous operating temperatures and pressures in reactors and the influence of radioactivity on the brittleness, creep, and other qualities of reactor materials and components suggest that regulators ought to approve extension, if at all, only in rare circumstances. LAES officials then announced plans to build more reactors at the site, both to expand production and to benefit the town and its workers. This has upset Russian environmentalists and the European community. EU countries have asked Russia to close reactors 1 and 2, considering them unsafe. Leningrad's unit 3 was retrofitted but has had several incidents, accidents, and outages since the upgrades. The station continues to plug along into the twenty-first century, while emergency shutdowns become standard affairs.[43]

The decision to build more stations or prolong the life of existing ones will exacerbate a problem with spent fuel. Spent fuel accumulates everywhere—in Russia, in France, in England, in the United States. Only 60 miles southwest of St. Petersburg and its 5 million residents, the worn reactors should have been shut down years ago, but operating licenses have been extended, while plans to build at least four new reactors, one at a time to replace them, move ahead.

If You Build Them, Where Will the Waste Go?

Are floating reactors a viable technology, or do they suggest the need to be certain of the true costs of nuclear renewal before moving ahead? Engineers and other enthusiasts of a nuclear twenty-first century claim today, as they have for fifty years, that nuclear energy will solve problems of tightness in fossil fuel markets. They point out that, in contrast to fossil fuel plants, reactors do not contribute to global warming and do not emit particulate or pollutants into the atmosphere that contribute to heart and lung disease. They assert that they have solved the problems of nuclear safety and cost, perhaps not making energy "too cheap to meter," as they claimed in the 1950s, but designing inherently stable reactors and getting close to solving the critical problem of committing nuclear waste to safe burial. Yet American and Russian plants suffer from the same challenges of safe operation: siting close to major population centers, premature aging of facilities under the action of high temperatures and radiation "creep," the potential of a catastrophic meltdown or explosion that endangers hundreds of thousands if not millions of nearby residents, and growing quantities of waste.

Many specialists believe that cleanup and safe storage of military and civilian waste must proceed with adequate funding before nuclear mavens add additional waste to already overburdened facilities, not to mention before building more reactors and producing more fuel. The halting effort of the United States to identify a permanent state-of-the-art waste repository—billions of dollars have been expended on a yet-to-open facility at Yucca Mountain, Nevada, 60 miles from Las Vegas—indicates that extensive uncertainties plague the nuclear industry, even as presidents and engineers assure the public that limited national resources ought to be spent on floating reactors, and that reactors will free nations from dependence on foreign oil. Although required by federal law—and by common sense—the design and construction of a resting place for such waste as spent fuel rods have been waylaid by legal, environmental, and political concerns.[44] In 1982, the U.S. Congress passed legislation to require the Department of Energy to open a waste repository by 1989. Congress stipulated that sites east and west of the Mississippi River be evaluated to ensure fairness in the process, although from the start it was likely that the requirement that a dry, seismically stable site be found meant that a western state would be chosen. Soon, coalitions of congressmen and congresswomen from the northeast and southeast and election politics conspired to leave only western states under consideration. Energy officials focused on Hanford, Washington; Deaf Smith County, Texas; and Yucca Mountain, the last designated by law in 1987, with the president to make the choice final and binding after completion of detailed studies.

Over twenty years, Department of Energy officials produced mounds of evidence for public comment, and they hoped for confirmation of Yucca Mountain, even as they confidently tunneled into the mountain. During a recent tour of the facility, I was impressed by the skill that engineers had demonstrated in drilling into the ground. Yet both Nevada and some Department of Energy officials have now questioned the choice of Yucca Mountain, considering it unsafe and an unfair burden on Nevada, which has no reactors. First, the region has a high level of seismic activity.[45] In addition, government scientists may have falsified data on rate of water infiltration at the Yucca site, while Yucca's main contractor, Bechtel, overestimated the ability to isolate nuclear waste in engineered containers.[46] Yet another challenge to safe operation is the transport of 70,000 tons of spent fuel across forty-four states to Yucca Mountain, passing within a half mile of 50 million Americans, through some 703 counties with a total population of 123 million people—over 100,000 shipments in all over three decades, eight every day, mostly by truck.[47] Storage casks have been designed to travel well on flatbed trucks and railway cars, past unknowing residents on the way to permanent storage, perhaps to a repository in Nevada. The manufacturers and officials of the federal Nuclear Regulatory Commission assure us that the casks are long lived and, when entombed for transit, able to withstand a crash, derailment, or an explosion. Yet, given daily automobile and truck accidents and frequent train derailments with chlorine and other volatile chemicals that often require nearby residents to be evacuated, these tens of thousands of trips of nuclear fuel heading for a yet-to-be-opened repository should raise red flags.

Not long ago I sat in the office of the Mayor of Severodvinsk, Alexander Beliaev, a friend; a man devoted to the welfare of his clean, orderly city, much cleaner than other Russian cities; and a man unruffled by the now mundane task of removal of nuclear fuel from submarines and its temporary storage within city limits. Although their population has dropped from 250,000 to 200,000 inhabitants owing to a mass exodus of residents since the fall of the USSR, Severodvinskians remain proud of their nuclear heritage, the submarines they built, the submarines they decommission as part of arms agreements with the United States, the spent fuel they handle within city limits, and the furniture and floating reactors they hope to build. Perhaps one-quarter of residents are pensioners, another quarter children, and the shipbuilding industry remains vital to supporting all of them. Beliaev has often visited the United States, including Portsmouth, New Hampshire, Severodvinsk's sister city, site of a naval facility with an equally glorious past and waste whose future remains uncertain, where 133 submarines were built, and whose older residents still mourn the loss of the USS *Thresher* off the coast in 1963 with all 129 men on board lost. The P/S Connection, a citizens group that promotes cultural, educational, art, and business exchanges and promotes discussion of the cold war legacy, works diligently to raise awareness of the environmental costs of the nuclear age. But beyond its official registration as an NGO with the Russian Department of Justice, the P/S Connection remains a temporal entity whose American members must always gain approval of the Federal Security Service (FSB), the inheritor of the KGB, to enter Severodvinsk, and whose Russian members are inclined by local circumstances to favor the construction of PAES for the jobs and electricity they bring.

In the thinking of officials from Rosatom, town fathers of Severodvinsk, engineers at Sevmash, workers at the plant, and federal officials up to former President Putin, floating reactors symbolize the crucial confluence of a glorious indigenous engineering tradition, the continued presence of Russia as a great power—not because of the sale of natural resources but because of its pioneering achievements in space, nuclear energy, and other fields of big science—and the need to keep an entire closed city gainfully employed.

To promote their plans, they have calculated nuclear electrical energy costs at 25–40 percent lower than a fossil fuel station. This ignores the significant cost overruns, which are typical for nuclear power facilities of any nation, and construction time, which is always three to five years longer than estimated if the past is any judge, even if they succeed at standardizing reactor designs and construction practices. Promoters stress the "tax benefits" of the station in new homes, stores, and kindergartens that will be built. They point out how employees will be trained at the local technical university, and that other regional higher educational institutions will open new departments to train them.[48]

The Russian and American presidents and their closest advisors generally tout nuclear power as a panacea for the world's energy problems. Yet awareness and criticism of the rejuvenated programs remain muted and dangerously un-informed, in Russia because of the government crackdown on independent expertise, the emasculation of the federal environmental protection service, and weakening of the nuclear inspection agency, in the United States because of fear of overreliance on fossil fuels, and in both countries because of continued engineering hubris, out-of-hand dismissal of public concerns, and the nuclear tradition of underestimating costs and obstacles and overvaluing benefits. Costs and duration of reactor construction have not declined even as standard components and techniques have been introduced, but rather have increased as engineers have encountered new and unexpected challenges regarding safety, stability, repair, and aging of facilities at each step.

When promoters of floating reactors and other vulnerable technologies sanguinely dismiss those public concerns, they ought to consider the warning of one of their own leaders, a founder of reactor technology in the USSR, the engineer Nikolai Dollezhal. In 1981, in a prescient article published in the Communist Party's leading theoretical journal, *Kommunist*, Dollezhal warned that the Soviet nuclear energy industry should no longer build stations with scores of reactors located close to major cities, with fuel assemblies and spent fuel moving in and out, past children and mothers, stores and schools, with great uncertainties surrounding safe evacuation in case of an accident—as Three Mile Island and Chernobyl demonstrated, not to mention Katrina and New Orleans, with hundreds of thousands of people trapped behind even though they had three days of warnings to evacuate, not the fifteen minutes one might have in the case of a nuclear accident. Or, consider floating and submersible devices that have sunk in high seas and low, nuclear and not—the *Titanic*, the *Thresher*, the *Kursk*. The *Kursk*, at 508 feet long, capable of holding twenty-four nuclear missiles, the largest attack submarine ever built, launched in 1994 out of Severodvinsk, sank to the bottom of the Arctic Ocean in 2002, carrying 118 men and two OK650B reactors, each at 190 MW.

Nuclear power may be viable if the public is openly involved in its development, in decisions about where and when to build reactors, and in evaluation of costs. Those costs will include higher than estimated transmission charges to account for siting far from population centers; the claiming of vast areas to ensure huge exclusion zones; additional layers of human, physical, and electronic protection against the risks of terror and accidents; decommissioning; insurance indemnification paid by utilities and owners, not subsidized by governments; safe transport and storage of radioactive waste of all sorts; modernization of unshielded facilities; and cleanup of extensive regions of pollution. The first PAES will be floated out of Sevmash dry docks into the White Sea to serve Severodvinsk in the near future, with a dozen more to be built in the next decade to be moored in bays, estuaries, tidal basins, and inlets around the world, producing electrical energy and heat, perhaps desalinating water, and serving as an inviting target for natural and terrorist disaster. If there were a serious accident at the first PAES, how many of the residents of Severodvinsk would be able to escape exposure to radiation as they fled along the two-lane road to Arhhangelsk, and when might they return home?

Masabikh Akhunov (1928–2008), “Roads,” 1969, linocut. Planners and builders imposed a Cartesian grid of roads, railroads, factories, and cities over the socialist countryside with the goal of making nature itself—and its rivers, streams, and forests—function according to plan. They disposed of waste haphazardly, assuming that economic production was more important than weakness before nature. The environmental costs of this approach will be felt in many regions for decades to come. Courtesy of the Allan Gamborg Gallery, Moscow, Russia.

CHAPTER FIVE

INDUSTRIAL DESERTS

Technology and Environmental Degradation under Socialism

A few years ago I persuaded the MIT library to bring the leading journal of the Soviet State Committee for the Construction Industry, *Beton i Zhelezobeton* (*Concrete and Reinforced Concrete*), to my office for a semester. I told the repository librarians that I needed to peruse the last forty years but did not have a specific volume in mind. Since no one to their knowledge had taken out one volume, let alone forty years of them, they happily delivered it to me. I sought articles on the use of concrete in the nuclear industry to verify accounts that engineers had conducted detailed studies of how much they might water down concrete (to save resources) and still use the versatile stuff in nuclear power stations. If used in construction near the reactor vessel, would it withstand the high temperatures, pressure, and radiation? They determined that they might indeed cut costs by modest additions of water; after all, water is a good moderator of neutrons. In the process of leafing through *Beton i Zhelezobeton*, I gained a good sense of the highly centralized construction industry, particularly the universal specifications that Moscow-based engineers and officials adopted for construction of apartments, factories, roads, and, yes, nuclear power stations. Engineers penned scintillating articles on the heroic march forward of the concrete industry; provided hyperbolic discussions of thousands upon thousands of cubic meters of concrete, growing by monthly and yearly targets, poured in hydroelectric power stations, nuclear reactors, and other massive objects; and touted the glorious development of prefabricated concrete forms as the foundation of a modern, automated, mechanized construction industry. The civil engineers, architects, and other specialists reveled in economies of scale, the pursuit of standardization, and mass production and poured concrete far and wide across the landscape.[1]

Not surprisingly, as the previous chapters have explored, in this fascination with large-scale technological systems as the most rational and efficient means to an end—in this case, the creation of a modern industry based on efficiencies of production and ease of assembly—Soviet construction engineers shared a great deal with their European and North American counterparts.

Socialist engineers founded and modernized a series of important industries in the effort to control and exploit natural resources, as part of the process of the transformation of nature and the people in it into socialist entities. The goal to tame nature to benefit society grew out of Enlightenment ideas of the ability and desirability to improve on nature's gifts through the application of scientific understandings. The state occupied a central position in the diffusion of technology toward these ends. It supported the development of science directly and indirectly, through army engineers, research institutes, commercial road building programs, ministries that tabulated the extent of resources, and so on; financially and legally through budgets, laws, regulations, and statutes; and ideologically in the views of leaders and citizens alike that dams, canals, railroads, electrical power systems, reactors, and rocket ships confirmed the legitimacy of the system—capitalist or socialist—and its leaders. In both systems, officials, specialists, and planners viewed nature as a commodity machine, and planners adopted large-scale approaches to transform nature in the goal of producing various commodities quickly and cheaply. Governments, banking interests, research institutes, scientists, engineers, and industry joined forces to create the modern factory, at the same time turning nature into a machine.[2] They engaged in what might be called geoengineering—projects of massive scale to convert "useless" nature through reclamation projects, hydroelectric dams, and irrigation systems to ensure that water did its "duty" before flowing uselessly away to the oceans and seas.[3]

Socialist and capitalist engineers shared enthusiasm for projects of great scale. They saw technology as a panacea for various economic, production, and even social and political problems. Many of them believed that technology, as some kind of value-neutral artifact, could be applied willy-nilly to such political conundrums as how to ensure access to resources for present and future generations, how to organize the shop floor (essentially, Taylorism), or how best to employ available but limited capital and labor inputs. Their unbounded visions extended in the socialist case, as we have seen, from the city to the countryside and forest. Technologies of transport and communication would end the backwardness of the countryside overnight, transform the peasant into a modern citizen, and end backbreaking labor.

Another similarity of socialist and capitalist systems involved ideological justifications. The large-scale design of technological systems represented conscious choices of officials and engineers to adopt designs that demonstrated visually the power of the state and the power of science. Scale served to demonstrate the ideological significance of technology and simultaneously confirmed the superiority of the economic and political system. Hydroelectric power stations, railways, canals, and space programs generate legitimacy for political systems. Leaders in capitalist and socialist systems claim that the large-scale technological systems serve "democracy," whether the proletarian democracy of the Kuibyshev Hydroelectric Power Station or the American democracy of the Grand Coulee Dam. For New Dealers, the Tennessee Valley Authority was "grass roots democracy."

While England, Germany, and the United States engaged the industrial revolution in the nineteenth century, scores of other nations pursued rapid industrialization in the twentieth century. After World War I the Soviet Union, and after World War II the socialist camp generally, pursued rapid modernization in implicit and explicit competition with the capitalist world—in particular with the United States. Even in competition, however, the leaders of the socialist East European nations, North Korea, and Cuba borrowed liberally from the technological experience of the capitalist nations, although relying heavily on the USSR. And like in the capitalist West, their geoengineering and other projects acquired significant momentum. Even when costs got out of hand or environmental damage became clear, the engineers and construction firms moved forward, always assuming that they would discover solutions to the problems of their own technological making, for example, vast quantities of radioactive waste, areas of desertification and "dust bowls" in the Plains states and in southern Africa, clear-cut forests, and so on. For all these reasons the irreversibility of projects once started and their significant environmental costs appear to be universal attributes of twentieth-century technologies irrespective of political system.

As challenging to our preconceptions as these similarities may be, the differences between the way that socialist and capitalist nations pursued, invented, developed, diffused, and applied technology may be more compelling still, and they may help us understand the great environmental degradation under socialism. First, in many of these ways—hubris of engineers, scale of projects, and ideological significance—the socialist nations embraced big technology with a verve and energy unrivaled in the West. Whether Stalin's plan to transform nature, Kim Il Sung's great tunnels, or entire hero cities of industry throughout East Central Europe, these technological systems went forward without pause, nature and the people in it be damned. If the Americans poured cubic yards of concrete at Grand Coulee Dam, then Soviet workers would pour even more cubic meters of the stuff at the thirteen hydroelectric power stations on the Volga River. While nuclear engineers in the United States commercialized atomic energy with pressurized water reactors (PWRs), Soviet engineers built the inherently unstable channel-graphite "RBMK" reactor infamous for Chernobyl in larger and larger units, and the first two generations of Soviet PWRs lacked containment vessels as a hedge against an explosion or meltdown. While the naked pursuit of profit and mechanization of agriculture gave Americans the Dust Bowl, in North Korea and the USSR collectivization of agriculture has led to famine and millions of deaths.

Second, engineers and planners pushed the development of technology while rarely considering consumer preference. Indeed, a feature of centrally planned economies is to rely strictly on planners' preferences to determine product mix and quantity, and further to emphasize production norms to the detriment of environmental considerations. Consumer goods, housing, light industry, and so on, lagged in development, although the socialist nations surely had the engineering skills to pursue these products and technologies. In the Khrushchev era, the proliferation of such journals as *Gigiena i Sanitariia* (*Public Health and Sanitation*) and *Voprosy Pitaniia* (*Problems of Food Science*) indicated an effort to pay more attention to the workers' well-being. But, as a rule, the citizen or consumer had virtually no input into engineering decisions through any kind of institutionalized technology assessment process; the worker, peasant, and white collar bureaucrat all were less important than the machine. In the capitalist democracies, increasing public access to the policy process, including technology assessment (TA), characterized the second half of the twentieth century. Through public interest science, non-governmental organizations (NGOs), and the individual litigant, citizens often intervene in the TA process, leading usually to technological systems that are more efficient, cleaner, and safer to operate.[4]

Third, socialist organizations and projects acquired nearly unstoppable momentum. They built massive construction trusts to achieve the ends of reworking nature. They moved inevitably forward through the forest, across the steppe, and into the tundra, rarely slowing, for two reasons. One was, again, the absence of public opposition to the projects. In the second place, the absence of market mechanisms also meant that the state was responsible for employment—full employment. Even before one project had been completed, the ministry, construction trust, or institute responsible for it would secure approval for another massive project to ensure that workers stayed busy, whereas at the end of a project in a market economy the workers would lose their jobs. Socialist organizations morphed inevitably from one narrowly focused geoengineering firm into another and another, each one acquiring tens of thousands of employees, and shedding them as still another geoengineering firm was formed from it. For perhaps the best example, Metrostroi, the organization responsible for building the Moscow metro founded in 1931, shed a division to create Kuibyshevgestroi in the 1940s, which built the Kuibyshev and other hydroelectric power stations along the Volga River. (It was joined with Kuibyshevstroi, a gulag construction organization created in 1937.) Kuibyshevgestroi grew to 70,000 employees and then formed a division for construction of power stations on the Angara River in Siberia, Angarastroi; Angarastroi grew from 5,000 employees in 1952 to 70,000 by 1958, as the massive firm pushed across Siberia building factories, cities, and power stations.

Finally, the central role of slave labor in the diffusion of technology under socialism, especially in the Soviet Union, China, and North Korea, signals a major difference with the experience of capitalist nations and a reason for the great human and environmental costs. From the early 1930s onward the Soviet secret police operated a system of labor camps (the infamous Gulag) filled with hundreds of thousands of innocent political prisoners, peasants suspected of being kulaks, minority nationalities, and others who were forced to develop resources in the most inhospitable regions of the empire. The prisoners built canals and dams; mined gold in Kolyma in the Far East; dug coal and other ore in the permafrost near Vorkuta; established forestry enterprises that operated on human and animal power, not machinery; and built tens of thousands of kilometers of power lines, roads, and railroads—all on meager rations, inadequate medical care, and miserable housing. Leaders saw the slave labor system as economically advantageous and crucial to the process of imposing technologies of transport, communications, mining, and processing over the tundra and taiga, while simultaneously providing a vehicle to reeducate and retrain recalcitrant bourgeois sympathizers, Trotskyites, and other recidivists. Granted, we must not ignore the tradition of prison labor under capitalism. Every county in the rural southern penal system of the United States employed prisoners, primarily African Americans, in forced hard labor precisely to establish the preconditions for modern industry: building roads, working mines, and raising rice, tobacco, and cotton, while receiving a pittance wage. Wardens also touted the role of hard labor in reeducation of criminals.[5]

On some levels, we would expect the socialist system to ensure greater attention to environmental issues. After all, the state served and protected the interests of the worker. Collective ownership of the means of production ensured that those interests were served, while under capitalism each landlord and capitalist would seek to maximize profit and resource exploitation with insufficient attention to the needs of others. The trap here was that the authoritarian socialist state differed from its capitalist counterpart in the essentially unlimited power it acquired to change the economy, society, and natural environment. Socialist leaders had no doubt that power generation, transport, communications, industrial production, and other technologies that they unquestioningly applied to the agrarian world would transform the landscape and the people in it. Socialist engineers willingly engaged the opportunity to embark on large-scale projects. They believed that they would make up for a lag in economic performance and technology in a relatively short time when not handicapped by legal, regulatory, and other obstacles that persisted in "irrational" capitalism. Together, the engineers and leaders welcomed the availability of armies of workers who might be conscripted to new projects everywhere without the uncertainties of market mechanisms interfering, and without the nuisance of public protest that projects went too far. Without economic, legal, or moral constraints, what limited environmental degradation?

Soviet economic development policies led to the formation of industrial deserts, but to date few analysts have considered what was specifically Soviet in promoting such extensive environmental degradation and such callous disregard for people and nature. Historians have studied the efforts of Soviet ecologists, environmentalists, and other specialists to limit this devastation of land and seas and of the humans and wildlife that inhabited them. They have considered the uniquely Soviet techniques for forcing the pace of resource development that contributed to the great social and environmental costs of living in the former USSR. Others have examined the development of regulatory frameworks, the failure of Communist Party officials to enforce laws, and the role of writers, scientists, and ordinary citizens to protect at least some of the great natural beauty of the USSR, for example, Lake Baikal.[6]

Soviet leaders claimed that they would industrialize in one generation, not the three or four needed in the West, leading to great savings in resource use. They argued that planning would ensure rational processes with lower costs and higher efficiencies than in the West. They claimed that industrialization would serve the worker, not the capitalist master. They admonished the worker to industrialize in one generation because of pressing dangers: hostile capitalist powers surrounded the USSR and would attack it, so the USSR needed to become an industrial fortress. But in this effort output of heavy industry was the basis of rationality, and any individual who suggested a more measured approach faced attack as a wrecker. With this mind-set, planners came to see capricious nature itself as an obstacle to industrialization plans. Nowhere was the war on nature more violent than in Perm, Cheliabinsk, and Sverdlovsk Provinces in the Ural Mountain region so rich in ore, minerals, coal, and oil that fed hungry, ever-burgeoning chemical, metallurgical, and nuclear industries.

The result was the development of technologies that employed rudimentary safety and pollution control systems. Workers' safety inspectorates had weak investigative, enforcement, and punishment powers. The worker and peasant of Eastern Europe, the Soviet Union, North Korea, and China paid for industrial development with their health and safety even more than those in Manchester, England; Lowell, Massachusetts; or other sites of the industrial revolution. By the last decade of Soviet power, an increasing number of specialists had become active in the technology assessment process and contributed to relatively open discussion of crucial resource management and environmental issues,[7] but extensive and in many cases irreversible damage had been done. The epitome of these human and ecological disruptions wrought by these construction trusts, smelters, and other factories, mines, and dams were industrial deserts that formed in the Ural Mountain region.

Industrial Deserts

From Perm to Nizhnii Tagil, from Sverdlovsk to Cheliabinsk to Magnitogorsk, and east to Novokuznetsk and Kemerovo, a vast, toxic rust belt of chemical, metallurgical, and nuclear factories and extractive industries spewed smoke, acid, and poison into the air, water, and land over decades of Soviet power. In Berezniki, a center of potash and fertilizer production, children under fifteen years old were 8 times more likely to suffer from blood diseases than their contemporaries in 121 other badly polluted Soviet urban areas. Nizhnii Tagil is 87 percent industrial plant, the rest housing and stores, and the atmosphere is filled with twice the limit of ammonia and formaldehyde—as are the resident's homes. In Karabash, a foundry dominates a township of 18,000 people, putting out 162,000 tons of soot, sulfur, lead, arsenic, tellurium, and other metals and gases annually.[8] In Magnitogorsk, at one time Joseph Stalin's showcase iron and steel center, one-third of the adults and two-thirds of the children under fourteen years old have suffered from respiratory infections, and birth defects doubled from 1980 to 1990. In 1990 Magnitogorsk still used open-hearth furnaces to produce 16 million tons of steel annually—and 20 tons per capita annually of atmospheric pollutants.[9] Soviet gulag prisoners joined other poorly equipped workers to build thirty-four industrial cities in the Arctic and Subartic regions that poured pollutants into the air and water, notably Norilsk in north central Siberia and Nikel, a smelting enterprise (as its name implies) along the Norwegian border. The authorities forcefully moved indigenous peoples—Yakuts, Nenets, Khanti, and others—away from their homelands to bring the glorious, industrial, socialist utopia to the permafrost. By the end of the Soviet era, life expectancy for males had decreased to fifty-eight years, infant mortality exceeded that for many developing nations, and respiratory, cardiac, and other diseases had become epidemic, in large part because of the Soviet industrialization paradigm.

Of all regions of the former Soviet Union, the southern Ural Mountain region was the most heavily polluted. Each year more than 3 million tons of heavy metal waste entered the atmosphere, or roughly 3 kilograms per person per year. The number of sources of pollution quadrupled between 1975 and 1988, most of them in factories built with rudimentary pollution control equipment. Releases from copper smelting enterprises alone had completely denuded 100,000 hectares of all vegetation. Within the buildings themselves, dangers lurked. For construction materials, they used cement mixed with slag and alkali that found its way into lakes in which Cheliabinsk residents loved to fish. The levels of alkali were 10 to 100 times above norms.[10]

The smoke, dust, runoff, and leaks led to irreversible destruction of flora, erosion, ruining of microclimates, and the formation of what several Soviet scientists euphemistically referred to as "unique geochemical regions." I call them industrial deserts. The archetypical Soviet industrial desert is Cheliabinsk Province in the southern Ural Mountain region.[11] Industrial deserts are human constructs, regions that arose because of the concentration of industry and its unabated pollution. Since land was poisoned by industry, agriculture was pushed into poorer and poorer soils. Agronomists tried to make up for the poor soils with copious applications of chemical pesticides, herbicides, and fertilizers. They did not so much push the land to produce as overwhelm it. Extensive devegetation, the felling of forests without the pretense of reforestation, a decline in wildlife, and the poisoning of land, watercourses, and ground water in a vicious cycle resulted. One scientist could not identify any Ural Mountain ecosystem without significant anthropogenic effects. His studies showed approximately 375 threatened plant species in the Ural region.[12] Perhaps 500,000 hectares in Cheliabinsk Province had become industrial desert by the middle of the 1980s. Another scientist calculated that within fifty years an industrial desert would cover 20 percent of the region.[13] Yet only under Mikhail Gorbachev in the late 1980s could Ural scientists publicly address what was common knowledge of the devastation. One of them wrote, "Cheliabinsk province has become a zone of ecological devastation," a region "degraded" from bottom to top.[14]

The notion of an industrial desert describes well the Ural region and other areas where intense, virtually unregulated industrial activities poisoned waterways, forests, fields, and the cities and towns in which factories are located, and where the workers live close by or soon will live near highly polluting plants that envelop neighborhoods through incessant expansion. A desert, of course, is a rich if fragile tapestry of fauna and flora that has evolved to survive harsh extremes of heat, cold, and aridity. The soils and duracrust appear to be devoid of life, yet vital networks of root systems and microorganisms hold moisture and nutrients in them. So too, industrial deserts reflect a richness of processes and lives that at first glance are lost beneath the overwhelming weight of the killing processes of pollution. Vast environmental degradation results in now empty or at least greatly denuded landscapes in which mountains of slag, mining waste, and heavy metals seem the only distinguishing marks. Green, slowly moving rivers covered with petrochemical films exist seemingly only to wet the thirst of industry. Side by side in cities workers bring life to the factories, although they suffer the health consequences of the production of iron, steel, aluminum, tin, lead, fertilizers, and other chemicals.

Yet lush woods grow nearby, offering solace from industrial processes even if they too have suffered, perhaps irreparably, from pollution. City residents escape to them on the weekends, thinking that they may recuperate from the filth of urban existence. Even if the quality of air and water has improved since the fall of the USSR owing to the collapse of industrial production, the parks, forests, rivers, and ponds in the cities will require decades of remedial effort to recover any semblance of biodiversity. It is this dual meaning of desert—rich biodiversity that belies seeming emptiness—that will enable us to understand what distinguishes environmental degradation in the USSR, not only its scale and ferocity, but the creation of extensive voids or pockets of seeming emptiness, surrounded by cities and factories in which armies of workers struggled to build socialism, yet faced life-threatening conditions of labor and miserably bleak home life. Hence, an industrial desert is a rich tapestry of life at risk in harsh conditions, perhaps more fragile and less diverse than a desert, save for the factories themselves. The concentration of industrial activity, the levels of pollution, the epidemiological indices of a public health crisis, the true devastation—all of these things distinguish industrial deserts from environmentally degraded regions that exist in and around cities across the globe and distinguish Cheliabinsk and Berezniki from London, England; Gary, Indiana; and Dortmund or Bochum, Germany.

Slag heaps dominate the landscape from southwestern Pennsylvania to the Ruhrgebiet in west central Germany to Wales. In each of these areas, grudging efforts at reclamation have taken place. Near Pittsburgh small housing communities dot the slag hills, and brownlands have seen the creation of "permanent woodland vegetation on the steep slopes." In the Ruhrgebiet, officials have created a 750-hectare park for leisure and recreation along the Emscher River based on the Hoheward slag heap, which has already been partially recultivated, but where dumping still continues, and the "already greened Hoppenbruch slag heap" (Europe's largest). In Wales, reclamation of brownlands has even provoked a nostalgic poem to leave the Bersham slag heap as it is "in memory of those who put it there."[15] But in the Ural region, reclamation may never begin, and it is probably fruitless.

The "Forge" of the Soviet Union

The roots of industrial deserts are connected to mining and metallurgical practices that date to the Tsarist era. The Ural region had the oldest mines in Russia, with salt dating to the fifteenth century; iron, copper, and gold somewhat later; and the iron smelting industry dating to the seventeenth century. The region's asbestos, potassium and calcium deposits, magnesium, and manganese, all of them very high quality, were crucial to Tsarist Russia in times of war. The iron industry declined in the second half of the nineteenth century with the technological shift away from charcoal based on local forests to coke and to the new Ukrainian iron and steel industry in the Don Basin. Ural mining and metallurgy had relied on wood power. Wood required rather small furnaces that did not attract capital investment.[16] The denuding of nearby forests to make charcoal contributed to the formation of industrial deserts in later decades. While denuding of forests in England as early as the fifteenth century, in the Ural Mountain region in the nineteenth century, and in many other cases may be a precursor of the formation of industrial deserts, the telling factor is the creation of industry that pollutes air and water so that little will grow.

One reason for the inefficiency of resource utilization was that scientific research in support of the metallurgical industry lagged considerably behind that in Europe and America. The Tsarist government and the scientific community often mistrusted each other, the government fearing the alleged liberalism of the scientists, and the scientists angry over the lack of support given to them, so much so that many went to Germany and France for advanced research and training. Only a significant crisis, World War I, gave impetus to significant cooperative efforts. Unquestionably, most scientists and engineers were patriots who sought ways to help their beloved motherland. In 1915 specialists in the Imperial Academy of Sciences formed a Committee for the Study of the Natural Productive Forces (Kommissiia po izucheniiu estestvennykh proizvoditel'nykh silakh, or KEPS) to identify strategic materials for the war effort and how to manufacture them. KEPS survived the war in several Soviet organizations and acronyms, its efforts to study and tap resources acquiring Bolshevik impatience, Soviet scale, and imperial reach into Siberia and the Far North.

In Marxism, the Bolsheviks embraced an urban, industrial ideology and sought to transform the agrarian nation into an industrial superpower. Soon after seizing power in November 1917, they nationalized leading industries from banking and transport to construction and metallurgy. Because of civil war, the absence of capital, and disruption of transport and markets, rapid economic decline resulted. The Bolsheviks therefore retreated temporarily from the harsh measures of expropriation and nationalization under War Communism in favor of the New Economic Policy (NEP), in which they permitted some private ownership, trade, and a moneyed economy. As elsewhere, this helped the Ural region agriculture, forestry, and leather industries to recover. The government maintained control over fuel, transportation, and credit, and virtually all metallurgy and mining enterprises remained in government hands. Yet heavy industry remained in deep need of investment until the Stalin era because of limited resources and competing interests. Local and regional officials in the Urals lobbied successfully for investment to rebuild a technologically outmoded metallurgical industry that had not seen significant improvements in a century.[17]

When Joseph Stalin took power in the late 1920s, he oversaw a self-proclaimed "Great Break" with past economic, educational, and cultural programs. Stalin was determined to build "socialism in one country" through five-year plans that established superhuman targets for increased production, and he brought about rapid industrialization and collectivization of agriculture, both with extensive human and environmental costs. Toward those ends, Communist Party officials urged scientists and engineers to focus their research efforts on such fields of central importance to rapid economic transformation as metallurgy, solid-state physics, and heat engineering, on electrification and construction industries, on machine-building, and so on. Scientists who stood in the way of the targets for increases in production—those who suggested more modest goals, or worried about the low level of investment into housing, stores, and health care for workers, or already noted excessive resource use—were often accused of sabotage.[18] Many of them were arrested and tried, and a number were imprisoned or shot after such show trials as the Industrial Party affair (see chapter 1).

In agriculture the enemies were kulaks, the village strongmen or perhaps slightly more wealthy peasants, millions of whom were forced into exile and often ended up marching into the Gulag or other slave labor. They were let out of trains in the middle of nowhere, in areas marked only by surveyors' pegs, and left to fend for themselves or forced to build roads, railroads, mines, or mills, even before being allowed to build housing. Many of these kulaks died, as did millions of peasants during a famine that broke out in Ukraine in 1932.[19] Half of the nation's livestock was slaughtered by peasants rather than give it up to the collective farms.

The environmental costs of Stalin's Great Break for agriculture were exceedingly high. On the one hand, the consolidation of the small family plots of land that lay helter-skelter from one end of the village to the other into collective farms enabled efficiencies of labor and capital. Such modern equipment as combines and tractors could run virtually to the horizon and back. The creation of Machine Tractor Stations as a kind of extension service, the political arm of the party in the village, and repository of technology, fertilizer, and seed also facilitated transformation of outmoded and unreliable means of farming. The peasant traditionally relied on the three-field system. This enabled peasants to operate with a limited view of the external world with a limited good—good land. Each peasant household endeavored to use land—and the soil in it—to its maximum since his use of it was temporary according to communal dictates. Because the commune constantly redistributed the land and no household owned it, no household had long-term interest in fertilizing or upgrading it, but only in exhausting it. The commune therefore acted in a very limited way to prevent soil exhaustion by imposing the three-field system, where one-third of the land always lay fallow against exhaustion. As long as communal land use was the norm, then strictly coordinating choice and timing of crops served somewhat to protect the soil. Yet it also prevented the development of agriculture that produced surplus for markets. This would all change with collectivized agriculture, which enabled use of machinery and chemicals to push the land ever harder. By some calculations, at the end of the Soviet period, collective farms used 3 to 5 times more chemical pesticide, herbicide, and fertilizer than a farm in the United States. This poisoned the soil and increased erosion. Yet the collective farms were needed to feed the burgeoning cities and industry.

Industrial deserts came into existence owing to five-year plans to focus investment on heavy industry; an urgent, anxious concern that the sole proletarian state would soon face invasion from hostile capitalist nations; the political and ideological expediency of centralization of resource development; and the geological blessings of rich ore, coal, oil, asbestos, and other minerals bestowed on the Ural region that fed the growing industrial hunger. The Bolsheviks believed that large-scale, highly centralized projects such as those for electrification of the country best brought together modern technology and peasants cum workers to be made into progressive citizens, no matter the social dislocation.[20] In the first five-year plan (1929–34, but announced as completed in 1933), capital investment in the Urals quadrupled. Between 1928 and 1935 more than twenty major enterprises were built there. Factories, combines, and trusts came into existence, seemingly overnight. In the Chkalov region (today Orenburg) dozens of factories were established whose environmental legacy will be with residents for decades to come: Uralkhimmash, Stroimashina, Uglemash, Khimprom, Uralmash, Kamurallesbum, Severokhim, Uralasbest, Uralsel'mash, Uraltekstil. As these names make clear to the Russian speaker, these factories focused on chemical, petrochemical, coal, paper, asbestos, construction, and other products. As noted in chapter 6, at each of these factories, state officials paid little attention to worker safety, waste disposal, or efficient production practices.

Local and regional officials in the Urals supported the Stalinist five-year plans. They believed that they could recover the leading position of the Urals in mining and metallurgy from Ukraine through them. They welcomed the opportunity to secure investment capital for their factories and mines, although they eventually realized that plans imposed on them from the center had little relation to local capabilities. The overly ambitious industrialization program was known in typical Bolshevik understatement as the “Big Ural” program.[21] Big Ural represented a development strategy that became paradigmatic for the USSR and led to the creation of industrial deserts.

A mind-set of victory over nature and perceived human enemies predominated during the great industrialization drive. Simultaneously, party officials and planners focused investment on the factories themselves, less so on the social overhead capital. In every city or industrial enterprise I have studied in the former Soviet Union—the Atommash reactor factory in Volgodonsk, Akademgorodok (the Siberian city of science), the nuclear shipbuilding city of Severodvinsk, various paper and pulp enterprises from Arkhangelsk to the Urals and beyond—the authorities failed to provide adequately for the shelter, feeding, education, medical care, and entertainment of the workers. In the Urals, while party officials made some effort to house and feed worker recruits who flooded into burgeoning urban centers, their major concern was increasing production. Hence, investment funds for social overhead capital lagged. In Cheliabinsk the population grew fivefold from 1926 to 1939, but only a few apartment buildings went up. Water service was limited. There was but one tram line. Only in the late 1950s did some districts of the city get apartment buildings and asphalt streets, and there only 100 kilometers of tram line and 20 kilometers of trolley bus line served the masses. Officially, only one-tenth of the city was “green” with parks, gardens, trees, and laws; the rest was gray—concrete and metal. Furthermore, most workers were housed in barracks adjacent to factories.[22]

Owing to the overriding emphasis on industry, shortages of consumer goods became a persistent problem. A Stalin era joke asked, “What is the permanent feature of our glorious socialist economy?” The answer was “*temporary* shortages.” By 1939, residents of the Ural region noticed shortages of cigarettes, vodka, salt, suits, boots, and food. People stood in lines all night before stores opened to get what they could. The authorities ordered mounted police to disperse the crowds. When this failed, the secret police herded the dissatisfied comrades into lorries, drove them dozens of kilometers away, and forced them to walk back to town. Ration cards, which had not been seen since War Communism, were reintroduced. Even with emergency food deliveries, famine broke out.[23] But the revolutionary symbolism of building smelters, factories, and steel mills that rivaled those of Gary, Indiana, was more important than the quality of urban life or production realities.

Pipe Fitters of Nature

Soviet socialist science contributed directly to the formation of industrial deserts. The question was how best to harness modern science—proletarian science with its selfless pursuit of the truth to benefit the toiling masses, not as a handmaiden of profit—to the engine of industrialization. Specialists and officials joined together to create the scientific foundation for the development of Ural extractive, metallurgical, and other industries. In a few short years scientists received funding to establish research institutes whose focus was precisely extraction, smelting, and other industrial processes. Scientists, planners, and officials alike believed that they would conquer any obstacle standing in the way of increased production in a modern, rational socialist industry. This confidence, or hubris, contributed to underestimation of the human and environmental costs of industrialization. In January 1931 a Gosplan (State Planning Administration) commission, under central committee member Valerian Kuibyshev, and several leading scientists met to discuss the work of the new Ural region metallurgical and chemical combines. (As noted in chapter 1, Kuibyshev had a slightly more moderate approach to the industrialization than Stalin, believing that the Soviet Union must learn from American technological experience, but shared Stalin's enthusiasm for science and engineering as a key to the nation's industrial resurrection.) The commission members included Aleksandr Fersman, a geologist known for his expeditionary work in the Russian Arctic, who was instrumental in establishing the Kola Scientific Center to force the pace of exploitation of mineral resources in the Kola Peninsula and who produced extensive mineralogical maps of the Ural region;[24] Gleb Krzhizhanovskii, the head of the State Electrification Program (GOELRO); and Abram Ioffe, the director of the country's premier physics institute, the Leningrad Physical Technical Institute.[25] They concluded the need to establish narrowly focused research institutes to assist the burgeoning metallurgical industry.

By the beginning of 1932 some twenty scientific organizations had already come into existence, at least on paper, all of them connected with big industry, and none with ecological let alone biological directions of research, including the Physical Chemical Institute, the Ural Scientific Research Chemical Institute, Uralmekhanbor (involved in studies on enrichment of ore), and the Institute of Applied Mineralogy, with research stations at Berezniki—a city on the Kama River in Perm Province, the site of future chemical greatness in the production of potash, titanium, and sodium—and Magnitogorsk. Most of these research centers were in fact small, ill-equipped laboratories located within factories; this ensured their dedication to the narrow task of tying science to production, while the smoke and din obscured researchers' environmental considerations. At Ioffe's initiative, and with scientists and equipment from his own institute, they established the Ural Physical Technical Institute of the Commissariat of Heavy Industry (hereafter UralFTI) in Sverdlovsk. The profile of these institutes reflected the ethos of the Great Break, its programs for rapid industrialization, the transformation of the countryside into a machine, and the need for millions of tons of ore.[26]

During Stalin's Great Break, the Soviet Academy of Sciences also underwent profound changes that reflected the transformative impulse. Stalin insisted that the relatively autonomous Academy leadership accept new members in the social sciences whose Marxist credentials were unquestioned. Soon the Academy leadership approved the creation of a Technological Division that left little doubt about the importance of applied science and engineering to the regime. The Academy remained the center of basic research in the USSR, not the university as in the United States, while branch industry research institutes focused on applied science. (The technological division and its institutes were transferred to branch industry in 1961 as part of a reform process that indicated the rediscovered authority of scientists under Nikita Khrushchev.) Finally, in 1934, Stalin ordered the Academy's presidium to be transferred to Moscow, closer to the watchful eyes of the party apparatus. During this period, the Academy received increased resources to establish branches in the Ural region; in the postwar years, the Academy expanded further to Siberia and the Far East with the creation of scores of new institutes dedicated to putting science at the service of economic development. Institute personnel were harnessed to resource development through such programs as "Big Urals" and later "Siberia" and "BAM" (the Baikal-Amur Mainline, a new trans-Siberian railroad completed in the Brezhnev era).

Not surprisingly, therefore, the newly formed Ural branch of the Soviet

Academy of Sciences that appeared during the first five-year plans had an industrial focus. Fersman, chairman of the presidium of the Ural branch of the Academy, revealed the ethos of technological development that lay at the foundation of Ural region research. Referring to the branch's intended mission, Fersman said, "I'd like to think about the Urals [branch] not as [a part of] the Academy of Sciences but as an 'Academy of Sciences and Technology' where the scientific bases of technology would be hammered out [and] where we may set forth and solve the great problems of the scientific foundation of the mastering of the Urals."[27] In 1937 Ivan Bardin replaced the elderly Fersman as chairman of the branch. Bardin, who served into the 1970s, had a scientific profile that fully revealed the needs of the Ural region. He began his career in Lipetsk in the Sokolskii Iron Works, a pipe-casting facility that was part of the Novolipetsk Iron and Steel Works. Bardin participated in the casting of its first iron water pipes in 1934 and then initiated innovations in the works' blast furnace. In other words, the Ural branch fell under the able leadership of a pipe fitter.[28]

The Ural branch gained responsibility for the research program of the Il'menskii zapovednik (nature preserve), the first state-funded such reserve in the world, set up entirely for scientific research in 1920 because of the "extraordinary scientific value of the Il'emskii Mountains of the southern Urals near [the city of] Miass."[29] Russian and Soviet environmentalists established a number of these preserves before the revolution and scores after the revolution. Specialists in the reserves hoped to establish inviolable areas for study. They would be inviolable from an ecological point of view as somehow closed ecosystems and from an economic point of view as removed from state designs for development. Yet under Stalin and Khrushchev the preserves faced severe pressure to contribute to the economy. Il'emskii produced tons and tons of hay for collective farms in the Stalin period although remaining a "little corner of freedom."[30] To put it simply, nature preserves were not as high on the list of funding priorities as was pipe fitting, let alone tank and other armament production required during World War II and the cold war.

War on Nature; War and Nature

World War II and the cold war created the final preconditions for the formation of industrial deserts. A desperate search for strategic minerals and expansion of chemical and metallurgical industries to fight National Socialist Germany, and later the nuclear and bioweapons industries in the mad escalation to build weapons of mass destruction during the cold war with the United States, transformed the Urals into an armed camp. Nothing—not pollution abatement, hazardous waste monitoring and disposal, or public health considerations—was permitted to slow production. The presence of large numbers of forced laborers—first Soviet citizens, then German prisoners of war—also contributed to cheapening the value of nature or, in this case, of human life.

On the eve of the war, the Ural region, consisting of the Molotovsk (now Perm), Sverdlovsk, Cheliabinsk, and Chkalovsk regions and the Bashkir autonomous republic, extended more than 800,000 square kilometers and had more than 12 million inhabitants. It contained extensive mineral wealth: over sixty different important elements and 12,000 cataloged sites of such strategic materials as bauxite, potassium, nickel, cobalt, titanium, tin, beryllium, bromine, magnesium, rubidium, cesium, chrome, vanadium, industrial diamonds, and copper, plus peat and lumber. For many of them, the Ural region was first or second in total reserves in the USSR, and first or second in extraction of them, and extract them citizens, kulaks turned workers, prisoners, soldiers, and party activists would.

Military metaphors already characterized the approach toward economic development in the 1930s. World War II accelerated the transformation of the Ural region into an industrial "armed camp" that served the metallurgical, mining, and military industries. As quickly as they could, in many cases just ahead of advancing German divisions, the Soviets emptied entire institutes and factories, loaded them onto trains, and evacuated them to the east. The evacuation contributed to the expansion of the Ural branch of the Academy of Sciences, bringing thirty-five academicians and corresponding members of the Academy, among other specialists, to the region.[31] In August 1941, on order of Academy President V. L. Komarov, a Committee for Mobilization of Resources of the Ural Region for the War Effort was established to transform the Ural region into a military production facility. The focus was on new kinds of steels, identification of strategic metals, new production methods, new magnetic apparatuses for protection of ships from mines, and quality control in manufacturing shells. Economists at the Institute of Geography created detailed descriptions of more than eighty cities, towns, and villages from the point of view of locating the evacuated facilities or siting new industry in them. Other researchers identified locations for hydropower stations, railway lines, and collective farms. One study listed sixty potential sites for hydroelectricity alone.[32]

Scale and impatience characterized Ural and Siberian development during the war, not surprisingly given the life and death nature of the battle with Germany. The secretary of the Molotovsk provincial party committee, N. I. Gusarov, acknowledged that the natural resources of the province and the growing power of its industry enabled the "Stalinist Urals" to serve as "the main arsenal of the Red Army." Gusarov spoke of his hope to transform Molotovsk into "a second Baku," a reference to Azerbaidzhan, the homeland of the Russian oil industry.[33] Toward the end of creating an arsenal, between September and December 1941 roughly 200 enterprises were evacuated to the Cheliabinsk region. Party officials and managers turned schools, workers' clubs, and theaters into factories. Under their pressure workers got smelters and boilers on line within weeks. Industrial production in several Ural cities grew seven- or eightfold between 1940 and 1944. Entirely new facilities appeared in the cities of Miass, Chebarkul, Sterlitamak, Tavda, Irbit, and Shadrinsk.[34] In Berezniki—"the city of Ural chemists"—the construction of clubs, kindergartens, nursery schools, and roads lagged considerably until well after the war because workers were driven to increase the production of soda manyfold for tank armor, self-propelled guns, glass, and soap. At the same time, workers lived in dug-out earthen huts, hastily assembled barracks, or tents; because of the influx of machinery and workers needing space, the average living area per inhabitant declined to 2 square meters per person.[35]

Twenty-six new mines opened during the war alone, with another thirty to be opened during the fourth five-year plan (1945–49). These were all strip mines and open pit mines to minimize expense on materials and labor, guaranteeing that there would be long-term environmental costs.[36] In the absence of efficient, modern equipment, reclamation projects, or proper disposal practices, the mine waste filled rivers, streams, and valleys. In view of the well-known and shocking legacy of such coal mining waste disposal practices in the USSR, China, and the United States, the rush of the administration of George W. Bush to permit still more of this practice in Appalachia and elsewhere indicates a deeply flawed belief that the industry requires less regulation.[37] Increased profits—as the Soviets knew—will not necessarily encourage job formation, increase safety, or encourage attention to the environment.

The Urals had no problem with job growth during the war. As machinery and laborers arrived from the east, sleepy villages and towns were transformed overnight into industrial centers where production grew three-, four-, and fivefold in the stretch of months. We are accustomed to thinking of urbanization in England, Germany, and the United States during the industrial revolution as being a violent, sudden, and unplanned process with great environmental and human costs. Yet in the USSR the migration was more sudden and violent, often at the point of a gun, and paradoxically, because of the metaphysical importance of the plan under Stalin, unplanned. Hundreds of thousands of people arrived in the Urals to power industry. Cities grew rapidly, doubling in size: Sverdlovsk to 425,000, Novosibirsk to 406,000, and Kemerevo to 133,000. Pipe fitter Bardin's Lipetsk grew threefold between 1926 and 1939, was evacuated during World War II, and then doubled in population by 1956 and gained another 60,000 inhabitants by 1962, reaching a population of 194,000. The inventory of construction enterprises in the Urals and West Siberia grew threefold from 1940 to 1943, with 2,250 large industrial enterprises built in the eastern USSR between 1942 and 1944.[38] The workers disassembled, crated, shipped, and reassembled milling machines for armor taken from Mariupol, Ukraine, and Leningrad (from the Izhorsk Metallurgical Factory) to Nizhnii Tagil and Magnitogorsk during the winter of 1941/42. Literally overnight they set to the production of tanks, airplanes, mortars, artillery guns, rifles, bombs, bullets, and charges. Haste and inexperience meant a constant struggle to use stamps, extruders, lathes, and other machine tools efficiently.[39] Resource waste resulted.

One of the major directions of industry was tanks. The famous Ural tanks won the great battle at Kursk that helped change the course of the war. Made of Magnitogorsk steel, these tanks were built at the Ural Wagon Factory (Uralvagonzavod), itself a product of the first five-year plan. Uralvagonzavod daily sent hundreds of T-34 tanks to the front from its conveyors, thousands upon thousands in the first year alone.[40] The German military command assumed that their occupation of the European USSR would lead to Stalin's rapid capitulation. But by April 1943, Reichsminister Albert Speer wrote Hitler about the need for action against the Ural industry that had become the "basic industrial forge of the military might of the Red Army." (At the same time, Hitler was asking Speer if it was not possible to build locomotives out of concrete to save steel for armaments.)[41] The Wehrmacht was never able to attack the Urals, whose industry, workers, and resources secured victory in World War II against Germany.

At the outset of the war, able-bodied men from collective farms and factories signed up to fight. Most were sent immediately to the front, with little training and poor equipment, and hundreds of thousands fell or were captured in the first engagements. Who filled their places at the lathes and punches and presses? Many of them were recent recruits to the Komsomol (the Communist Youth

League), 1,400 from the Sverdlovsk city committee, 800 from Nizhnii Tagil, and so on. War also meant increased numbers of female laborers akin to Rosie the Riveter in the United States, perhaps Ludmilla the Lathe Operator. The factory committees of the Komsomol of the Sverdlovsk region sent more than 14,000 girls to the factories. At the Verkh-Isetsk Factory, women and old men learned at the furnaces how to make specialty steels for the machine tool industry and for armaments.[42] The rapid replacement of skilled laborers with inexperienced young people and old folk required rapid, on-the-spot education under the eyes of the few remaining experienced workers. Their close supervision served its purpose as productivity of labor grew 2 to 4 times from 1941 to 1942. Yet this was a matter of quantity rather than quality in terms of workers and the parts, shells, and other things they produced.[43]

The excessive human costs of wartime industrial mobilization resulted not only from the life-and-death pressures of war with Germany, but from the use of slave labor, which cheapened the sense of the value of human health and safety. The government ordered special workers' brigades and labor camp prisoners into the construction fray. Special construction brigades that were military in jurisdiction and organization were mobilized three weeks after the German invasion on July 8, 1941, to build in short order enterprises of defense industry, rebuild destroyed facilities, and also bring various fortifications into existence. According to the memoirs of the commissar of the construction industry, S. Z. Ginzburg, earlier a protégé of Commissar of Heavy Industry Sergo Ordzhonikidze, who served as the deputy minister of the oil industry, a man with no qualms about forcing the pace of nature transformation, the authorities organized dozens of huge construction brigades, totaling an army of 400,000 men. In 1942 there were sixty-nine brigades, thirty-five of which were located in the Urals. The brigades were centered in Sverdlovsk and Cheliabinsk, as well as in Miass, Zlatoust, Magnitogorsk, Troitsk, Chusovoi, Berezniki, and Chkalov. Some of the men came from local factories, but tens of thousands of "mobilized Germans" (Soviet German citizens who had been expelled from their homes in Ukraine and other republics) were also forced into the construction projects under the watchful eye of the secret police. Another large group of labor conscripts consisted of 1 million kulaks and their families who were exiled for their alleged opposition to collectivization. Roughly 220,000 of them ended up in the Ural region on the eve of World War II. Poles, Kalmyks, Tatars, and Ukrainian nationalists were exiled in smaller numbers, many from Crimea. The groups were moved about the Urals as needed by the NKVD.[44]

Science, Technology, and the Postwar Expansion of Siberian Industry

After the war, and especially after the death of Stalin, the Soviet scientific enterprise expanded rapidly for several reasons. One was the pressure of cold war military competition with the United States. Another was the effort to make industrial production more scientifically based. A third was increasing autonomy for scientists in the Khrushchev era. Between the Nineteenth and Twentieth Communist Party Congresses (1952–56), the number of scientific workers in the Academy of Sciences nearly doubled.[45] While ecological thinking was reborn or rediscovered during this period, and public opposition to several state-sponsored, environmentally costly projects found a broad audience, the overriding emphasis remained on harnessing science to the engine of socialist industry. There would be no rest for workers or nature after World War II.

In the late 1950s scientists promoted the expansion of their disciplines into the provinces with the Ural branch of the Academy growing rapidly, and with branches of the Siberian division of the Academy established in Yakutia, Irkutsk, Krasnoiarsk, Buriatia, Tomsk, Chita, Kemerovo, Tiumen, Barnaul, Kysyl, and Omsk. Even in outposts of Soviet imperial power among the Yakuts, the goal was to tame nature. The Yakut Center of the Academy boasted a Permafrost Institute, an Institute of Physical-Engineering Problems of the North, and a Mining Institute. The Ural Scientific Center was the second largest center in Siberia in numbers of employees and institutes. The focus of its employees continued to be mining, metallurgy, chemistry, and geophysics.[46] The expansion of the military industrial complex during the cold war made billions of rubles available for these and other centers to thrive.

The scientific establishment continued to support big industry, and big industry based on old, tired, inefficient, and highly polluting production processes spread, engulfing towns, workers' neighborhoods, and then city outskirts. Magnitogorsk, Cheliabinsk, Karabash, Kyshtym, Nizhnii Tagil, Zlatoust, Kirovgrad, Sredneuralsk, and Miass added blast furnaces, smelters, refineries, and new factories to produce iron, steel, copper, petroleum products, PCBs, railway vehicles, trucks, and automobiles. With the exhaustion of deposits at Magnetic Mountain (Magnitogorsk), ore deposits at Rudnyi (northwest Kazakhstan) and titaniferous magnetite at Kachkanar filled the demand. Anywhere scientists identified rich deposits, planners dreamed of building smelters. Other complexes produced ferrovanadium and vanadium steels and copper (at Krasnouralsk). Asbestos came from the appropriately named Asbest to the east. This list could be significantly longer, and, from the point of view of hazardous waste and other pollution, unfortunately it was.

Three new areas entered into the industrialists', planners', and scientists' field of vision, each of which had a long-term environmental impact. The first research focus was geared to the assimilation of resources in the tundra, especially oil and gas of the Tiumen region. Toward this end, scientists and planners pushed both fragile Arctic ecosystems and the humans in them to extremes.[47] The second focused on the need to develop new energy resources to power burgeoning industry, especially hydropower. During the war, Soviet planners and engineers were forced to build forty new hydroelectric power stations to supply relocated armaments industry. The speed with which they built them suggested that they could build stations anywhere quickly and get away with cursory examination of local geological and climatic conditions. They redoubled efforts to study Siberian hydroelectric potential at this time, in particular on the Ob and Angara Rivers. In 1947, the first postwar conference on the development of the productive forces of East Siberia was held in Irkutsk, a large Siberian town on the Angara River, 70 kilometers downstream from Lake Baikal. The Amur, Enesei, Angara, Ob, and Irtysh would become planned, rational, Soviet rivers, each with a series or cascade of large hydroelectric power stations.[48] The negative environmental consequences of the taming and pollution of these rivers may never be reversed.

The Soviet hydroelectric industry grew from modest beginnings on prerevolutionary roots into an unstoppable nature transformation enterprise. Many of the engineers who participated in the State Electrification Program (GOELRO) had advanced projects for new coal-fired and hydro-powered stations before 1917. They gained Lenin's and the party's endorsement to pursue these projects in the 1920s, although construction was delayed by labor, machinery, and equipment shortages and by the need to learn on the job. The Soviets often relied on German, American, or Swedish turbogenerators. With the five-year plans and the rapid expansion of industry, the demand for electrical power also increased sharply, with Soviet factories meeting the orders. The former Siemens factory, now called Elektrosila, and the Kharkiv Turbine Works supplied turbines in larger and larger units; by the 1980s, Elektrosila forecast building single 4,000 MW turbogenerators that would be shipped on a specially built fifty-axle flatbed railway car to Siberian rivers for installation.

Gulag-based nature transformation projects (for example, the Belomor Canal) augmented the burgeoning electrical power industry. The leading hydroelectric engineering design, Gidroproekt, also known as the All-Union Hydrological Design Institute, grew out of Stalinist labor camps and engaged in such projects as Belomor, the Baltic–White Sea Canal, whose construction led to the death of tens of thousands of slave laborers. The director of the project, S. Ia. Zhuk, guided Gidroproekt, which was eventually named after him when the former gulag organization was turned into a respectable earthmoving operation after the death of Stalin. Although Zhuk Gidroproekt gave up the murderous treatment of its "employees," it never abandoned its violent attitude toward nature, with no river too small or too large to succumb to the planners' T-square and then to armies of workers remaking the river for installation of Elektrosila turbogenerators. On the eve of the breakup of the USSR, the hydro-enterprise had grown to hundreds of research and design institutes, construction organizations, and bureaucracies, with tens of thousands of employees, whose projects included the notorious plan to divert up to 10 percent of water from Siberian rivers into canals for "redistribution" to European and Central Asian rivers for industrial and agricultural purposes. Over 250 organizations participated in the Siberian river diversion project, each one of them convinced of the minor impact of their activities on environmental conditions.

These tendencies and handicaps spread quickly into Eastern Europe. Soviet and East European engineers established intimate working relationships in a variety of fields, including hydroelectricity. Building on the Stalinist hubris to transform nature and the experience of building a cascade of dams from the source of the Volga River to its delta, by 1951 Soviet engineers had already shared plans with their fraternal if inexperienced brothers to build a series of dams along the Danube River in Hungary and Czechoslovakia. Not content to build hero cities devoted to industry and to collectivize agriculture, they were determined to transform the river itself to improve shipping and accelerate the exchange of Soviet and East European goods. During decades of study no one questioned whether the Danube needed one or several dams, nor the environmental impact of the projects. By 1976 the socialist governments of Hungary and Czechoslovakia signed a treaty (abrogated by the Hungarian government in 1993) to build the Gabcikovo-Nagymaros dam system. The design focused on transport; design engineers sought to end the frequent periods of shallow water that stranded ships. But absent any public concerns, any opposition to the project would have to come from the engineers themselves, and the dam inevitably gathered great momentum, especially after the OPEC oil embargo of 1974.

Engineers abandoned any pretense at modesty, adding to transportation improvements designs for hydroelectric power stations. A large reservoir would be built at Dunakiliti, which straddled both countries. From there, a 17-kilometer canal would divert 90 to 95 percent of the Danube's flow to a hydroelectric dam at Gabcikovo in Czechoslovakia. About 100 kilometers downstream in Hungary at Nagymaros, another power station and dam would be built. Construction began in 1978. But by the end of the 1980s, as socialism began to collapse, green activists began to agitate against the Gabcikovo-Nagymaros dams, as well as against large-scale projects in Lithuania, Ukraine, and Russia.[49]

Some fifteen years ago Volodya Vizgin, a Moscow friend and fellow historian of science, gave me a postcard of a Palekh box. The second most instantly recognizable Russian art form after the nesting dolls or matrioshki is Palekh—black-lacquered wooden icons, decorative boxes and broaches with religious, historical, and other intricate scenes painted into the surface. Although of limited prominence before 1917, Palekh artists organized into a kind of proletarian collective after the revolution, which gave them greater currency with the authorities and enabled their technique to be incorporated into Stalinist and post-Stalinist art forms.[50] Like other forms of art, the Bolsheviks co-opted the Palekh form. They feared the overtly religious messages of most boxes. But rather than entirely stultify Palekh, as they did in the case of much handicraft industry that they viewed as a petit-bourgeois anachronism, they saw an opportunity to shift Palekh's message and eventually to earn hard currency from international tourists. The shift in message resulted in Palekh boxes with scenes that glorified yet domesticated the Soviet leadership and, of course, that depicted glorious technological achievements. The icons of Bolshevik rule were, after all, large-scale technological systems. My Palekh postcard allegorically depicts the taming of the Angara River by a hydroelectric power station, no doubt the Irkutsk station. In vivid colors and Palekh style, two muscular workers stand astride the river while taming a powerful horse; the workers are Angarastroi, the horse is the Angara River itself. In the background, barely visible and painted in white to indicate aluminum smelters that have yet to be built, are ghostly factories releasing smoke into the air. But there was no doubt that the factories would come on line, or that they would belch black smoke, and there is no sense that the taming of the Angara will have negative consequences. Rather, the Soviet engineer and worker will rebuild nature for the better.

In 1954, in fact, an engineer from the Mosgidep design institute proposed using 20 kilotons of TNT (more than the Hiroshima atomic bomb) to open one outflow of Lake Baikal—the Angara River—so that more water would flow out, producing billions and billions of kilowatts of energy. Scientists had had their eyes on the Angara River since the NEP. They opened the Angara Design Bureau of the Gidroenergoproekt Trust to conduct research in 1930, producing in 1936 a plan for construction of six stepped hydroelectric power stations on the river starting at Irkutsk, only 70 kilometers from the source of the Angara at Lake Baikal. Mosgidep engineers got involved after the war in the design of the Irkutsk station, a design approved in January 1950 as part of the Stalinist Plan for the Transformation of Nature, with the newly established Angarastroi to carry out the work. No disjunction between the Palekh box and engineers' plans existed, except for the fact that hydroelectric capacity far exceeded demand in the region.

The third area of technological innovation with extensive environmental costs concerned the nuclear enterprise (see chapter 4).[51] Engineers quickly built a series of massive, but environmentally unsound, plutonium production reactors, uranium isotope separation and enrichment facilities, and fuel fabrication plants. The most well-known center was Maiak in Cheliabinsk for manufacture of plutonium. Haphazardly managed high- and low-level radioactive waste dumps serving Maiak and dozens of other facilities filled the Ural region. From the weapons design point of view, the most well-known facility was Arzamas-16, installed at the centuries-old St. Sarov Monastery in the middle of dense pine forests on a high riverbank. In keeping with the desire to make religion serve the state, the monastery became Arzamas-16, the center of nuclear warhead design.[52] Slave laborers transformed Sarov into Arzamas.[53]

The decision to locate Arzamas in the central Ural region near the metallurgical, construction, and chemical facilities of Cheliabinsk, Perm, and Sverdlovsk Provinces was based on strategic considerations and proximity to industry and employees. Nearby on the southern shore of Sinar Lake they established Cheliabinsk-70 (now Snezhinsk) and Cheliabinsk-40 (now Ozersk), where Maiak is located. Like such massive uranium and plutonium production facilities as Oak Ridge, Tennessee, and Hanford, Washington, in the United States and Sellafield in the United Kingdom, those in the USSR stretched to the horizon. One such factory, the Ural Electrochemical Combine, used gaseous diffusion to separate uranium isotopes.[54] The combine, established in 1946, introduced industrial centrifuges in 1960, and its main building was almost 1 kilometer long and held 700,000 centrifuges. A sixth generation of serial centrifuges was completed in the early 1980s.[55] As with lumber, chemical fertilizers, asbestos, steel, coal, and other products, rapid production and large scale were central to the design of facilities, safety was an afterthought,[56] and often the operators forgot that there was a difference among timber, fertilizer, asbestos, and nuclear fuel.

Three events stand out, but they represent only a fraction of the true costs of the haphazard disposal of radioactive waste and accidents throughout the region. The first involved a 40 square kilometer area near the confluence of the Techa and Misheliak Rivers containing 200 waste storage sites, twenty-five of which remain open. Between 1949 and 1956 vast quantities of highly radioactive waste entered the watershed at the source of the Techa and spread far and wide. The second occurred in September 1957 when a nuclear waste dump at Kyshtym exploded, sending millions of curies of concentrated military radioactive waste into the atmosphere—a significantly larger quantity than at Chernobyl. The explosion required the evacuation of 11,000 people and created a dead zone of several hundred square kilometers.[57]

The third concerns the Maiak facility, which included a series of reservoirs for nuclear waste, with a total capacity of 380 million cubic meters. The reservoirs were separated from the Techa River by a simple dam. In 1951 the nuclear authorities began to pump billions of curies of cesium- and strontium-laced radioactive waste from the reservoirs into the bottom of the nearby Lake Karachai. The resulting reservoir held 24 times the radioactive debris released in Chernobyl. In the parched summer of 1967, Lake Karachai evaporated, and winds blew the radioactive dust more than 50 kilometers away, affecting 41,000 people.[58] By early 1996, the Maiak complex had accumulated 500,000 cubic meters of solid radioactive waste and 400,000 cubic meters of liquid radioactive waste deposited in reservoirs throughout the region. The plant continues to discharge 25 becquerels of liquid waste annually. According to a study conducted by the Russian and Norwegian governments, since 1948 the Maiak nuclear complex has leaked 8,900 petabecquerels (PBq) of the radioactive isotopes strontium-90 and cesium-137 into the environment as a result of accidents and the deliberate discharge of liquid waste.[59]

The Ural region was also a center of biological and chemical weapons production. In April 1979, an anthrax epidemic killed dozens of people in Sverdlovsk, with perhaps thousands of individuals afflicted. The Soviet authorities reported that the anthrax came from meat sold on the black market. Many people in the USSR and elsewhere believed that the cause of the anthrax was the unintentional release of a biological weapon. After the breakup of the USSR, an international team of researchers investigated the cause and extent of the epidemic. They concluded that an unintentional release of anthrax spores in aerosol form from a biological weapons facility had descended on the city. Given the nature of the Soviet system, it is not surprising that the government jeopardized health and safety in a city of 1.2 million inhabitants by locating a biological weapons facility in it rather than find an isolated site, not to mention one that operated with safety as the paramount concern.[60]

Post-Stalin Environmentalism in the Rational Soviet Economy

Under Nikita Khrushchev, whose brief era of rule (1955–64) was a period of reformism, and Leonid Brezhnev (1964–82, a period of greater conservatism), Soviet leaders moved away from Stalinist policies that emphasized economic growth and industrial development at all costs. They hoped to maintain programs to create an industrial superpower but also to improve the status of the consumer by investment in housing, food, and medical care. Party officials, working in concert with managers, legal specialists, and others, introduced a series of laws and regulations to control pollution and limit rapacious use of resources. To some extent, they pursued these changes to demonstrate that the USSR stood at the forefront of the environmental movement, not lagged behind western nations that had established environmental protection agencies, and to some extent they sincerely realized the need to change wasteful and highly polluting practices. Yet it remained less expensive for managers to pollute, pay modest fines, and refuse to introduce new control technologies than to miss reaching target plans. No less than in the United States, where Department of Defense officials have increasingly sought exceptions to rules and controls over pollution, degradation, and biodiversity, or have simply ignored them since the passage of the National Environmental Protection Act (1969) with the various clean water and clean air acts and their emendations,[61] so in the USSR the pressure to achieve parity with the United States in the cold war arms race ensured that issues of pollution were an afterthought in the military industrial complex. Industrial deserts expanded.

As part of his de-Stalinization "thaw," Khrushchev pushed a series of economic and political reforms intended to improve the performance of the economy. These included efforts to develop Siberian resources, build new irrigation complexes in Central Asia, rejuvenate agriculture, and increase the output of consumer goods, including the food industry, with increasing production of meat and dairy products. The economy grew rapidly at 8 percent annually. Yet planners continued to embrace inefficient and highly polluting large-scale projects as the foundation of the economy, among them massive hydropower stations built in regions before demand justified them, metallurgical plants, canals, and irrigation systems. Many of Khrushchev's policies were inconsistent, if not far-fetched, especially in agriculture. For example, he maintained his support for Trofim Lysenko and his so-called Michurinist biology with its Lamarckian environmental, not genetic, foundation. His Virgin Lands and corn planting campaigns were unmitigated environmental disasters; after the plowing up and exhaustion of millions of hectares of land, rampant erosion followed.

While scientists, citizens, and decision makers made some strides in reversing several of the most damaging of Stalinist policies, all in all in the Khrushchev era, the record is a spotty one. Beyond agriculture, the expansion of the military industrial complex (with the nuclear enterprise producing vast quantities of hazardous waste) and of mining, metallurgy, and energy production facilities contributed to the degradation. The failure to develop comprehensive nature protection legislation meant that there were few brakes on development. Such unique jewels of nature as Lake Baikal in south central Siberia suffered the consequences of industrial development. Authorities of the pulp and paper industry determined to build superfluous mills on the shores of the lake that have threatened the 1,200 endemic species.

Soon after Leonid Brezhnev and his allies in the party deposed Nikita Khrushchev in 1964, they claimed that the country had entered the stage of "developed socialism." Khrushchev had embarrassed them by promising in 1961 to achieve communism by 1980, clearly a difficult goal given the poverty in the countryside, the shortages in the cities, the growing costs of waging the cold war, and increasing awareness of extensive environmental problems. In their claim of "developed socialism," they sought to convey the message that socialist society had nevertheless transformed into something qualitatively more advanced than in the Stalin and Khrushchev eras and that rivaled the capitalist West. Developed socialism became a frame of reference throughout Brezhnev's days in power both for the nation's own and for western achievements in a variety of arenas. Economic growth, progress in culture and science, and advances in the area of environmental protection and rational use of resources—all of these things indicated such achievements. Specialists gained a greater role in balancing economic and environmental issues for a number of major water management projects.[62]

Yet western observers characterized the Brezhnev era as a period of "muddling through," while domestic critics under Gorbachev criticized it as a time of "stagnation." Environmental problems grew steadily worse, the pronouncements of the Soviet leaders notwithstanding. Erosion, deforestation, and pollution accelerated. The priority of economic development left the land disfigured, the water poisoned, and the air polluted. Whether agriculture and its excessive use of chemical biocides, forestry and its indiscriminate clear-cutting and waste, or industry and its mortal contamination, the Soviet system may have been "developed," but it was also increasingly polluted "socialism." And the citizen—the ostensible beneficiary of the leadership's enlightened rule—lived in an increasingly dangerous environment.

During the Brezhnev era, Soviet planners and political authorities increasingly promoted economic development through large-scale programs intended to integrate various sectors of the economy, regions of the country, and institutions across ministerial and geographical barriers. They resembled such heroic and wasteful programs as "Big Urals" from the 1930s but were bigger still. The programs went beyond five-year plans to cover ten- and fifteen-year periods, hundreds of institutes, and broad swaths of land. The authorities believed that the programs would inject greater rationality into planning activities and accelerate economic growth, which had begun to slow considerably. One of the most important programs was "Siberia." It involved literally hundreds of research institutes, industrial enterprises, and engineering firms geared toward encouraging Siberian settlement, building Siberian factories, digging up Siberian ore, plowing up Siberian soil, tapping Siberian oil, and damming Siberian rivers. The Ural Scientific Center (earlier "Branch") had the honor of coordinating the "Ural." Like "Siberia," "Ural" consisted of energy production, ore prospecting, extracting and processing, hydrological, metallurgical, construction, transportation, and nuclear programs, but it considered housing, medicine, and especially the environment as afterthoughts.[63] To put it another way, engineers and applied scientists represented nearly half of the Soviet scientific profession, the Ural region was their home, and the natural environment was both their laboratory and workshop.[64]

Several scientists, writers, and other citizens mounted public environmental campaigns in the media to protect the environment—and such symbols of pristine nature as Lake Baikal—without fear of arrest as under Stalin. Soviet writers contributed to the opening of environmental discussions not only through letters and articles but through novels. In *Russian Forest* (1953) Leonid Leonov used a personal conflict between two forestry experts to drive the novel's plot about rational utilization of forest resources. Forestry experts discussed the book widely, and it played an important role in the official adoption of scientifically based plans as opposed to plans set according to political goals. The effort to save Lake Baikal from paper mills also figured prominently among writers. Nobel laureate Mikhail Sholokhov broached the subject at the Congress of Soviet Writers in 1956 and again at the Twenty-third Party Congress in 1966. Over the next few years, party officials sought to restrict the spread of environmental information in the media. Still, writers often managed to get around these restrictions, occasionally in highly visible venues, for example, in *Literaturnaia gazeta*. This might be the equivalent of Aldo Leopold publishing *Sand County Almanac* in the *Atlantic Monthly*, or better still Rachel Carson publishing excerpts of *Silent Spring* in 1962 in the *New Yorker*. Yet no equivalents to Rachel Carson's *Silent Spring* were published in the Soviet Union.[65]

The nationalistic Valentin Rasputin, a leader of the village prose genre of writers, spoke out in defense of Lake Baikal, directly accusing some top officials of lying and incompetence for approving the construction of paper mills on the shore of Lake Baikal. He became one of the leaders of the Baikal movement. He regarded the struggle to preserve the lake and its environs as a fight to save Russian culture. His *Farewell to Matyora* describes the failed efforts of the inhabitants of a historic island town to save their homes from inundation of water backing up behind a new hydroelectric power station, the loss of their cemeteries and traditions, and their forced removal into ugly, new, concrete apartments. This fictional account represents the scores of cases where industrial projects destroyed people's lives and nature. Ultimately, literary efforts to raise concerns about the environment may have gained large audiences, but they failed to alter the Soviet economic development model.

This may be because of a more pronounced effort to use the print media to tout the achievements of the socialist economy. Even after the decline of the genre of socialist realism, in which heroes were heroes, villains were villains, and nature was a villain, too, or perhaps a capricious woman who refused to heed to the dictates of the plan, most authors wrote gloriously of the delights of heavy industry; reveled in its grime, smoke, and steam; and praised those with brain and brawn who endeavored to tackle any production problem—resources, bottlenecks, and nature be damned. The authors produced singularly riveting reading. A book series on Ural factories called *Biography of Ural Industry*, published with huge press runs, glorified the mind-set of the Ural region engineering, industrial, and military enterprise and human transformation of nature. The first book in the series was *Uralmashers* (*Uralmashovtsy*), to commemorate the factory's fiftieth anniversary. An understandably celebratory compilation, it focused on the construction and operation of the factory, especially the T-34 tank, and the role of leading party personalities and engineers. Other series publications included *The Factory Named Lenin and We Workers* about Uralelektrotiazhmash, which made transformers, hydropower generators, and other machines, and *My Pride: Vagonka*, also about the Uralvagonzavod.[66] Literature on ecological questions was restricted to narrow, out-of-the-way publications or specialized journals with relatively small readership, and until the late 1980s it rarely addressed industrial degradation in a consistent fashion.

Living and Working in an Industrial Desert

Scientists and engineers in the Ural region contributed to serious if not insurmountable environmental problems by virtue of their allegiance to industry. Political bosses exhorted workers to stick to the straight and narrow and somehow to increase production in increasingly decrepit factories built without pollution control equipment. They had done their best to create the appropriate mind-set for the region's residents, for example, by giving names to the streets that reflected economic desiderata of the region. In the scientists' neighborhood of Sverdlovsk you found Lathe Operators, Metallurgists, Physicists, Chemists, Geologists, and Engineering Streets. The House of Culture in Sverdlovsk was named, ominously, after Felix Dzerzhinsky, the first head of the secret police. If cultural affairs fell to Dzerzhinsky, why should it be surprising that responsibility for environmental monitoring and enforcement fell to scientists at the Ural Energy Ferrous Metallurgy Combine?

Through such programs as "Ural," industry continued to garner attention and investment, while the workers' living situation, public health, and environment gained passing mention at best. Indeed, the workers, party officials, and engineers all lived in mortal danger, surrounded by smoke-belching mills, hazardous particulate, heavy metals, and other threats in every region every day. When the Upper Kama River basin potassium and magnesium salt mines increased production for fertilizers, factory workers breathed in fumes and filth and then ingested fertilizer residues on their food. When a fourth factory at Berezniki and a third at Solikamsk came on line, they turned out 1.6 million tons of potassium fertilizers annually. The cities of Solikamsk and Berezniki expanded in population and space to envelop new enterprises. The cities grew out from the factories, swallowed up small villages on their outskirts, and put greater numbers of workers at risk from exposure to chemical pesticides and fertilizers, daily at work and nightly at their homes.[67] Each industrial or military step forward put greater stress on the Ural environment and the people who toiled in it, and each step put workers in the way of industrial harm.

The expansion of environmental research was always an afterthought in institutes of the scientific, metallurgical, and nuclear establishments of the Ural region—as it was an afterthought elsewhere in the socialist workers' paradise. For example, the biological station of the laboratory of radiation ecology of the Institute of Ecology of Flora and Fauna in Zarechyi, located not far from the Beloiarsk Nuclear Power Station with its breeder reactors, temporary waste storage pools, and spent fuel rods, was founded in 1955. Zarechyi physicists eventually added a biophysical research station on the territory of the Beloiarsk station for monitoring water and land around the station.[68] The fact that nuclear reactors were in operation for over a decade before the Zarechyi station opened gives a sense of the level of concern about environmental issues when energy production was the goal.

The demands of war against wreckers, against capitalists and nature in the 1930s, against the Nazis and nature during World War II, and against Americans and nature during the cold war had diverted attention from the rapid formation of industrial deserts. By the 1980s, however, scientists, some industrialists and party officials, and many citizens publicly recognized the ecological nightmare they faced. Two factors contributed to their awareness. First, they realized the disjunction between the way the people of industrial cities lived and the rhetoric of leading politicians and scientists as they described their victories over nature through increased industrial production. The second was the Gorbachev revolution and the coming of glasnost and perestroika that encouraged discussion of the costs of living and working in the socialist workers' paradise.

In the absence of active public involvement in environmental issues within the closed Soviet political system, it fell to scientists aware of problems to come forward. Specialists were tardy in recognizing the sour environmental fruit of their research and development labor for several reasons. First, they had been trained entirely within the Soviet tradition to believe in the centrality of industry to the nation's future and in their ability to lead the masses along the path of economic development and technological style that they had chosen. Second, specialists young and old were largely Urals born, raised, educated, and employed, and their specialties reflected the profile of the Ural region. They earned degrees in fields of metallurgy, extractive industries, and industrial production, often in correspondence courses or night school at institutes connected with factories, and only rarely in issues central to the environment.[69] They were the pipe fitters of nature. Where would the vision come from to deal with the causes and legacy of industrial deserts?

Another reason for the absence of critical attention toward environmental issues was the paucity of ecologists, biologists, or their institutes willing to consider those issues. To be sure, during the Brezhnev era, as part of the expansion of the scientific establishment, the number of specialists trained in these areas also grew rapidly. The government was active in various international environmental conventions, commissions, and treaties. At home, the government passed new statutes to regulate hazardous materials and punish polluters. It established hundreds of monitoring stations and government agencies to collect data from the stations and enforce statutes. Yet the agencies had limited authority or resources to punish violators, and in many cases the data remained classified. Regulation by the regulated was the rule. Furthermore, many of the major environmental organizations that might have served as the source of environmental thinking or activism, for example, the All-Russian Society for the Protection of Nature (VOOP), had been co-opted by the state. These obstacles were crucial to the genesis of, and refusal to recognize, the formation of industrial deserts. An ominous cloud of inaction, obfuscation, and moral blindness hung over the Urals, with mortal impact.

Finally, whistle-blowing culture never developed under socialism; criticism meant loss of authority or job. Specialists everywhere had a difficult time criticizing the system that educated them and from which they benefited. They were the nation's elite. Scientists, in particular physicists, conducted their research on a pedestal. They thrived in a cult of science based on their achievements in space and nuclear power. They debated the two cultures of humanists (*liriki*) and scientists (*fiziki*) and who best understood and could improve on the human condition, as Sir C. P. Snow framed the debate.[70] In this debate, the authority of the *fiziki* was largely unquestioned. On top of this, as the country's intellectual elite, they enjoyed higher salaries and greater access to consumer goods. In the Ural region, too, they enjoyed rather comfortable living conditions. The institutes of scientists of the Ural branch of the Academy were located primarily in the Kirov region of Sverdlovsk (today Ekaterinburg), one of its greenest and quietest. Established in 1943, by the early 1980s some 200,000 individuals lived here among its forty-nine scientific research institutes, design organizations, and higher educational institutions. The region boasted six movie theaters, two theaters, a philharmonic orchestra, four Houses of Culture, five clubs, a Hall of Pioneers, three museums, hospitals, ninety preschools, twenty schools, sixty-seven bookmobiles, and twenty-nine libraries serving 104,000 readers with books on Uralmashzavod and other topics with iron-clad guarantees to excite the mind. They lived in 3 million square kilometers of apartments, a generous portion by Soviet standards, located along 185 wide streets that totaled 140 kilometers in length and 250 kilometers of sidewalks. The town fathers referred to the region as "beautiful, clean, and well-situated" with parks and greenery. Beginning in the early 1980s, they made a strong effort to eliminate the barrack housing that persisted from the war.[71]

Although living in this relative comfort and privilege, scientists began to experience environmental cognitive dissonance. They raised concerns about industrial deserts when they recognized that their cities had become the epicenters of air, water, and land pollution. Sverdlovsk attracted all of the worst of industrial misfortunes. The inhabitants required not only comfortable housing in nice neighborhoods, but also clean air and green zones, and not only scraggly trees along the street, but parks, ponds, and singing birds. Toward that end, scientists worked on treating industrial wastes, halting the discharges, and establishing industrial parks isolated from residential neighborhoods. They sought to reclaim nature from industry, but they faced a daunting task. They saw how within Sverdlovsk city limits several lakes and ponds had grown increasingly filthy over the Soviet decades, in large part because the metallurgical industry merely discharged untreated wastes into the Iset River that ran through the center of the city. The banks of the Iset were littered with the urban filth of bottles, cans, and trash, the surface covered with oil slicks the color of the rainbow, the shoreline with dead fish. The five large streams that flow into the Iset had been artificially channeled to serve as sewers for industry. Most residents even forgot what the names of the streams were. Children stood at filth's edge, fishing for what managed to survive. Pity their nervous systems when they ate fish laden with heavy metals.

In Sverdlovsk as in all of the cities of the Ural region—Miass, Tobol, Ural, Kama, Tavda—radical cleanup and reclamation were required. Take, for example, the Upper Isetsk Pond. It had been a place for relaxation and a source of municipal drinking water, but a daily influx of 450–500 kilograms of harmful organic compounds killed the pond. The Shartash Lake, a major weekend attraction for Sverdlovsk residents, had become a sink for organic matter, ammonia, and phosphorous according to evidence assembled by scientists of the Ural Research Institute of the Economy. In 1978 the Sverdlovsk city executive committee passed a resolution to restore the lake. Virtually all industrial enterprises added to the capital stock of Sverdlovsk in the preceding decade built filters and other equipment to limit dangerous discharges into the atmosphere and water. Yet the filtering equipment worked intermittently if at all, and managers preferred to pay miserly fines rather than maintain it. Worse still, much of the industry in and around the city dated to the 1930s, 1940s, and 1950s. It continued to belch smoke and release hazardous waste, no longer in the name of the struggle against capitalist encirclement, or the life-and-death struggle with the Nazis, but because that was the way it had always operated. The growing number of automobiles added to air pollution. Some scientists advocated the acceleration of "greening" programs, for Sverdlovsk had only 16,700 hectares of park land and forest, with only 2,100 hectares, or 17 square meters (170 square feet) per person, for public use. Targets to add 4,300 hectares of green space in parks and along boulevards by 2000 were not reached.[72]

Eventually scientists from the Ural Research Institute of Water Resources put their minds to saving the ponds, streams, and rivers. They called for interbasin transfers of water from Siberian rivers. The project took root in the 1960s in the Kuibyshev (city) branch of the Gidroproekt. Gidroproekt was responsible for many of the postwar megaprojects that destroyed river ecology. Scientists at its Kuibyshev branch were obviously enamored of the Kuibyshev Hydroelectric Power Station and other nature transformation projects that Soviet power had enabled. They had no doubts about finding a technical solution to a problem of technological origin. They anticipated water shortages in Cheliabinsk, even if industry strove to limit growth in demand by recycling water in closed systems and filtering it. These engineers raised interbasin transfers from Siberian rivers through canals to Cheliabinsk as the best solution.[73] This meant that specialists had chosen as their path the time-honored—and disastrous—axiom of treatment of industrial waste employed for centuries that "the solution to pollution is dilution." Even if the Iset today looks and smells better, the cleanup of such American rivers as the Monongahela in Pittsburgh, the Cuyahoga in Cleveland, the Charles in Boston, and others over the last quarter of the twentieth century indicates that it will take decades of concerted effort and expense to cleanse Russian rivers and lakes, especially those in the Ural region, to make them safe for swimming and fishing, and this task has not even begun. Degradation has been so significant that the fauna—including people who habituate nearby—must warily approach activities of work, play, and rest.

There were rays of hope, if not light, that pierced the poison cloud. Researchers at the Institute of Ecology of Flora and Fauna (IERZh), established in the early 1970s, developed a program called "Ural-Ecology" to promote rational use of resources and consider environmental protection measures. This was not the usual long-term planning and study that enabled Soviet authorities to postpone action, but a belated undertaking to promote scientific management of the region's rich natural resources. The program sought legal means to protect flora and fauna, especially forests. In the northern Ural and Tiumen regions, the focus was reclamation of damaged lands. Fifty-five institutions and organizations of the Ural, Komi, and Tiumen regions eventually took part in ecological studies and programs.[74] An institutional basis to support environmental studies slowly developed, and it attracted a number of young scholars to its fold. The institutes included IERZh, the Ural Scientific Research Institute of Water Resources, the Ural Forestry Experimental Station, the Sverdlovsk Forestry Institute, the Tiumen SibrybNIIproekt (Siberian Fisheries Research Institute), and the Orenburg Research Institute of Conservation and Rational Use of Natural Resources.[75] Yet engineers at these institutes were limited to technological solutions to technological problems of their own making, not the radical restructuring of industry and waste management practices that was required.

Another positive indicator was the growing involvement of citizens' groups in green issues. Student groups at various higher educational institutions in the Urals began to organize as part of a national *druzhina* movement that originated at Moscow State University in the 1970s to promote ecological research, nature protection, public education, trash pickup, and other programs in the face of government inaction. Like other organizations, they were watched closely by party organizations, in this case by the Sverdlovsk city Komsomol.[76] Professional scientists were more likely to work through such organizations as VOOP, the major Soviet mass environmental organization.[77] Twenty-six percent of the Soviet population belonged to VOOP chapters, in the Sverdlovsk region 20 percent, but of IERZh employees, 93 percent belonged. Among the members were the director of the institute, V. I. Bol'shakov, and S. A. Mamaev, chair of the committee on environmental protection of Ural Scientific Center and a leading scientist in its Botanical Garden. In addition to pressuring industry to modernize pollution control equipment, VOOP's members sought to "green" Sverdlovsk and clean up its rivers, lakes, and ponds.[78]

Mamaev boldly stated that it was not enough to establish a new field of study called environmental science. Rather, there was a need to "ecologize" all science, for example, engineering specialties through the development of clean technologies. In the Urals, money for ecological study or environmental law enforcement did not grow on trees. In fact, in many places there were no trees. Industrial polluters had for decades spewed poisonous gases into the atmosphere. The costs of reclamation—and of installing scrubbers and filters, seeking appropriate waste handling and disposal methods, and considering public health—were far greater than the authorities would approve. Only an end to Soviet power broke the cycle of industrial development, reaching and surpassing targets, fighting enemies internal and external, and destroying the environment.[79] At the height of the Gorbachev era, Mamaev spoke about the transformation of the Urals precisely into an industrial desert.

Let Them Eat Concrete

Since the Ural region remains crucial for the twenty-first-century Russian economy, its environment will remain at risk. In 2000 the Ural Economic Region consisted of 4.8 percent of Russia's territory, 18.8 percent of its inhabitants, and 13.5 percent of its economic infrastructure, which produced 14.5 perecent of the GDP and 19.0 percent of the country's industrial production. It remained the metallurgical capital of the nation, producing 46 percent of the ferrous and nonferrous metallurgy, 41 percent of the coke, 43 percent of the steel, and 57 percent of the steel pipe.[80] Russian leaders seemed no more anxious to deal with the environmental issues connected with this production than their Soviet predecessors. Indeed, in 2000, President Vladimir Putin disbanded the short-lived Russian environmental protection agency, assigning its enforcement functions to the provinces without adequate personnel or funding. Instead, the Ministry of Natural Resources, similar to the United States Department of the Interior, has gained great power to accelerate the development of the nation's rich natural resources.

The Ural region was the archetypical industrial desert. Here, from the first days of Soviet power, military metaphors predominated in the pronouncements and approaches of the political operatives, economic planners, and engineers who sought to tap resources and master nature. World War II reinforced a mind-set of war at all costs against enemies, including nature, a stance against slacking and going slow. The cold war led to the establishment of nuclear, chemical, and biological weapons industries with inadequate attention to the dangerous production processes and the lethal wastes they produced. Party officials justified these costs in the name of a constant struggle against ubiquitous and tireless enemies. Workers paid with their lives. The fact of the matter is that living and working in the southern Ural region involved the creation of and exposure to deadly industrial wastes, nuclear fuels, and biological and chemical weapons. Managers, scientists, and workers were so devoted to the causes of increasing industrial and military production in short order, and so fearful of potential enemies, that they paid little attention to the environmental costs of their work. Like elsewhere in the former USSR, the roots of the ongoing environmental crisis therefore are in the confluence of engineering knowledge, central planning and the sanctity of plan fulfillment at all costs, an ethos of industrialization, and a mind-set of war against nature, no less than war against other enemies of Soviet socialism.[81]

It may be impossible to reclaim the Ural region from hazardous waste, the best intentions of scientists and engineers notwithstanding. The pace, scale, and design of projects of decades past made it inevitable that environmental consequences would be great and long lived. Those who suggested a moderate pace for industrial development and greater attention to the creation of the appropriate atmosphere in which to consider housing, public health, and nature protection concerns were first branded as "wreckers"[82] and later marginalized or ignored. The result is that five regions of the USSR, according to the government, were "on the brink of ecological disaster." The Ural region is the worst offender. There is strong evidence that the People's Republic of China and the Democratic People's Republic of Korea (North Korea) have also embraced the Soviet model of economic development and political control, with similar extensive social and environmental costs.[83] This was the least desirable outcome of the harnessing of science to the industrial engine of socialism in the name of the toiling masses, but perhaps inevitable given the ideological and economic desiderata of Stalinist development programs.

Lipa Grigorevich Rojter (1910–94), "The Apprentice," 1957, linocut. Men and women, young and old, joined together to build socialism. Workers' safety seemed an afterthought as inexperienced workers were forced into the production process and encouraged to see only the horizon—not the dangerous equipment around them. Courtesy of the Allan Gamborg Gallery, Moscow, Russia.

NO HARD HATS, NO STEEL-TOED SHOES REQUIRED

Worker Safety in the Proletarian Paradise

> There's nothing wrong.
> You won't die.
> It will pass.
> You will live to your wedding.
>
> *A doctor's diagnoses*
> *at a one-room infirmary*
> *in the Russian Arctic*

In 1989 I dropped into the Soviet "Toys 'R' Us," Dom Igrushki, not far from October Square in Moscow, to buy my two-year-old son several toys. He had come down with chicken pox and was quarantined to our room in the Academy of Sciences hotel, and the repeated showings of *Teenage Mutant Ninja Turtles* and the Japanese cartoon *Voltron* on television, only weeks earlier permitted as a new sign of Gorbachev's glasnost and perestroika, distracted him only so much. I bought a few games, a metal truck, and a steam shovel. No sooner had Isaac started playing with them than the toys broke apart into small edible pieces. I was reminded of this event by the belated response of officials in the Bush administration Consumer Product Safety Commission to move decisively to protect American boys and girls in the face of Chinese toys laced with lead, made of dangerous small parts, and containing other hazardous imperfections. One source of the problem was that President Bush had appointed industry representatives to leading positions in regulatory agencies who considered it quite acceptable to work with trade organizations while ignoring consumer groups; in the USSR, no independent consumer groups existed, while industry representatives were worried entirely about output, little about safety, and rarely considered product liability and the consumer. Product liability, in fact, had little meaning. At least there was a positive side to Isaac's experience: playing with the Russian toys prepared him to survive on Soviet playgrounds, anchored on concrete or asphalt, whose swings, merry-go-rounds, and other rides and climbs made of standard piping had long before acquired rusted, dangerously sharp edges. Everywhere you turned, you saw the rusted, sharp edges of Soviet life in construction projects, in automobile, railroad, and plane travel, in factories, and in forestry and agricultural operations.

In the United States, fear that regulation would limit economic growth and stifle employment joined with a belief that the unregulated market was somehow sacrosanct to prevent truly meaningful worker safety laws until the New Deal. The market would also somehow ensure worker and product safety. Yet American mining, manufacturing, and other industries had significantly higher accident rates than in England and other countries during the tumult of the industrial revolution of the nineteenth and twentieth centuries. Machines and power sources were largely left unguarded, while factory managers sought ever-increased output and displayed little interest in improving safety. Various commissions set up before and after the Civil War had little power or authority, and workplace conditions in many industries actually deteriorated. It took legislators until the twentieth century to realize that only federal, not state, laws were effective in improving the situation, although some employers recognized that accidents had costs, and that workers were not replaceable cogs, especially after the passage of state workmen's compensation laws and increased employers' liability; forty-four states passed workmen's compensation laws in the second decade of the twentieth century. One of the major milestones was the Pure Food and Drug Act of 1906, legislation encouraged by a work of fiction, Upton Sinclair's *The Jungle* (1906). By 1910 Congress had established the Bureau of Mines in response to a series of mine disasters. But the Bureau was a scientific, not a regulatory, body. Further efforts to ensure mine safety—and safety in other industries—would have to come from the legislative branch of government.

Inevitably, if slowly, manufacturers set out to guard workers from machinery, while machinery makers developed safer designs. They required workers to wear safety equipment. They created national organizations to promote industrial safety, joining state and federal governments and universities in research on work safety. Accident rates eventually began to fall in the 1920s and 1930s. Yet Congress passed the Fair Labor Standards Act only in 1938, finally putting an end to child exploitation: the act required employers to pay child laborers the minimum wage and generally limited the age of child laborers to sixteen and older. One has the sense that the specter of socialism had something to do with legislation in the United States. If the capitalist system was the better system, why had the Soviets, at least on paper, managed to promote worker safety and create universal employment? The U.S. government would have to act during the Great Depression.

At first glance, the dangers associated with modern industrial technology, and the responses of engineers, managers, and policy makers to those dangers, would appear to hold across economic systems. Similar machinery and equipment hold similar risks to workers. Regulators have little choice but to adopt safety measures to protect them. In spite of the delay in adopting industrial safety measures in the United States and other capitalist nations, they pursued worker safety on the shop floor with greater vigor than the USSR—that socialist nation dedicated to the glory of the proletariat. Soviet leaders were more capable of creating posthumous heroes out of the Soviet laborer than the capitalist boss.

We often hear the argument that we Americans have done too much in the name of safety and accident prevention. Children need to learn to walk and play, fall down and get back up. Climbing jungle gyms, jumping off, rolling, and getting a few bumps and bruises and scraped knees are a part of growing up. Yet few people deny that playgrounds built on woodchips with toys, slides, swings, and rides made from hard but flexible plastics with smooth edges should also be part of growing up. Once grown up, American workers are also accustomed to safety measures on the shop floor to protect them from moving machinery. A century-long effort that includes such rudimentary innovations as the yellow lines painted on factory floors has significantly reduced injury and fatality rates. While it may have taken longer in the United States than in England, Sweden, or France to introduce laws and regulations, and while some business people lament them as too costly or even unnecessary, most citizens welcome such federal workplace safety agencies as the Occupational Health and Safety Administration (OSHA, founded in 1971)[1] and the Mine Safety and Health Administration (MSHA)[2] as crucial institutions in any industrial democracy.

In the USSR, and to some extent in Russia to this day, a different kind of safety philosophy and attitude toward accidents prevailed that was shared by managers, party officials, and workers, too. In this chapter I call this attitude of fatalism, if not lack of concern about many avoidable accidents in modern industrial society, “unsafety.” How can we understand the fact that to this day in

Russia, men and women, boys and girls engage in unsafe activities, sanctioned or not, avoided by Europeans and North Americans as too risky, or requiring government regulation to protect the citizen from danger to himself and others? Unsafety reflects a lax attitude toward human life, while also greatly overvaluing economic performance as a crucial criterion of public good. While officials struggled to introduce modern laws and standards for industrial safety and public health, they also faced self-imposed pressures to fulfill production plans that diverted attention from safety, especially during the Stalin period of heroic five-year plans for industrialization. Soviet authorities threw workers into the factory, logging activities, and other sectors of the economy without vigilance toward accidents, let alone safety goggles, helmets, or steel-toed shoes. When accidents occurred, Soviet investigators always blamed the workers, never the technology or process, and assumed that more talk by party activists about the need for greater discipline, more reading of the classics of Leninism-Stalinism, and less vodka—but not necessarily safer equipment—would solve the problem. In fact, a dangerous stroll through the forestry, construction, nuclear, and other industries reveals that Soviet workers' democracy did less to protect the proletariat than it should have—and less than in the capitalist democracies of the West.

This was not the way workers or leaders thought it would be. When Vladimir Lenin addressed issues of the modern manufactory, he anticipated the construction of well-illuminated, well-ventilated, and safe facilities under socialism. The production of copious amounts of electricity would enable the agricultural laborer and the industrial worker alike to live and work in cleaner, quieter environments than those under capitalism, out of harm's way of powerful, modern machinery. According to Lazar Kaganovich, the Moscow Party Committee chairman responsible for the construction of the city's subway system, the Moscow Metro similarly would whisk the worker to and from work in spacious, dirt-free wagons, arriving at work—and at home at the end of the day—refreshed, energetic, and ready to continue building communism, not exhausted and weighted down by poverty as in London, Berlin, or New York.[3] On paper at the very least, national statutes on wages, workplace safety, sanitation, workmen's compensation, and union rights and privileges equaled or exceeded those of other countries. Specialists studied industrial hygiene in comparative perspective to ensure the adoption of progressive statutes.[4]

On paper, that is, Soviet leaders embraced a legalistic attitude toward all aspects of Soviet life. As part of the dictatorship of the proletariat, the Bolsheviks used proclamations, new rule-making procedures, and violence to destroy the bourgeoisie. After the Bolsheviks seized power, Lenin, a lawyer by training, issued proclamation after proclamation, day after day, concerning important issues of both rule (nationalization of property, of banks, and so on) and law to indicate a sharp break with the bourgeois past. Overnight new statutes on marriage and divorce, labor and the workplace, private property, and dozens of other areas appeared. It was important for Soviet leaders to demonstrate for both the domestic audience and the international community that the socialist state would protect the rights of the workers. With his own "Stalin Constitution" (1936), Stalin asserted that workers had gained complete rights—more than guaranteed in the U.S. constitution—as a reflection of the achievement of the classless society. This constitution also guaranteed, or rather required, that workers work as part of their freedom—and obligation to society. The authorities simultaneously issued progressive laws concerning workplace safety, exposure to dangerous chemicals, hours of work, and environmental regulation to the end of the regime. We must assume that these laws were for propaganda purposes because enforcement of those laws, issuance of fines, and training of lawyers to prosecute the law lagged far behind what industrial safety required.

Soviet laws were nevertheless a clean break with those from the Tsarist era. A factory inspectorate had existed before the Russian Revolution, but laws related to enforcement of workers' rights were weak or vague, enabling factory owners to avoid enforcement. Factories smaller than a certain size and without motors were excluded from their purview, and the inspectorate never had sufficient numbers of personnel to carry out its work, nor were there offices in every province.[5] Ultimately, Soviet workers gained access to such perquisites as free medical care, access to sanitaria, vacation facilities, and camps for their children. But, judging by archival materials, in reality the Soviet worker encountered significant hazards in his or her place of work. To put it quite sadly, Soviet officials placed propaganda about safety well ahead of real safety, and only if it did not slow work. They failed to create regulatory agencies or inspectorates with sufficient power and purview to protect the worker and the consumer. And while we cannot measure the impact of attitudes toward safety at work on the personal attitudes of Russian citizens toward safety at home, at play, or in the automobile, their attitudes do depart significantly from citizens in the industrial democracies of Europe and North America.

Several difficulties confront us in dealing with this subject. First, the Soviet authorities classified national data on accidents, so we must assemble that information in a piecemeal fashion from local archives. Similarly, few social scientists have actively considered risk and safety in the Soviet experience. They have focused instead on the ideals and ideas of public health and the heroic efforts of specialists after the Bolshevik seizure of power to combat epidemics of typhus, cholera, scurvy, sexually transmitted diseases, and other problems of a preindustrial society. They have pointed to the establishment of the Commissariats of Health and of Labor (Narkomzdrav and Narkomtrud, respectively) and the efforts of their personnel to break with Tsarist inaction in treatment of the worker. Personnel of Narkomzdrav and Narkomtrud indeed attacked the problems of public health and industrial safety with vigor, at least until Stalin's rise to power. Taylorist specialists in the Institute of the Scientific Organization of Labor studied worker-machine-manager interaction and orientation in pursuit of both efficiency and safety. All of these personnel had to deal with the problem that many citizens were illiterate or barely literate, a problem that persisted into the 1940s. Narkomzdrav was largely successful in its "sanitary enlightenment" campaign. Sanitary enlightenment was a product of the October Revolution—health, education, and sanitary measures to remake society. The goal was to end epidemics and also to turn citizens away from folk healers considered backward and dangerous to the modern hospital state.[6] But once Stalin's industrialization campaign commenced, industrial hygiene lost importance.

The Reality of the Soviet Industrial Experience

The American engineer John Scott participated in the construction and operation of Magnitogorsk, the Soviet copy of Gary, Indiana, one of Stalin's "hero projects" intended to demonstrate the advantages of socialism over capitalism, while producing huge quantities of iron and steel in modern Bessemer furnaces. At dozens of new enterprises like Magnitogorsk, workers would not toil but gladly produce iron and steel, elsewhere cement, nickel, and asbestos, in cities named Nikel and Asbest and other burgeoning municipalities named after crucial yet hazardous materials. Yet as Scott described, the Magnitogorsk construction site was anything but a worker's paradise. Poorly equipped peasant-workers struggled against the elements—against bitter cold in the winter, dressed in rags, and against mud and mosquitoes in the summer. The dining halls were known for long lines and small portions of low-quality food, and they were incubators of various intestinal and respiratory ailments. The authorities gathered the peasants at sites like Magnitogorsk to transform them overnight into conscious loyal communist workers. They offered reading and writing classes along with some technical training better to use the few available machines. But this training was often an afterthought to the needs of fulfillment of production norms by armies of inexperienced laborers, who often ruined equipment out of ignorance. The bosses forced the laborers into backbreaking work with rudimentary tools, giving little time to the exhausted workers to improve their skills or struggle with their illiteracy. High accident rates characterized the site. Frequently, workers slipped from icy scaffolding to their deaths below. They turned to alcohol to salve their wounds.[7] The workers were both exhausted and treated as expendable. These same patterns of exhortation of workers, inadequate training, failed literacy campaigns, poor conditions of work, and alcohol abuse led to high accident rates at construction sites throughout the nation. Homage to production engendered a poor attitude toward safety that spread among managers. Coming to understand that they were merely cogs in the socialist machine, workers also developed a fatalist attitude toward their work.

Simultaneously, the Communist Party leadership engaged in a campaign to discredit the old intelligentsia, including a large number of foreign engineers engaged in the industrialization effort to make up for any lags in target fulfillment. Engineers who recommended a more moderate approach, such as expenditures on workers' comfort, housing, and safety, were labeled as "wreckers." The first show trials that Stalin and other officials orchestrated, the so-called Industrial Party and Shakhty (Mining) Affairs, chronicled the discovery of sabotage, the identification of its perpetrators (representatives of foreign capital), and punishment of death for their heinous crimes.[8] The message was not lost on other engineers. As quickly as they could, they designed and built tools, machinery, equipment, power stations, paper mills, smelters, and other facilities and brought them on line without delay. Given the backwardness of Russian industry and the shortage of tractors, cranes, steamships, generators, and so on, engineers and planners sought simple if functional designs to achieve the task at hand. Safety and pollution control were an afterthought. They avoided innovations that might have improved efficiency or safety but required time to introduce because of the pressure to fulfill that year's plan and to avoid the accusation that they were slackers or, worse still, wreckers. The result was, to a much greater extent than in mid-twentieth-century European and American factories, danger that lurked everywhere in mines, smelters, and factories. All of this led to growing ennui among the workers, a lackadaisical attitude toward safety, and still more alcohol and more accidents.

The pace of the Stalinist industrial campaign and the attitude of managers about the relative expendability of workers also affected women laborers. In the 1920s the Bolsheviks passed a series of regulations to limit the presence of female laborers in the most dangerous jobs—mining and metallurgy, for example. Yet women were drawn into those jobs in increasing absolute numbers, if a smaller percent of total workers in those sectors, and they were often engaged in precisely the most difficult tasks.[9] Female laborers joined the labor force in growing numbers because they were needed to fulfill the wildly ambitious targets of the five-year plans. By the end of the 1930s, women were one-third of the labor force. They were also expected simultaneously to recall their traditional roles as child bearers, mothers, and homemakers. In this time of rapid economic and political change, the nuclear family became one island of stability among the din of burgeoning industry.

The forest and collective farm were no more places of modern industrial hygiene than the factories. Poor living conditions seem to have contributed to the lackadaisical attitude of officials and workers alike toward industrial safety. Lumberjacks of such major organizations as Dvinoles and Kotlasles (the Dvina and Kotlas Forestry Trusts, respectively) in Arkhangelsk Province frequently complained to party officials about their housing, miserable food, and the lack of books, films, or even simple board games for entertainment. Their barracks and dining halls were filthy, damp, and unheated, the latter lacking dishes, pots, and pans. There were no washing facilities. They might go weeks without bathing or having clean clothes. They slept on straw mattresses, attacked by bugs, often without sheets and pillowcases.[10] These miserable conditions persisted for decades. For example, the plan for housing construction for Dvinoles and Kotlasles workers indicated 11,550 square meters of new quarters in 1949. Given thousands of workers, this amounted to 2 or 3 square meters of living space per worker, and the plan was only 70 percent completed because of shortages of materials and laborers. Enterprise managers were more concerned with lumber harvest than housing, so they ordered construction workers to the forest as well. The plans for 1950 called for completion of twenty-seven dormitories, each for thirty-five lumberjacks, but only five of them were in some stage of construction by mid-year. Roughly 1,300 workers were required for construction, but only 150 to 200 individuals were employed in this task.[11]

In every industry it was the same story: the absence of housing and other simple comforts, especially for younger, recent hires. The Northern Rivers Steamship Authority had at least 279 families living in kitchens of communal houses that were used by dozens of other families throughout the day. When on shore, the merchant marines lived six to eight people per room, and even many captains shared space with five or six other people in rooms that were 3 by 5 meters. Low pay, poor housing, absence of medical care, and so on, took its toll on their attitudes. They worried about their families' living conditions when at sea, no matter how devoted to their chores they were. Said one administrator, "If we recondition six apartments with our shock workers, then still many find poor conditions, have big families and live on the edge. The worker will keep himself together on the ship if he knows that his family is well taken care of at home."[12] Perhaps one in ten sailors had his own apartment. The miserable conditions led to high turnover and thence to inexperienced workers with basic skills being thrust into positions of responsibility.[13]

Lumbering is a dangerous activity wherever it occurs. In the Soviet Union it was even more dangerous because of the shortage of equipment that might take pressure off of the men, and because of the rudimentary nature of the equipment. By the late 1930s, in spite of ever-increasing harvest requirements, Dvinoles had opened very few safe roads, had fewer tractors, and even had fewer parts to maintain the machines. In one year, they ordered 205 tractors, but factories delivered only eighty-six of them. None of the tractors had safety cages for the operators, and none of the operators wore helmets or goggles. Dvinoles planners indicated 275 kilometers of roads of various kinds, but only 140 kilometers had been built. Comrade Medvedev, the main engineer and deputy director of Dvinoles, concluded, "I personally consider it a great mistake that we don't have any technology whatsoever in the forest. It is a basic law on the foundation of which we should carry out all activities, to which everything should be subordinated, on which the brains of our scientific-technical personnel ought to work. We do not have technology in the forest . . . Is it possible that [officials of the Commissariat of Forestry] have not been in the forest? But it turns out that the Commissar is also an enemy. If he were a man who was devoted to Soviet power, he would look at what goes on in the forest." Indeed, Medvedev asserted, they had "retreated" from modern technology, which was the same thing, in his mind, as wrecking.[14]

By the 1950s, Kotlasles, with its twelve forestry enterprises and fifty-eight logging operations, could still count only 257 tractors (half of them acquired in the preceding two years), 118 winches, 195 small portable generators, and 1,100 electric saws. Getting into the forest and getting the wood out was a challenge given the fact that roads were bumpy, filled with puddles, potholes, and even boulders, and consisted of deep mud in the spring and deep snow in the winter, as well as the fact that the men had to attack the forest with equipment inadequate to the task. In all Kotlasles had a total of 117 kilometers of narrow gauge rail at nine operations, 140 kilometers of automobile roads, and 140 kilometers of tractor roads. The target plans for felling were never fulfilled, especially plans concerning use of machinery that came in at 43–45 percent of targets. Brute human force was the key.[15] Imagine pulling sleighs of lumber with poorly shod horses or riding tractors of uncertain reliability.[16] Even if they were to get the equipment needed, they lacked qualified workers to operate it. In the Sevles Forestry Trust in 1936 the personnel office could not fill hundreds of positions: they needed 210 mechanics but had only eighty-one, they needed 1,300 tractor operators but had only 400, and they needed 200 portable generator operators but had only fifty-one. They were short over 100 engine specialists, 100 drivers, 135 smithies, 200 couplers, 130 lathe operators, 58 electricians, and so on. Nor had authorities established vocational schools to train more than a handful of these folks.

The problem with substandard and poorly operating equipment extended to the very organization intended to supply parts for repairs, Glavleszapchast, whose shortages prevented repairs of scores of tractors, bulldozers, cranes, generators, and saws. Exacerbating the problem, Glavleszapchast had only half of the 200 required qualified employees, and they could not retain them. Plus, they lacked machine tools to fabricate parts. Of the 101 tractors sent to Glavleszapchast for repairs before the winter 1954/55 logging season, forty had yet to be fixed well into the lumbering season.[17] Arkhangelskles (the Arkhangelsk Forestry Enterprise) reported the same problems: late in 1954 only 28 percent of repairs on tractors were completed, none on truck or automobile engines, they couldn't get spare parts, their shop was too small, and they had only fifty-five of the required 147 mechanics.[18]

Technological lag created obstacles to efficient and safe operation in every sector of the economy. Industry simply could not produce all of the new machine tools and machines themselves to replace equipment that dated to the Tsarist era. This was an especially grave problem in the shipping industry. Bolshevik visionaries imagined the opening of a year-round shipping lane from Arkhangelsk on the White Sea, through the Barents and Karsk Seas along the Arctic coast, and eventually to Vladivostok. They created Glavsevmorput (the Main Administration of the Northern Sea Route) toward that end, with its various divisions responsible for studying the climate, the currents, the ice flows, the potential for freight shipment, and so on.[19] Glavsevmorput was given a series of steamships, freighters, cutters, motorboats, and icebreakers that dated to the Tsarist era. The administration sent these ships and sailors into icy waters with insufficient understanding of how they worked, let alone the nature of currents and changeability of the weather. The age of ships, the inexperienced nature of the workforce, and natural challenges imposed by the northern climate strained the ingenuity of ship captains and their vessels to the extreme. Captain Pechuro of the "*Lenin*" worried that his seventeen-year-old icebreaker could not keep up with the demands placed on him and his crew. Pechuro reported, "We escorted barges of wheat from the Ob [River] to Arkhangelsk. We dragged along small barges that were hardly sea worthy and on which it was necessary to put sailors so that they could bail water with fire pumps." Even with the *Lenin*'s help, they lost two of their best steamships. One, a 3,000-ton boat, went down near Belyi Island in five minutes after taking on water.[20]

Accidents at sea were an endemic problem related to all of these other factors: poor repairs, old vessels, high labor turnover, and inexperienced workers without incentives and with relatively low qualifications and insufficient knowledge about Arctic geography, weather, and transport.[21] Captains with long service quickly learned that the "the slightest wavering or carelessness or negligence will have great consequences when at sea."[22] Party officials understood precisely that high labor turnover meant more accidents: new sailors aboard the Arctic fleet meant insufficient training and inexperience, as a result of which the "number of accidents because of human error grows." For Glavsevmorput's fleet in 1946 there were eight accidents, in 1947 sixteen, and in the first half of 1948 five more. The main reason was "insufficient technical literacy, violations of laws concerning operations, and violation of discipline."[23] But the officials provided no incentives to sailors to stay on the job in terms of housing, pay, or training because they considered it cheaper to thrust new workers to sea.

The problem of inadequate qualifications extended to all levels of personnel, with direct implications for safety. A report to the Communist Party secretary responsible for inland river transportation of the Arkhangelsk region in late 1946 revealed that efforts to retrain captains and technical specialists employed by the Northern Rivers Steam Ship Authority had failed, with a "large number of accidents" the result. The accidents demonstrated "the lack of preparedness of a significant component of the commanders of the fleet." Only 22 percent of the captains had general middle education, 23 percent middle-technical education, and the rest with only elementary and some special courses. There were no reserves, which limited the ability "to move staff around and to replace the incompetent ones." The authorities needed to retrain seventy-one steamship captains, forty mechanics, thirty-six motorists, 127 stokers, and 360 other technical employees, and they had no training schools to do so. Comrade Makarychev, the chief engineer of the authority, reported that "fifty percent of our mechanics do not correspond to their position. Eighty percent of technical accidents devolve from the weak staff of mechanics."[24] Workers everywhere lacked qualifications other than time at their posts. Rarely had they finished even middle school.[25]

The northern shipping season lasted only from late June to October. By mid-October cyclones had appeared and wet snow was frequent; ships became icebound as early as November. The treacherous and unfamiliar waters of the Barents and Karsk Seas and Arctic Ocean created significant dangers. In the best case, captains had carried out preliminary sounding in search of rocks, reefs, and other hazards. Yet even the experienced captain was often at the mercy of good luck. Dozens of ships were lost, sinking after striking unknown objects or crushed in the ice. Scores of sailors perished in the depths or froze to death on ships. Given the hostile environment in which they sailed, explored, and delivered goods, it is shocking to read in ship manifests how often captains sailed with insufficient supplies of food and fuel. The authorities ordered captains and their crews to take on conquest of the Arctic in the name of the glory of the Soviet Union and the glory of their profession yet inadequately equipped them to do so.[26]

Similar to the conquest of the Arctic, Soviet officials ordered the conquest of the skies in the 1930s through a series of aviation spectacles, including polar flights, but at great human and technological cost. Posthumous heroism—victory over the elements and the machine—and outperforming the West were more important than pilots and planes.[27] Accidents plagued the military and civilian aviation sector as well. An investigation into the causes of a February 5, 1938, crash of an N-114 airplane on Vaigach Island under pilot communist L. K. Shukailo, killing all people on board, revealed that Shukailo had willfully ignored rules, regulations, and elementary facts by flying in inclement weather and dismissing orders to cancel the flight. Yet had he not been raised to seek heroic results? The investigation further revealed that the entire aviation wing lacked any kind of labor discipline, let alone any interest in engaging in political education. In the short time since he had joined the Belomor Aviation Detachment in November 1937, Shukailo had committed a series of violations, some minor and some major that had damaged aircraft. He had flown with defective tires, caught the engine on fire, and previously engaged in risky maneuvers such as the kind leading to the Vaigach crash. The investigation into this and other accidents indicated that base personnel—good communists among them—had engaged in all sorts of troublemaking, including drunken orgies with nonparty individuals. The commandant of the wing had consorted with his secretary in front of everyone, gotten her pregnant, and then shamelessly shipped her off to Leningrad.[28] Would orgies with party members alone have improved safety performance?

One reason for the lackadaisical attitude toward worker safety and accidents may have been the fact that most organizations learned about production on the fly. After all, thousands of new organizations and factories came into existence in a few short years, each trying to use newer, but not yet widely available, technology. One of those organizations was Sevzryvsplav (the Northern Explosives River Lumber Float Organization), whose employees used dynamite and other explosives in the lumber industry to keep the logs moving downstream in the spring float. They dynamited both to engineer rivers and to eliminate logjams. Eventually officials of Sevzryvsplav developed a 100-hour course to train young specialists in both theory and practice. The graduates were mostly twenty-five to thirty-year-olds, all men, although some were as young as nineteen years old, and roughly 10 percent of each class was dismissed for not passing muster.[29] In Sevzryvsplav shortages of work clothing and gloves and the seasonal nature of the work once again contributed to high labor turnover, as well as to the high death rate. In 1939, six of roughly 120 employees died in accidents.[30]

If the factories producing the machines and infrastructure needed in the field or factory were negligent, then they were also responsible for accidents. In the railroad industry, train engineers faced the unenviable task of trying to keep locomotives running at higher speeds and unloading freight quickly, yet running on rails prone to failure. The Pechora department of the Arkhangelsk-Moscow railroad line discovered that at least 32,000 rails, or more than 200 kilometers of poor-quality, lighter rails, were subject to failure. Crashes and accidents had resulted. Engineers had had to slow their trains in some cases to 15 kilometers per hour. A heavier rail was being manufactured by 1952, but only 85 kilometers of rail had been replaced. On top of this, 1,148 railway bridges built during World War II of low-grade, untreated pine had begun to rot from truss to weight-bearing beams, and only a few hundred of them had been replaced.[31] In 1948 there were four crashes and 264 cases of substandard work, while in 1949 there were ten crashes and 377 cases of substandard work. The authorities reported a "huge accident" with a passenger train at the beginning of 1950, although not revealing how many injuries or fatalities. But they determined that the cause was a "low level of labor and government discipline among workers connected with train traffic." In the previous fourteen months they had issued over 1,000 administrative punishments, including 212 involving legal proceeding, 673 for violations of technical norms, and 197 for truancy or leaving work. The high level of truancy in all industries is all the more shocking given the kinds of punishments a worker faced for violations of socialist norms in Stalin's USSR.[32] Let us remember that officials without exception determined that workers were at fault in every accident, never the technology itself. Nor did they understand how their cavalier attitudes toward health and safety were the true culprit.

The rails continued to deteriorate, limiting freight and speed. By May of 1954 the majority of rails of the Niandomsk division of the Northern Railroad had worn down to 9 millimeters and thinner, and scores of sections failed technical inspection daily. Many of the rails were built according to prerevolutionary specifications. The workers attempted to make some headway. In 1951, 10,316 highly defective rails were replaced; in 1952, 9,277; in 1953, 13,200; and in the first half of 1954, 5,482. But 11,400 defective rails remained, and the numbers continued to grow. The dispatcher issued as many as eighty orders daily to limit speeds, again, to 15 kilometers per hour. Over 170 kilometers of the main line out of Moscow to Arkhangelsk were in need of capital repair and 234 kilometers in need of medium repair. Endemic substandard work resulted in three crashes and one accident. The deputy minister of the Ministry of Means of Communication informed the Niandomsk officials that the ministry could do little to help since they lacked the rails to repair more than 59 kilometers of track, strengthen 5.5 kilometers of turns, and regrade 215 kilometers of track during the year.[33]

Accidents frequently occurred on the narrow gauge railroads used for transport of lumber, too, because of poor construction in the first place and inadequate repairs. On October 15, 1954, at Pudukha seventeen wagons and engines derailed. They reluctantly took lumberjacks out of the forest, who spent hours with timbers and levers to get the cars back on the tracks. A party official worried that no one took responsibility, and no one had organized safe operation of the narrow gauge railway. Party officials instructed the forestry enterprises to increase the frequency of lectures and the number of study groups that considered the glorious role of the Communist Party and Stalin as a way to combat the accidents. One wonders if the officials were surprised that their lectures on party history did little to stem truancy, fight growing crime problems, and combat alcoholism.[34]

Prison Labor, the Gulag, and the Value of Human Life

By the late 1920s, Soviet officials had established the first of a series of labor camps to handle critics of the state and common criminals. One was located in a monastery on the Solovki Islands in the White Sea. Eventually, the secret police establishment hit on the idea of using the camps as a source of very cheap labor for the burgeoning industrialization campaign and as a place to reeducate opponents, priests, merchants, and other bourgeois elements in the advantages of the Soviet system through hard labor. By the end of the 1930s, the camps had consumed millions of people and spread across the Far North and the Far East primarily for their economic purposes. Such organizations as Dalstroi (the Far Eastern Construction Organization) and Sevdvinlag (the Arkhangelsk-based Northern Dvina Labor Camp) threw thousands of poorly equipped workers into the industrialization campaigns. They mined and smelted in Amderma and Norilsk in the Arctic. They felled trees and built railway lines through the taiga. The prisoners seldom had good housing or adequate clothing or tools, and they essentially starved to death over months and years. A flagship effort in the simultaneous reeducation/industrialization campaigns was the construction of the Belomor Canal, during which tens of thousands of laborers died from starvation, disease, and exposure. The gulag general responsible for the Belomor Canal, Sergei Iakovlevich Zhuk, gained respectability for his murderous projects after Stalin's death.[35] The Gulag was disassembled with various amnesties, commutations, and rehabilitations (often posthumous) under Nikita Khrushchev. The authorities then transformed many of the prison organizations into construction and engineering organizations, in Zhuk's case into the Zhuk Gidroproekt Institute, the nation's leading hydroelectric power station design institute to this day.

The extensive use of forced labor of all sorts must have conditioned the attitude of unsafety. Party officials often ordered thousands of "free" workers to leave their homes and families in one part of the country for another. But prison inmates—millions of innocent political prisoners, so-called "kulaks" or wealthier peasants, Volga Germans, Estonians, Lithuanians, Latvians, Poles, Germans, and other spoils of war—were also required to toil in unspeakable conditions, with high fatality and injury rates. These people were truly expendable to their captors. It must be noted that much of the Arctic and Far East labor force was slave labor in the infamous Gulag. The guards and officials in the camps were rough with their prisoners, many of whom died of disease or starvation. We can get some sense of the difficulties of labor in the camps from a report of the Sevdvinlag NKVD in 1946, where some 10 percent of the labor force was unable to work on any given day. We do not know the mortality rate with certainty.[36] Even after a secret resolution of the Central Committee in 1954 to ease some of the conditions of camp prisoners, commandants and guards continued to abuse them, placing some prisoners in isolation for lengthy periods, shooting others without provocation. Thousands of prisoners refused to work. Escapes became endemic.[37]

Shortages of lumberjacks meant that thousands of workers—and not only gulag prisoners—were sent into the forest to attack the trees. They included seasonal workers from other republics. For example, the Communist Party sent agricultural laborers from agriculturally rich Moldova to Arkhangelsk Province as the Moldsel'les (the Moldova Forestry Trust). The Moldovans met head on the usual miserable living conditions and dangerous work conditions and rejected the mistreatment. In the first half of 1953, Moldsel'les lost more than 17,000 man-days to truancy, mass desertions, excessive drunkenness, and other "amoral manifestations." The workers had been thrown into a kind of hell and preferred to sell various canned and bottled goods from home on local markets at speculative prices.[38]

Public Health and the Industrialization Campaign

In spite of the efforts of specialists to introduce modern medicine to the new Soviet state, medical care was inadequate to the task of rapid industrialization, and this contributed to unsafety. The bosses seemed more concerned with lost man-days than illness. They accused workers of shirking. This aspect of unsafety is paradoxical because officials invested a great deal in developing a medical delivery system. By the end of the Khrushchev years, roughly 6 percent of the budget went to public health. This dropped significantly in the next two decades under Leonid Brezhnev, to 1 or 2 percent. However, in addition to being centralized in the cities, medicine also lacked prestige. The Soviet "doctor" was not the specialist of high status that *he* was in the West, but often an individual who had only finished five years of university, and *she* faced the usual problems of lack of modern equipment and access to medicines. *She* (60 percent of doctors were female) was also poorly paid. This is not to denigrate the contribution of female specialists to medicine, but to indicate that it was considered a less prestigious occupation. Ultimately, in fact, in spite of the provision of universal free medical care, good medical care was a perquisite of the party and economic elite. Furthermore, the provision of medical care—like the provision of housing, schools, and stores—was almost always an afterthought, and better care went to well-positioned individuals with connections, not workers. Some local officials were clearly frustrated by this state of affairs. While it may be a logical jump to claim that the attitudes of Russian citizens toward safety and public health were conditioned to some degree by what we now know was miserable health care, we can assert on the basis of archival documents—and on the basis of my observations over the last twenty years—that workers and agricultural laborers understood that to get ill or suffer an injury meant delayed treatment by persons of low qualifications in poorly equipped facilities with few medicines or other technologies.

Indeed, during the initial stages of Stalin's industrial campaign, officials provided inadequate resources for the crucial task of public health given their interest in attracting workers to the tasks of "socialist construction" and keeping them on the job. Arkhangelsk Province provided much of the timber for the thousands of ongoing construction projects in the European USSR, and its exports generated crucial hard currency. Yet Narkomzdrav sent an "entirely insignificant number" of young doctors into the region to tend to 1.1 million inhabitants. In 1933 the authorities assigned the region's health department, Sevkraizdravotdel, seventy-five doctors, while in 1935 only eighteen more were sent to tend to the sick. Most of the agricultural towns and villages had no regular medical service even when they had a hospital or emergency ambulatory center. The region's hospitals in Vilegodsk, Niuksenitsk, Pavinsk, Primorsk, Lezhsk, Verkhovazhsk, Chebsark, and five districts of Komi Province had only one doctor instead of the three required. And the "industrial centers" of Arkhangelsk, Vologda, Sokol, Kotlas, Syktyvkar, Narian Mar, and Mezen were short ninety-two medical personnel: twenty-five surgeons; twelve gynecologists; fourteen eye, ear, and throat specialists; eight pediatricians; four psychiatrists; four radiologists; and twenty-five public heath doctors.[39] (To call Narian Mar or Mezen an industrial center in the twenty-first century is stretching it.) Naromzdrav's response seems to have been to revise the number of doctors needed downward. Initially stipulating the establishment of one infirmary for every 500 forestry workers, in 1936 it raised that to 1,000 workers. The forestry enterprises could not meet that relaxed target even by lowering qualifications for medical personnel.[40]

The further one got from Moscow, from Arkhangelsk, and then from regional centers, the less likely you could rely on medical service of any sort, let alone find a first aid kit. As of February 1937, the Khichmeno-Gorodetskii region, a territory 106 kilometers from the nearest dock and 156 kilometers from the nearest railroad, had 60,000 inhabitants served by two hospitals and three infirmaries attended to by two doctors in all. One, Tarasev, was a drunkard, while the other was a morphine addict. Epidemics of typhus, dysentery, and measles hit frequently, in 1936 killing 2,876 people, 1,207 of whom were children. Mortality exceeded fertility in the region by 566 people.[41] The so-called cultural bases, established to bring modern medicine and education to such indigenous people in the tundra as Nenets, Komi, and Saami, consisted of little more than a room, a bed without linens, no instruments or equipment, and a few medicines. The bases exposed the local people to illnesses and diseases brought in by people from the Soviet world. Medical personnel were few and far between, lacking advanced training or bedside manner. Nenets reindeer herder patients complained that the doctor of their cultural base, Matiushev, often urged patients back to their jobs with such comments as "There's nothing wrong," "You won't die," "It will pass," and "You will live to your wedding."[42] Other doctors worked too quickly because of demands on their time and were often rude with patients, and the absence of qualified replacements meant that you could not fire them. One medical assistant, Kashpirovskii, had improved his behavior, "but has taken up a new method of 'calming' the sick—he hits them on their sex organs."[43]

If emergency care was needed, the patient rarely got it. The USSR had few ambulances, and in most cases they were poorly equipped trucks that had to navigate treacherous, bumpy roads. To the end of the Soviet period, ambulances were notoriously late to arrive, and then the patient, manhandled into the back, was likely to suffer additional injury from the jostling. In the provinces, it did not help matters that rural electrification and establishment of citizens' band radios or telephone systems lagged literally decades behind the establishment of the economic production units at factories, on farms, and in the forest.[44] A critically injured individual was not likely to recover quickly.

On top of this, the worker injured at his place of work had little recourse to the courts to get compensation for his pain, suffering, and loss of livelihood. Managers tried to hide accidents because of the significant criminal penalties they faced for being found negligent, in addition to which the entire organization might lose its place in competition for bonuses. Workers knew that it was not in their interests to hide their injuries. Managers therefore tried (illegally) to engage workers to agree to some payment under the table that was larger than the amount of legal compensation that a worker might receive. Lawyers employed by the enterprise assisted the managers in evading the law and justified it by pointing out that the worker would get more money this way. Their responsibility was to protect the enterprise and the production process, not the worker.[45] Thus, of course, the dangerous working situation that led to the accident in the first place remained. In 1989, I myself witnessed a pedestrian getting hit by a car on a busy Moscow street, the driver and his passenger exiting the vehicle and, after a cursory examination of the bleeding man, lifting him bodily without a stretcher or immobilization of his limbs, stuffing him into the rear seat unconscious, and driving off—presumably to the nearest hospital.

The Propaganda Campaign for Production Ignores Safety

A major source of the mind-set of unsafety was the prolonged and aggressive campaign to increase production at any cost that unfolded in national, regional, and local newspapers, in film and literature, and in the arts. The five-year plans required great sacrifice from all citizens and superhuman effort. On many levels, the plans succeeded, for the USSR became an industrial powerhouse where an agrarian economy had existed only years earlier. An entirely new intelligentsia committed to the industrial transformation of Soviet lands and peoples assumed power in the party, in the bureaucracy, in factories, and in educational and scientific institutions. And within eight years the USSR was prepared to engage Germany in a war, survive that war barely, and then engage the United States in the cold war with even greater industrial achievements—and human sacrifice. Yet the constant exhortations to increase production in the face of equipment and other shortfalls led to a cheapening of the value of the labor of men and women and of the laborers themselves. Party organizers pushed industrial production at meetings, in discussions, in so-called Red Corners of workers' clubs where agitprop took place in the print media (including local and factory newspapers and bulletin boards), in Red Tents of the reindeer herders, and through film. Propaganda posters replaced religious subjects with technological ones. The new icons of Soviet power were the heroic worker heroically commanding the heroic machine in scenes of victory over nature and its various ores. Graphs pushed into the proletarian heavens. In other posters, electrical power lines spread into the countryside to power new factories. But rarely in any poster does a worker wear what western industrial engineers considered proper attire. In this light, we should have great affection for safety posters in American places of work.

Officials approved a new genre of arts and literature called socialist realism to glorify the Soviet hero disinterested in himself, perhaps disinterested in family, determined only to apply Bolshevik methods to victory over all enemies, including backward technology, enemies of the people, and the occasional saboteur or wrecker. In stories with industrial themes—many of them have industrial themes—the reader learned of the glorious pursuit of plan fulfillment. The authors wasted no words on safety, hesitation, or weakness of will. No accidents occurred. The occasional subtle point might be the bourgeois expert at a construction site who realizes the errors of his ways and throws himself 100 percent behind his proletarian leader in pursuit of bringing the factory on line, for example, the engineer German Gleist in Fedor Gladkov's novel *Cement* (1924, but the forerunner of the official genre). In another example of this genre, Vasilii Azhaev's *Daleko ot Moskvy* (*Far from Moscow*, 1948), the hero, the engineer Batmanov, modeled on the director of the huge Stalinist dam project at Tsimliansk on the Volga, Barabanov, successfully urges workers of the Dalstroi construction trust to build a pipeline connecting a new oil refinery at Komsomol'sk to Okha on Sakhalin Island. In fact, Dalstroi, the Far Eastern division of Stalin's gulag camps, used prisoners mercilessly to mine gold and other resources, with disease and death often the result.[46]

Hooliganism, Alcoholism, and Other Problems of Labor Discipline

A major source of high rates of accidents in Russia and the former Soviet Union was alcohol abuse.[47] It is not a stereotype to suggest that Russians love alcohol. The government has tried numerous times to fight alcoholism through stern and halfhearted measures. The government of Tsar Nicholas II even declared prohibition during World War I, denying the government extensive revenues to conduct the war. Officials have long recognized the problem of alcohol abuse but have disagreed over what to do about it.[48] Such Soviet leaders as Leonid Brezhnev and Yuri Andropov insisted on greater "labor discipline," which often meant to fight alcohol abuse. In May 1985, Mikhail Gorbachev declared a new "dry law" that included shorter operating hours at liquor stores, smaller bottles, fines and punishments, and the destruction of vineyards in Moldova and Georgia, which led to longer lines, discontent, and the disappearance of sugar from shelves as people turned to the production of *samogon* (homemade booze). By his example of drinking alcohol only in small amounts at official functions, and by his own words, former President Putin also struggled against alcohol abuse. Yet the situation seems to be getting worse, contributing to a high accident rate. The Russian minister of public health declared on television in October 2007 that younger and younger schoolgirls are drinking beer during the day, treating it as if it were some kind of juice. Everywhere you turn, on buses, in parks, on the street, people chug bottles of beer in clear view, although by law they must have bottles in paper bags. The ministry estimates that one of three premature deaths in Russia is connected with alcohol. A culture of alcohol contributed directly to unsafety in the former USSR.

As a number of specialists have pointed out, we do not know the real extent of alcohol abuse or its contribution to high mortality and accident rates in the Soviet period because of the closed state, lack of access to clinical and other data, and Soviet reluctance to talk about this significant problem because of the glorious stories of enlightened leadership, hero projects, full employment, worker contentment, and the ideal state. The extensive discussion of delinquency, crime, and alcoholism, although not accidents, in the open press, especially after the death of Stalin, indicates recognition that this was a significant, if not the major, problem in Soviet industry in terms of lost workdays, shoddy goods, and absenteeism, especially among the most hazardous professions (mining) and among all manual workers (loggers, fishermen).[49] These same sources indicated that it became a deepening and widespread problem.[50]

Perusal of archives for four industries (fisheries, forestry, communications, and transport) in Arkhangelsk Province from 1930 to 1964 suggests that party officials and managers believed that alcohol abuse more than any other issue contributed to failure to fulfill plans. One could provide hundreds of individual examples; a few will suffice. A high level of alcoholism plagued the development of the northern sea route. Yet labor turnover was so rapid, and workers in such great demand, that a man fired for drunkenness on one ship would easily be hired on another. All the captains seemed to be aware of this.[51] In 1934, party officials of the Pechora River Steamship Administration attributed fulfillment targets at only 62 percent of the plan to a series of imprecise reasons: the absence of militant party-political work on board ships, the failure to mobilize party organizations, few political discussions, and no socialist competitions. Perhaps a greater problem was that workers used vodka to excess. One party investigator wrote, "Steamships approach the docks, the captains will take vodka by the boxes and get drunk, when they approach the barge, they get drunk. Rare is the steamship where they aren't drunk."[52] Sailors spent most of their time on shore waiting for their next sail in a drunken stupor.[53]

The forest was another place of excessive drink in order to pass the time in miserable work and living conditions. It led to hangovers, truancy, and to workers leaving the job well before the end of the working day. Alcohol helped the workers ignore the absence of soap, salt, and even bread, the absence of consumer goods, and the low-quality food in the dining hall.[54] In isolated Amderma on the inhospitable Barents Sea shore where gulag prisoners built mines—and died—party officials themselves turned to alcohol to pass the time. These officials also made a contribution to the spread of syphilis.[55] The staff of cultural bases, established in the tundra to convert indigenous peoples from nomadic reindeer herders into modern Soviet citizens anchored to settlements and integrated into the economy, frequently turned to alcohol to salve their loneliness[56] and also seem to have promoted drinking among the indigenous people.

While anecdotal evidence may not be compelling to many readers, twenty years worth of evidence indicates a pattern. As I discovered on my training runs through factory neighborhoods, the Soviet authorities requisitioned huge carts of beer and kvas (a fermented bread drink) to factory entrances. This enabled workers to have a bit of the hair of the dog that bit them the night before, and with the hangover temporarily fixed for them to avoid pitching forward into moving machinery. The carts have disappeared, but easier access to alcohol means that the same pattern holds. The life expectancy for Russian men is roughly fifty-five years, or fifteen to twenty years less than that in Europe. I have seen workers picking up a half-liter bottle of beer on the way to work, and I have seen a larger number stagger home.

Gorbachev, Chernobyl, and Industrial Safety

Industrial safety issues were explored in a new light—dare I say radiance?—after the Chernobyl disaster on April 26, 1986, when reactor no. 4 at the station exploded, spreading vast quantities of dangerous radioisotopes throughout the Northern Hemisphere. Initially, the Gorbachev administration responded in understated terms, with a brief announcement of an accident and some indication that remediation had begun, as if to minimize the extent of the accident or its ramifications for public safety. But Mikhail Gorbachev had promised perestroika (restructuring) and glasnost (openness) as the major policy distinctions of his rule, with glasnost intended to gain public support for reforms. Over the next few months and years, journalists published exposés about the human and environmental costs of the Soviet industrial development model, including past disasters and accidents, many of them about the chemical, metallurgical, and nuclear industries. A kind of "radiophobia" developed, as the Soviet press referred to it, and perhaps a kind of technophobia as well. Citizens who had learned about the glory (and inherent safety) of life in modern society now confronted a strange, new, unsafe world. The media finally began to cover automobile, train, and plane crashes and other accidents as in some ways unavoidable in modern industrial society. Yet, reflecting the always ambivalent attitude about safety and technology and the typical determination of blame, Soviet investigators determined that personnel at the Chernobyl station were at fault for the accident, not the design of an inherently unsafe reactor carried out under the direction of Academy of Sciences President Anatolii Aleksandrov.[57]

In the initial effort to contain the damage at Chernobyl, the government ordered tens of thousands of soldiers into the breach, armed with shovels and wheelbarrows, often wearing no more than a cotton mask, although a number were given loosely fitting lead aprons, to gather the pieces of fuel and highly radioactive graphite that had been thrown dozens of yards into the surroundings and cart them back to the reactor hall. Robotic devices failed in the high radiation, so these "biorobots," as they were called, replaced them. Many of the "Chernobyl veterans" courageously faced the great danger of exposure to radiation. Many of them drank down a bottle of vodka before they faced that risk with the belief that the vodka would protect their testicles from excessive radiation.[58] After a two-week battle, these men had calmed the reactor. Officials were already planning to bring the surviving reactors of the Chernobyl station back on line as quickly as possible. Toward that end—and the end of containment of the spread of radioactivity—they built a concrete "sarcophagus" around unit number four. Since they believed that speed was of the essence—they wanted electricity—they ordered concrete pourers, dump truck drivers, and other construction specialists into the accident site with inadequate concern about the high levels of radiation and once again with little safety equipment.

Having evacuated—after a three-day delay—Pripiat, the residence town of Chernobyl operators and their families but 3 kilometers from the reactor, they determined to build a new town, Slavutich, 35 kilometers from the station, for new operators and their families.[59] (By the way, there were but a few bottles of iodine tablets available at Chernobyl or any other reactor site in the USSR that could be taken to block the thyroid's uptake of radioisotopes.) Officials attracted 27,000 young workers to Slavutich with promises of new apartments, many of whom later married, and many whose children have birth defects and cancers, especially thyroid and leukemia. Since the final shutdown of Chernobyl in 2000, several thousand workers have remained behind who are taken by train to the reactors to complete decommissioning and emptying of fuel.

Urban Sights and Sounds

I would like to suggest that attitudes about unsafety that developed during the Soviet period have persisted into the twenty-first century. To this day, most Russian construction sites do a poor job of keeping pedestrians out and workers safe within. As for road repairs, the most one can hope for is a poorly illuminated sign indicating a road hazard or workers just 10 to 15 meters ahead. Jersey barriers, plastic barrels, and flashing lights to indicate the need to slow down, to merge, to pay attention to workers ahead, or the posting of a cop car with lights flashing, have only recently appeared in twenty-first-century Russia. In Moscow and Petersburg, many of the industrial firms have shifted to western standards of safety. In the provinces, safety seems to be a concern of a century far in the future. One explanation may be that safety officials do not need to worry about a large number of foreigners reacting in horror to workers laboring at heights without safety harnesses, let alone hard hats, protective eye and ear equipment, gloves, and work boots. In Arkhangelsk in 2007, I visited seventeen apartment and office building construction sites within 2 kilometers of my residence, including one involving replacement of underground asbestos-coated steam pipes. I saw five hard hats in all.

But there are signs of hope. The Putin administration recognized the need, for example, to combat the epidemic of carnage on Russian roads. According to the Russian Ministry of Civil Defense and Emergency Response, 34,506 people died in road accidents in 2004, while in 2005 the scale, death rate, and injury rate all increased. In three-quarters of all traffic accidents, drivers are at fault. Alcohol plays a role in every eighth accident, speed in every third, and driving in the wrong lane in every seventh. (All Russian drivers believe that the potholes are worse on their side of the road and therefore drive on the other side when they can. On the way back from any destination they also drive on the wrong side of the road, bizarrely insisting it better than their current side of the road.) Considering the significantly fewer automobiles and fewer kilometers traveled, the fatality rate is probably on the order of 5 times higher than in the United States, where 45,000 died in automobile accidents in 2006. Many of the fatalities are due to what the Russians called euphemistically "a lack of culture" among drivers. Many more drivers than you encounter in Europe are unrepentantly aggressive, discourteous, immature, and dangerous. They consider the pedestrian sport, not reason to yield. It would help for the police to enforce traffic laws. I myself, in over twenty years of visiting the former Soviet Union, have never seen a policeman stop a driver who has run a light or failed to yield to a pedestrian in a crosswalk, and policemen themselves have nearly run me down in a crosswalk. Police have much more time to stop drivers to verify their drivers' licenses and registration, which they do with impunity as they fish for small bribes. I am not asking for high-speed chases, but until the police enforce traffic laws more consistently and aggressively, the drivers will control the cities. When queried about the problem, many Russians will respond, "U nas—duraki and dorogi" ("That's Russia for you. We have fools and roads").[60]

The number of pedestrians in Russia killed has increased 80 percent since 2000, during which time a total of 100,000 pedestrians were killed and over 500,000 were injured. Part of the problem is that pedestrians do not always cross at crosswalks. Yet because of Russian drivers, crosswalks are no guarantee of safety. It would help to have timed lights with dedicated pedestrian walkways and signals, but outside of Moscow and Leningrad these are a rarity. It is, however, a vast improvement that the Russian Ministry of Civil Defense and Emergency Response now publishes accident data, and we should remember the importance of public access to product safety information and accident rates as a way to create a culture of concern.

Yet a culture of fatalism persists, and it extends to seat belt usage. The majority of Russians do not use seat belts, although they are required to by law. In most cases, the seat belts have dropped to the floor. The only time many people will use a seat belt is when they see a policeman and worry he'll stop and fine them. Many of them still harbor the idea that seat belts are somehow dangerous. How will you get out of a flaming vehicle quickly if the belt malfunctions? They do not realize, or perhaps ignore, the fact that a person leaving a vehicle (that is, as a projectile traveling at 70 or 80 kilometers per hour) almost certainly will die on impact. And should you wish to put on a seat belt, the driver (a taxi driver for example, or an acquaintance) will tell you not to bother since it's unnecessary, or that it's necessary only outside of the city. Many of them even believe that it is safer to be drunk rather than sober in a crash, for the body is more relaxed. Seat belt use increased significantly when the fines for failing to use seat belts increased 1,000 percent on January 1, 2008.

During the Putin years, several private organizations banded together to end the road carnage. This is a positive sign, and yet automobile safety has had a public face in Europe and the United States for forty years. Recall that Ralph Nader came to prominence in 1964 with his *Unsafe at Any Speed*, a criticism of the inherent unsafety of the Chevrolet Corvair. Volvo introduced the first standard seat belts on vehicles in 1967. Airbags were developed by the early 1980s and should have been standard on all American automobiles—with the result that European manufacturers would have introduced them, too, and tens of thousands of lives would have been saved—had President Ronald Reagan, in the name of cost savings for the industry, not public safety, not delayed their introduction until the late 1990s. In the USSR and Russia, such simple standard safety features as dashboard padding, collapsible steering wheels, safety glass, side guard door beams, better crashworthiness of the passenger compartment, and airbags were all introduced significantly later and are still not universally available. That is, Russian vehicles, unlike the Czech Skoda and Korean Hundai, which have international markets, do not meet international safety standards. This, and the inability to provide replacement parts, is just one reason they can't be sold abroad successfully.

Roads and road safety have been a perpetual Russian problem, as we know from the previous discussion of forestry roads. The glacially slow pace of technological improvement in the design and construction of roads reflects again different attitudes toward safety. In the United States, beginning in the late 1950s and early 1960s, under pressure from the Insurance Institute for Highway Safety (founded in 1959), automobile manufacturers and road engineers began to think of safety in a new way. Until that time, safety advocates focused their efforts on preventing crashes by changing driver behavior. As part of a revolution in attitudes toward consumer product safety and litigation, engineers recognized the need also to develop technologies to reduce the consequences of crashes. The Insurance Institute notes that "because of the focus on crash prevention, many lifesaving vehicle designs were overlooked. For example, a few physicians advocated safety belts in the 1930s, but US automakers didn't begin installing lap belts as standard equipment until the 1960s—and then in response to state mandates. Shoulder belts didn't become standard until the 1968 model year when they were mandated by federal law."[61] Interest in profits led automakers to argue that vehicle characteristics were irrelevant: people caused crashes, so people, not vehicles, needed to change. Another reason for the lag was the nonscientific approach to safety.

To combat these problems, the Institute began aggressively to collect data and analyze it precisely in pursuit of an active role in traffic safety. In the spring of 1972 the Institute published *To Prevent Harm*. The alumni magazine of the Massachusetts Institute of Technology, *Technology Review*, drew on the study to argue, "There must be a continued effort to reduce the frequency of crashes. But there must be new emphasis on improving the protection which vehicles provide their occupants and on making vehicles themselves less subject to damage and less expensive to repair." The Institute opened its Vehicle Research Center, which included a state-of-the-art crash test facility, in 1992 and publishes data on vehicles to assist the consumer in making informed choices.[62] Yet only in the twenty-first century has crash testing and publication of data become a standard feature of the U.S. government's National Highway Traffic Safety Administration (NHTSA), although, adopting an entirely too friendly view of the ability of industry to regulate itself, the Bush administration weakened NHTSA's scope, purview, and rule-making ability. It watered down a regulation requiring tire pressure monitoring systems on vehicles (an action later overturned in court), advanced an ineffective standard that otherwise would have protected passengers in rollover accidents, and permitted outdated standards for door locks, seat backs, gas tanks, and headrests to remain in place.

Fortunately, U.S. roads are built to exacting standards. Not so Russian and Soviet roads, which in their design and maintenance fail to take into account the fact that accidents will occur and that roadways indeed contribute to them. Whether streets or highways; gravel, dirt, or asphalt; forest, agricultural, town, or city, these roads age rapidly. Built with inappropriate machines used in other sectors of the economy, built cheaply with inadequate foundation and thin surface, they degrade overnight, developing washboard bumps and huge potholes. At more than a moderate speed, the driver easily loses control. All roads lack guard rails, water and sand barrels, and other technologies to lessen the impact of accidents. Signs at best are an afterthought. Illuminated and/or reflecting signs to indicate exits, turns, and hazards have only recently begun to enter Russian consciousness. Unfortunately, Russian officials rarely consider such traffic-calming measures as speed bumps, narrower streets and broader sidewalks, bicycle paths, and lowered speed limits. They have much to learn from their Dutch, German, and Norwegian colleagues, who have determined that the automobile must be slowed and its drivers converted into mothers, fathers, brothers, sisters, and friends of pedestrians. Traffic calming is such a foreign concept in Russia that no translation of the idea into Russian exists.

As automobile ownership expands at an exponential rate, these safety problems have become another public health epidemic. Were money the answer to the problem, the problem would be big but perhaps solvable. Yet the Putin administration has failed to provide adequate resources. Only 1 of every 100 kilometers of road in need of repair was repaired in 2006; the government estimates the need to build 2 million kilometers of modern roads. According to Russian government statistics, in 2006 the federal budget for highway and roads programs needed $90 billion but received $20 billion. And in 2007, highway officials requested $100 billion and received $43 billion. Such simple safety devices as accurate maps have just appeared. During the Soviet period, there could be no accurate maps of value to Soviet citizens or foreign spies alike.

Lessons of the Russian Culture of Unsafety for American Regulators and Citizens

A few years ago I observed workers of the Moscow City Heating Authority cut open a huge section of sidewalk on Leninskii Prospect to get at a steam pipe that had ruptured. We see the same kinds of ruptures in all cities as infrastructure, under great temperature and pressure, succumbs to natural aging. Steels creep and break, reinforced concrete decays, the old must be renewed. On numerous occasions Consolidated Edison of New York has faced the same challenges of repair in difficult conditions that the Moscow workers experience. With the cooperation of police, Con Ed workers quickly move residents out of harm's way, erect relatively hermetic plastic tents, and enter the fray in full battle regalia of sealed suits and respirators. Not so in Moscow. Over a series of weeks, under open skies, the workers jackhammered down to the pipes covered in insulation permeated with asbestos. Wearing only leather gloves, they cut through the pipes with chainsaws fitted with diamond-tipped blades, used a crane to lift out the pipes, and dropped them onto the back of Kamaz dump trucks, whose operators rumbled off down Leninskii Prospect without bothering to cover the pipe in any way. The same process of repair with inadequate attention to worker and resident safety continues to play out all over Russian cities today.

On another occasion, I visited a lumber mill in Arkhangelsk Province on a very hot July day. The mill's owner was a superb guide. He showed me the entire operation and asked the workers who were on lunch break to cut some logs into planks using gang saws. The mill workers appeared from their cots in the mill through the mist of sawdust in sandals and shorts. No one wore any safety equipment—no goggles, no earplugs, nothing. Upon learning that I was an American, the men not only joyously completed their task, but then brought out a few bottles of vodka to drink with me before the afternoon shift. These workers, and those of the Moscow Heating Authority, have grown up on Soviet-era playgrounds and played with Soviet-era toys. While the Putin administration has shown its deep concern about industrial accidents, declining life expectancy, excessive smoking (especially among males), and growing alcoholism rates, it may be another generation before government officials successfully create a new attitude toward risk and safety so that all citizens may enjoy the benefits of the modern industrial world.

Take a flight in Russia. Before the plane has reached the gate, before the fasten-seat-belt sign is off, several passengers will be up and about the cabin to get their bags and put their jackets on, oblivious to the threat they pose to themselves and others, and to the admonitions of the flight attendants. Many of them will head to the restrooms during the flight for that cigarette, and the flight attendants rarely stop them, nor do they see to it that they are arrested on arrival at the terminal. I suppose, however, that the planes themselves are an improvement. It has been fifteen years since I saw on the Novosibirsk-Irkutsk flight an open flame on a Bunsen burner device being used to heat up chicken.

The most important tool to combat unsafety is openness. An informed citizen is a safer citizen. During the Soviet period, data on health, safety, accidents, and pollution were usually classified. The Putin administration began the practice of publishing safety data on accidents in all areas. It adheres, for example, to International Atomic Energy Agency standards for monthly reports on incidents at nuclear power stations. The data may be hard to find for some industries, but they are there. And some consumer groups have begun to form to force the federal government to pass legislation concerning product liability to protect the consumer, at the same time strengthening laws to improve workplace safety. Shockingly, taking a page out of the Soviet manual for worker safety—with an emphasis on secrecy and deception, and being in cahoots with big business—the Bush administration abandoned in many cases accepted safety practices in the name of profitability for business. After 2001, the Mine Safety and Health Administration staff was downsized by 170 positions. Industry officials appointed to administer mine safety lowered or ignored fines required by law and fired whistle blowers, with the result that accidents and deaths are on the rise. The budget in real-dollar terms for the Occupational Safety and Health Administration was cut, and the agency lost 162 positions from its already inadequate staff after 2001.

Deregulation and subterfuge exist in other industries. Nicole R. Nason, administrator of the National Highway Traffic Safety Administration, issued a ruling in 2006 to silence her staff researchers; they could no longer speak on the record with reporters about automobile safety. This built on a determination, published in April of 2004, that would forbid the public release of some data relating to unsafe motor vehicles, saying that publicizing the information would cause "substantial competitive harm" to manufacturers.[63] The Bush administration Labor Department spent the last weeks of his presidency making a new rule that would make it much harder for the government to regulate toxic substances and hazardous chemicals at the workplace. Business groups support the measure, while public health officials and labor unions say it will delay needed protections for workers and result in additional deaths and illnesses.[64] As some American officials consider relaxing standards or cutting budgets for regulatory agencies, permitting the sale of unsafe things, or creating institutions founded on secrecy, it is well to remember the great human and environmental costs of the experiences of the culture of unsafety in Russia.

Is it possible that America and Russia share more features than we realize? Beyond vast geography, rich natural sources, and desire for empire, do they share a common attitude about the place of technology in modern culture and its relationship to people? I sense an overriding interest in the acquisition of technology and its application to the natural world. Both nations desired to build the most modern, the most advanced, and the largest technological systems possible. The engineers in design institutes and construction firms, supported amply by their government, saw citizens as less important than the technology itself. They stressed fulfillment of the plan, the search for profit, not the public health and safety of the citizen. Yet for over 100 years, in spite of brief periods of backtracking, the U.S. government has become increasingly involved in regulating industry in the name of public health, as all enlightened governments, capitalist or socialist, must.

In the early nineteenth century, members of the English Parliament passed several laws aimed at protecting defenseless people from such dangers of the industrial world as treacherous machines and unscrupulous owners. Over several decades they increasingly restricted child labor and female labor, at first particularly in mines, hours of work, and so on. Somewhat later, the United States and other countries followed suit, although in all cases the governments failed to provide adequate budgetary support or personnel to ensure compliance. The Soviet government intended to demonstrate that, unlike the capitalist nations, it would protect the worker and make the workplace safe. On paper at least it succeeded. But by putting production ahead of safety, output ahead of pollution control, and iron and steel ahead of human bones, party leaders presided over the creation of a perilous workplace. The devil-may-care attitude extended to the home, to the store, and to recreation. Ultimately, the rise of a consumer culture with the expansion of the middle class ensured that industrial safety and product liability assumed a central place in other modern nations. Perhaps this culture of safety will develop in twenty-first-century Russia as its well-educated middle class grows.

Natalia Gippius (1905–94), "The Female Tractor Brigade—Mordovia 1942–1943," 1950s, lithograph. Liberated from paternalist family relations and patriarchal government, women would join the labor force in increasing numbers, especially during Stalin's industrialization campaign of the 1930s. They became doctors and other professionals in greater numbers than in the capitalist world. But they also, under Stalin, reacquired the responsibility to be the pillar of the family; hence, they had a twofold burden under socialism: to work a full-time job, and to take care of the family, often with little help from the menfolk. Courtesy of the Allan Gamborg Gallery, Moscow, Russia.

CHAPTER SEVEN

THE GENDERED TRACTOR

Women would share the benefits of socialism. They would be freed from patriarchal relations of bourgeois marriages at home in which they were treated as property and of low-wage exploitation and discrimination at work. They would overcome higher illiteracy rates than males, gain admission to higher educational institutions, and find opportunities for employment in fields previously closed to them, including as specialists in medicine, science, and technology. The same technological and political revolution that accompanied the transition from capitalism to socialism would put an end to the drudgery of housework and eliminate arduous tasks in the factory. In this environment women could be industrial managers, doctors, even tractor operators. The heroic socialist woman treated patients, weighed assays, poured concrete, operated jackhammers, and plowed the collective farm soil, smiling victoriously each step of the way.

A famous photograph from the 1930s that documented the construction of the Belomor Canal shows a woman with a jackhammer breaking up bedrock. The canal was a crucial early Stalinist hero project intended to demonstrate the ability of socialist society not only to rework nature in the absence of technological assistance from the West but to rework men and women, especially politically suspect individuals, into conscious, devoted socialist subjects. The rare photograph may be unfamiliar to many people, but anyone who has seen David Lean's film version of *Dr. Zhivago* recalls that we encounter Zhivago's likely daughter at a massive hydroelectric power station where she works as an engineer. (In Boris Pasternak's book, we first meet Tanya as a laundry woman at the front during World War II.) Both images were meant to suggest that women had been freed from patriarchal Tsarist society and exploitative productive relations by the Russian Revolution in 1917. But it remained an open question what kind of liberation women would discover under socialism. As a number of scholars have indicated, at work, at home, and in school, they encountered both significant opportunities for and obstacles to advancement and achievement of equality with men.[1] What remains less clear, given the Bolshevik fascination with modern technology, is whether the relationship of women with technology profoundly differed from that under capitalism. Was socialist technology one of the sources of liberation of women in the USSR, Eastern Europe, Cuba, and North Korea?

Socialist systems were at the vanguard of the women's liberation movement. In the USSR, decades before the United States, Great Britain, or Germany, women received roughly equal pay for equal work and had access to positions considered traditionally to be bastions of male employment. Socialist leaders never debated whether women should have the right to vote; universal suffrage was a central tenet of proletarian democracy. Women quickly moved into industrial jobs in the 1920s in the Soviet Union, and into factories and mills in East Central Europe after World War II. While often not in the heaviest and most dangerous jobs, they were not prohibited from taking such positions. On the domestic front, there was similar progress. A Bolshevik decree of 1917 permitted divorce and, according to a Soviet legal scholar, ended the enslavement of women to patriarchal relationships, freeing them from the influence of the church. A law of 1926 strengthened the rights of women in part by recognizing seasonal or otherwise fictitious marriages into which women had entered temporarily for labor or other purposes as *de facto* marriages.[2]

During the 1920s, Soviet leaders struggled to recover from a steep economic decline brought about by the Great War, revolution, and civil war. They adopted the so-called New Economic Policy or NEP, which permitted small-scale capitalism and eventually contributed to economic recovery. But the NEP led to widespread female unemployment, especially when demobilized soldiers returned from the civil war, and progressive labor protection laws may have served to increase the number of unemployed women since it was easier to hire males for whom labor protection laws were little hindrance. The Bolsheviks intended to achieve sexual equality in part by the recruitment of women into the labor force, but with protective labor legislation to protect their specific biological distinctions. This legislation raised the issue, if women got special treatment for their reproductive role, how could they ever be recognized as equals in the labor force or elsewhere? Would communal institutions of child raising require them to return to work earlier than they or their children wished? Should they have paid release from labor during menstruation? One possibility discussed by specialists and officials was permission for a few short breaks during the day when women were menstruating. Drawing on the Soviet Taylorist tradition of NOT (*Nauchnaia Organizatsiia Truda*—the scientific organization of labor), the specialists studied such issues as proper orientation of the body, for example, how to sit, to ensure that the organs functioned properly. Several specialists argued that female acrobats, tightrope walkers, gymnasts, and others should be given three days off during their periods. A decision of the Commissariat of Labor in May 1931 ordered that women tractor drivers be transferred to lighter work during menstruation if the tractor did not have soft seat springs.[3]

The liberation of women from oppressive capitalist institutions did not go as far as socialist feminists had anticipated. After a brief period of experimentation with new ideas and institutions, and with laws that liberalized divorce and decriminalized abortion, Soviet women suddenly faced a growing dual burden of obligations in the factory and at home. When Stalin introduced five-year plans for rapid industrialization at the end of the 1920s, the demand for female laborers increased in virtually every sector of the economy. Yet the social turmoil that resulted from industrialization led to policies that tied women more tightly to traditional family relations. Simultaneously, they were denied access to safe and inexpensive birth control, no less than women in the United States and elsewhere; the U.S. Supreme Court ruled only in 1965 in *Griswold v. Connecticut* (381 US 479) that women had a constitutional right to privacy and invalidated a Connecticut law that prohibited the use of contraceptives. While not prohibited in the USSR, safe and reliable birth control was simply unavailable—insufficiently produced and of low quality—until the fall of the Soviet power in 1991.

Pro-natalist policies in other socialist nations were more draconian. In the early 1960s, Romanian dictator Nicolae Ceausescu determined to build socialism by adding 7 million Romanians to the nation's population of 23 million by 2000. He made pregnancy a state policy. He illegalized abortion. In 1966 he decreed, "The fetus is the property of the entire society. Anyone who avoids having children is a deserter who abandons the laws of national continuity." Granted, the population doubled, but infant mortality soared to eighty-three deaths per 1,000 births, or 7 times the European average. Failing to provide natal, neonatal, or postnatal care, one in ten newborns was underweight, while newborns under 1,500 grams were classified as miscarriages and denied treatment. Ceausescu further forbade sex education and contraception. Still, 60 percent of all pregnancies ended in abortion or miscarriage. So-called "menstrual police" began to round up women of reproductive age every couple of months to question them about their reproductive status, punishing them also financially if they were suspected of having an abortion.[4] If women and men had jointly engaged the tasks of homemaking, shopping, and child raising, if the Stalinist state had not insisted that women must be the centerpiece of the nuclear family to ensure social stability, and if manufacturers had provided such household appliances as gas or electric cook stoves, vacuum cleaners, washers, and dryers, perhaps they would have been truly liberated and welcomed the opportunity for more children. But they faced a dual burden of having to work full-time jobs and to care for the family, of being simultaneously liberated from outmoded capitalist institutions and subservient to larger state economic, political, and ideological goals.

Technology and Gender under Socialism

The disjunction between the pronouncements of socialist leaders, feminists, and party theoreticians about the joyous future for women under socialism and their incomplete liberation had interrelated political, socioeconomic, and technological roots. The case of the "gendered" tractor not surprisingly resembles that of the other cases in this book used to consider the place of technology under socialism. The nations of the former Soviet Union and Eastern Europe embraced rapid industrialization and collectivization of agriculture, itself based on the mechanization of the countryside, with an enthusiasm and pace that shocked observers elsewhere in the world. The leaders of those nations had no hesitation in their headlong pursuit of modern technology and its application willy-nilly throughout society. They accepted the Marxian viewpoint that a successful revolution from capitalism to socialism required industrialization on a great scale, perhaps greater than in the capitalist nations. They believed that they would avoid the human tragedy of industrialization as it unfolded in England, Germany, and the United States—poverty, filth, exploitation, dangerous work. They assumed that women would benefit equally as men and that minority nationalities would also be liberated from oppression and Great Power chauvinism. They set out to create educational and public health systems, green cities, and safe industries, and in many cases they indeed achieved remarkable things, in which women equally shared.

Perhaps because they commenced industrialization as largely peasant societies, socialist leaders encountered intractable, perhaps unavoidable obstacles: the violence of the transformation of peasants into conscious workers; the migrations—often forced—of dwellers of the countryside into burgeoning cities; the displacement of family members, including the separation of husbands from wives and children; extensive pollution and environmental degradation from mines to mills, from forests and rivers to the cities; and poor quality of life by a variety of measures—exposure to industrial noise and filth, lower life expectancy than in capitalist nations, and the creation of inflexible regimes that used coercive measures to achieve the social and economic goals of industrialization and collectivization, goals that they presumed could be the only true goals of the modern citizen. Women and children seem to have suffered disproportionately from unfortunate technological choices and the heavy-handed ways in which the state pushed technologies with immediate economic, if not direct military, benefit. Indeed, in every case considered in this book, the state was the prime mover in technological choices. Granted, the technological choices reflected leadership styles from Vladimir Lenin to Joseph Stalin and Nikita Khrushchev in the USSR, and from Nicolae Ceausescu in Romania to Kim Il Sung in North Korea and Boleslaw Bierut in Poland. Yet heavy industry and large-scale, centralized projects that served state political, ideological, and economic purposes were constant features.

Similarly, the decision to embark on collectivization of agriculture reflected a fateful socioeconomic judgment: that the peasant was backward, was overly religious, and did not understand agronomy; that his farm was an inefficient relic; and that he had to be brought into the twentieth century, by force if necessary. Socialist leaders likely believed that the peasant woman was even more conservative than the man, and with good reason. She was more religious and believed that she was the bedrock of the family. Seeking labor inputs for burgeoning industry, they did not worry about the human costs of displacement as families were pushed aside or pushed into the cities to assume new and unfamiliar industrial jobs. In spite of the goal of creating a society that ended the workers' alienation from the machine, the socialist factory was not only alienating, but a dangerous, filthy, noisy place to be. And socialist governments in East Central and Eastern Europe refused to learn from the Soviet experience. They adopted the Stalinist model of rapid industrialization and collectivization that had had such great human and environmental costs in the USSR, and they put additional burden on women and children. Party officials and economic planners focused investment policies everywhere and always on heavy industry at the expense of light industry and the consumer sector. This contributed to the creation of a society of scarcities: scarcities of food, comfortable housing, sporting goods, vacuum cleaners, refrigerators, and many other goods, scarcities that had more immediate and direct impact on women. When industry produced those goods, they were noteworthy for their brutish operation. The Soviet-era washing machines I have used seemed modeled on an industrial bread mixer, and the spin cycle generated high RPM, yet spit out still damp clothing, often tattered and stained brown or gray by allegedly treated and filtered municipal water. Considering their interest in encouraging higher fertility, the planners ought to have invested in consumer goods so that mothers knew that they had the assistance in child raising of a spin-dry cycle, if not a husband.

Perhaps the authorities assumed that merely the presence of socialist productive relations would ensure a healthy, collectivist, communal, nonalienating relationship between (woman) worker and machine. They believed that technology would rapidly transform the citizen into a new socialist man and a new socialist woman, and that it would transform capricious nature into a servant of the planned socialist economy. Socialist scientists and engineers driven by hubristic desire to improve the physical world, political officials hoping for military and economic benefit, and citizens enamored of their glorious scale—or forced to toil in their construction and pushed out of their homes and cultures to see them built—combined vision, finances, and physical might to build large-scale technological systems that dominated the landscape and daily life. These included canals, dams, hydroelectric power stations, and irrigation systems to transform riverine geography and ecology and railroads, roads, and highways that moved people and goods from the farm, forest, and mine to the factory and to the market, and from rural regions to urban ones, forever transforming the economic and political relations between them. Such symbols of technological verve and state power as jet airplanes, nuclear reactors, hydrogen bombs, space-ships, high-rise apartment buildings, railroads and roads, modern megafarms, telegraph, telephone, radio, television, tape recorders, computers, and dozens of other technologies came into being that reflected the hopes of leaders and citizens alike to improve the quality of daily life. Yet the infectious technological enthusiasm that characterized socialist thinking and carried over from decade to decade and from country to country gave us smoke-belching factories, high rates of industrial accidents, Chernobyl, and life expectancy and infant mortality rates that lagged behind the capitalist nations, but not such simple and important items as home appliances, feminine hygiene products, or birth control. Was a liberated woman under socialism like a fish without a bicycle?

In the socialist USSR, the postwar countries of Eastern Europe, North Korea, Cuba, and China similar hopes and similar costs accompanied the development of large-scale technological systems. Indeed, the governments of these countries pursued technological development with an enthusiasm and confidence that exceeded that in capitalist Western Europe and North America. Perhaps they had no choice for this enthusiasm. Their leaders and the vanguard revolutionary parties they represented took power in agrarian societies with a very small proletariat, not in the industrialized settings that Marx and Engels had predicted. They lagged considerably behind the capitalist nations in technology however you measure it—kilometers of track or road, capacity of electrical power production, numbers of automobiles, lorries, tractors, or combines, and so on. They feared war with capitalist nations and saw the need immediately to increase industrial production, especially in industries that were central to military might: mining, metallurgy, machine building, and construction. They collectivized agriculture, believing that collective farms were more efficient than small private plots, and understanding that the rapid and always violent process of collectivization would force peasants from the countryside to the burgeoning factories. All of these technologies and processes were to benefit men and women equally.

Another reason for their enthusiasm was their belief that technology somehow, magically, would transform their backward societies into socialist superpowers. Collectivization plus the tractor would change the peasant into a worker, if not a dedicated ally, overnight; the smiling, somewhat buxom female tractor operator became a major symbol of the propaganda campaign surrounding collectivization in the USSR in the 1930s. Electrification would ease toil in the factory and on the farm. Concrete, a magnificent, versatile material, could be spread over any surface, used in any structure, and manufactured in prefabricated forms to raise apartment buildings, spread roads across empty spaces, erect monuments and signs, and build factories. Radio, film, and the press would ensure a common method and common goals of all the socialist brothers and sisters who toiled selflessly toward the end of the communist future. Above all else, socialist citizens adopted an avowedly transformationist view of technology as a tool with a broadly political and social purpose beyond its more narrow technical functions as the best way to transform nature, society, and the people in them in a short time into socialist nature through socialist technologies with socialist productive relations and newly socialist men and women. Few authors criticized the various purposes, reach, or unanticipated consequences of technology, its environmental consequences, for example, or its unsettling impact on human social institutions and cultural traditions.

Yet, in embracing technology under socialism as a transformative tool, leaders, engineers, and planners tried to have it in two contradictory ways. First, they assumed that technology was value-neutral, an artifact or thing-in-itself, that it might be imported from a capitalist nation without attendant inequalities, and that new technologies would rise out of existing ones based solely on determination of technical innovations. In *State and Revolution* (1917) Lenin asserted that "any cook can learn to administer the state." This implied that workers should be able to run any factory, and indeed as workers established committees to run factories, industrial production plummeted, in large part because they lacked the experience to run them. This led the Bolsheviks to turn to so-called bourgeois specialists and managers to be centrally involved in the production process, if with a "red" manager looking over his shoulder. In Marxian terms, socialist planners, managers, and party officials frequently ignored or did not comprehend that technology involved relations of power between engineers, enterprise managers, planners and politicians, peasants and workers, and men and women. Second, they simultaneously adopted an avowedly political view of technology. Whether it be Lenin, who saw electrification as the key to building communism, or Trotsky, who argued that the railroad, roads, and other forms of communication would build the necessary connection between the countryside and the city, between the peasant and the worker, they recognized crucial political-economic and social functions of technology. That is, they both denied that technology had politics and maintained a strongly Lamarckian view of the ability of technology to transform the environment and the people in it. How did all of these views and attitudes play out with respect to the new socialist woman in the USSR?

The Soviet Margaret Sanger

Soviet leaders envisaged new citizens who would differ from their capitalist counterparts in their collective altruism, their commitment to the common good, and even the absence of criminality and other negative features of capitalism owing to the institution of socialist productive relations. They introduced a series of communal institutions for housing, health care, education, child raising, and provision of food. By transforming capitalist into socialist productive relations, they would create the new man and woman, likely within one generation. (Before his death in 1924, Lenin worried that efforts to transform the Russian peasant into a conscious socialist citizen would certainly take more than a generation and urged caution. Elsewhere he wrote that the tractor itself would turn the peasant into a communist. But under Stalin, of course, the Soviets abandoned all worry that a breakneck pace toward collectivization might alienate the peasant.) In their belief that change in the environment would lead to changes in human nature, party theoreticians and leaders had adopted an implicitly Lamarckian view of human heredity. In this, they differed from the eugenic—and determinist—view that increasingly prevailed among European and North American thinkers.

Many observers have properly praised Margaret Sanger for her efforts to bring safe and reliable birth control to American women as part of the process of their liberation from patriarchal state and family relations. Through the Comstock Act of 1873, which prohibited using mail to send "obscene, lewd, and/or lascivious" materials, women were denied even advice about birth control. Predating Ceausescu's menstruation police by nearly 100 years, the zealous Anthony Comstock gathered a team of investigators to enforce the Act and not only to fight against the dissemination of pornography but also to ban reproductive devices and prevent physicians from offering advice on birth control as well. Sanger directly fought the Comstock Act, was indicted for violating the law in 1914, but continued to publish a series of pamphlets explaining reproduction and offering advice on birth control.[5] In 1916 Sanger opened a birth control clinic in the Bronx, in 1927 organized the first World Population Conference in Geneva, and in the early 1940s helped establish the Planned Parenthood Federation. In all of these ways, Sanger sought to provide women with information and to improve public health. Yet in her writings about race and class, Sanger seemed enamored of the ideas of the eugenists and shared their concern about the high rate of fertility among "inferior" workers and immigrants.

In the United States, Germany, and other European countries, population control and women's rights experts, eugenists, and others advocated fertility control for a variety of reasons that shockingly interfered with individual rights. They placed the state's or society's rights over those of the individual in the name of good science and progressive policies. In the United States, during the Progressive Era (1890–1920), they sought to use the science of eugenics to eliminate disorder and degeneracy that seemed to threaten society during a period of rapid urbanization, migration, immigration, and industrialization. Eugenics would improve society's genetic stock scientifically, ensuring that the most fit mentally and physically reproduced. Simultaneously, women's rights advocates demanded that women have access to safe and inexpensive birth control both because of her individual rights and to protect herself. Population control experts worried about overpopulation generally, and sharing a great deal with their social Darwinist forebears, they feared society being overrun by large numbers of unfit individuals. These individuals usually were persons of color or working class or both. Eugenists, seeing such traits as "feeblemindedness," "kleptomania," "promiscuity," and a variety of diseases as heritable, wished to apply modern genetic knowledge to identifying carriers of those negative traits and then preventing them from reproducing.[6] There were two ways to prevent them from reproducing: segregation or sterilization.

In the United States, state government officials joined eugenists in seeking segregation through a series of laws that ranged from marriage licenses, to ensure "fitness" of the individuals to be married, to official determination of someone's alleged eugenic incompetence so that he or she would be placed in a special colony (prison or hospital) to prevent reproduction. Even more insidious was sterilization. Egged on by eugenists, thirty-three states eventually adopted sterilization laws to prevent those deemed by the state to be inferior from reproducing. The U.S. Supreme Court determined in *Buck v. Bell* in 1926 that the state had the right forcibly to sterilize "inferior" individuals, with Chief Justice Oliver Wendell Holmes writing infamously, "Three generations of imbeciles are enough." With California leading the way, over 65,000 were sterilized in the United States. The evidence of their unfit biological essence included alcoholism, feeblemindedness, moral perversion, and recidivism (those convicted of three crimes or more), with eugenics specialists and doctors determining after cursory examination whether an individual was fit. Indeed, the examinations often involved written reports, not any personal contact. Germany (Weimar and

National Socialist), China, and India also adopted government-sponsored sterilization programs in the name of progress, but not the USSR.[7]

The debates among Marxists and non-Marxists about the impact of the revolution on human nature and on such human institutions as the family were never clearly resolved. The essential question was whether the creation of socialism led to conditions in which the new Soviet man and woman would arise. Absent capitalism, would the new citizen be altruistic, communal, unlikely to commit criminal acts, and devoted to the proletariat? According to many writers, the socialist environment must transform the human being. This, of course, is a Lamarckian view, based on the supposition that living things adapt to changes in the environment and pass them on to the next generations. If, on the other hand, to put it in contemporary terms, humans were a product of their genes, then they would likely maintain many characteristics under socialism that prevailed under capitalism.

The discussion that Alexandra Kollontai and others engaged unfolded against the backdrop of the rise of eugenics. Eugenics was the science of the improvement of the human race. Using such tools as quarantine, anti-miscegenation and other marriage laws, blood tests, and even such coercive measures as forced sterilization, those deemed less fit by scientists could be prevented from reproducing, and the overall genetic quality of society would improve. Society would eventually rid itself of the less fit—generally this meant the poor, immigrants, and minorities. As Loren Graham explores, eugenics had a healthy reception in the USSR in the 1920s, although it is hard to establish hard and fast rules about the positions of the supporters and detractors. Many Marxists were eugenists, and many anti-Marxists were Lamarckian in their views. In Tsarist Russia both biologists and members of the lay public broadly accepted Darwinism. They were therefore prepared to engage discussion of eugenics in the 1920s, with two major organizations pushing this science. Early on, they discussed the impact of the revolution on their country, with some of them worried about its dysgenic impact with the loss of leading intellectuals, nobility, and others. By the mid-1920s they debated whether a socialist eugenics was possible. Many of them followed the European, especially German, lead in decidedly believing in racial differences, and a number of eugenists spoke in support of such state-supported measures as sterilization and anti-miscegenation laws to prevent the weak from reproducing.[8]

Yet party philosophers and others began to notice that the eugenists often engaged biologically determinist explanations at the expense of socioeconomic explanations. They believed that the conditions of socialism enabled precisely the creation of the new Soviet man and woman through new educational, insurance, medical, and other institutions. Many of them believed in the inheritance of acquired characteristics. Lamarckian explanations were important because of the role of the new institutions in remaking men, women, and children in modern socialist society. They expected rapid transformation of people into good socialist citizens with the creation of the socialist environment, while genetics seemed to set absolute limits to the betterment of human beings. They debated precisely what characteristics the proletariat inherited after the revolution. But all of this discussion raised a number of troubling issues: Did only good environments lead to the inheritance of good characteristics? Had the proletariat acquired only the debilitating effects of capitalism?[9] In all events, Soviet socialists criticized unfettered capitalism for its negative impact on the working class, and those like Kollontai believed in the improvement of women and men and their institutions under socialism.

One of the leading proponents of the view that an improved environment—in this case socialist productive forces and relations—would necessarily advance the human condition, especially the position of women, was Alexandra Kollontai, the major Bolshevik theorist of women's issues.[10] Kollontai shared none of these eugenic views. She was a long-time socialist, committed to the cause of workers' liberation and especially women's liberation. She believed that the socialist revolution was the single path to liberation from oppressive bourgeois marriages, patriarchy, exploitation in the work place, and barriers to employment in new fields. She did not write about technology and gender directly, but rather focused on the impact of changes in productive relations (not the productive forces such as tools, instruments, and technology itself) on women's position in communist society. She believed that disorganization and chaos that characterized capitalist industry would be overcome by rational organization of the available labor power of both men and women. This required the collective organization of the labor of housework and child rearing to benefit the collective. She called for the support of communal living, cooking, and child-raising institutions. Kollontai believed that women had to be freed from sexual and emotional dependence on men. There must be full equality of the sexes, including regarding sex itself. She believed that truly free women could choose her partners freely. She believed that women's liberation should extend fully to control of their hearts and bodies; she advocated open sexual relations that offended not only prudes and conservatives but Bolshevik leaders. Kollontai realized that all of this required the fostering of a new attitude or even "a new morality" among the proletariat.[11]

Kollontai devoted her adult life to socialist causes. She grew up in a well-to-do family and early on rebelled against her parents, marrying against their wishes, divorcing later, and through her life engaging in a series of relationships that demonstrated her belief in the importance of the independent will of women. She joined the Mensheviks, finding Lenin's version of communism too doctrinaire and valuing revolutionary consciousness among an intellectual vanguard over workers' initiative. She wholeheartedly supported the Revolution of 1917 and threw herself into Bolshevik causes, yet she soon joined the so-called Workers' Opposition in 1919 in protest against the bureaucratization of government under Lenin and the subjugation of workers' control and spontaneity to Bolshevik organizations. She also objected to Bolshevik reliance on Tsarist experts in industrial management. Kollontai became the first woman elected to the Party Central Committee. After the October Revolution, Lenin appointed her People's Commissar for Public Welfare.

Kollontai and other Bolsheviks sought to mobilize women for their complete liberation through Zhenotdel (the Women's Department of the Communist Party). During its eleven-year history from 1919 to 1930, Kollontai, Inessa Armand (often reputed to be Vladimir Lenin's lover), and other leaders of Zhenotdel called for reforms in health care, working conditions, child care, education, and family law to ensure women's equality in her dual role as worker and working mother.[12] Zhenotdel activists joined the campaign against illiteracy, for public health, and against sexual exploitation. Yet Kollontai and others like her could never resolve the central issue of liberation, motherhood, for men could be workers while women had to be workers and mothers. It was also unclear whether Zhenotdel and its supporters advanced a program for the liberation of women as women or a program to enable women to be more like men. Further, they could not decide whether special legislation was needed to protect women because of their biology. Would special rules regarding paid leave during menstruation not contribute to the belief that women were biologically inferior? Would such rules not transfer the patriarchal subordination from men in the family to the state? These questions became moot under Stalin. First, Stalin abolished Zhenotdel in 1930, claiming wrongly that women had achieved equality; he had tired of Zhenotdel agitation, which he found to be a nuisance during the industrialization and collectivization.[13] Then he introduced laws to tie women to the family. Kollontai had, by this time, been marginalized and pushed into the Foreign Service. She served as ambassador to Norway and Sweden and died in 1952 of old age, unlike other Old Bolsheviks, who were executed as enemies of the state.

Kollontai never doubted that the political, economic, and social revolution that accompanied Bolshevik power would end enslavement to bourgeois family institutions. She believed that social revolution would destroy the economic foundations of monogamy and its corollary, prostitution. Monogamy rested on the concentration of considerable wealth in the hands of a single man—and his need to bequeath this wealth to his children. Kollontai wrote, "But by transforming by far the greater portion, at any rate, of permanent, heritable wealth—the means of production—into social property, the coming social revolution will reduce to a minimum all this anxiety about bequeathing and inheriting. Having arisen from economic causes, will monogamy then disappear when these causes disappear?" At the same time, Kollontai argued, with the transformation of capitalist into socialist (collectively owned) means of production, "the single family cease[d] to be the economic unit of society." Housekeeping, child care, education, and other private institutions became social goods and public affairs. Socialist society looked after all children, legitimate or not. This contributed to liberation by removing social anxieties about pregnancy and enabled a woman to give "herself completely to the man she loves. Will not that suffice to bring about the gradual growth of unconstrained sexual intercourse and with it a more tolerant public opinion in regard to a maiden's honor and a woman's shame?"[14]

Yet in promoting these views, Kollontai encountered deep-seated social conservatism. Not only Russian and Ukrainian peasants but also Soviet sociologists seem to have held the view that a woman's role is more traditional, that she belongs in the home and kitchen. In interpreting their research results, the sociologists argued mainly over the policy of natality, but they did not question who should be the primary homemaker; maternal obligations were front and center in scientific and popular literature. School posters for the Pioneers, a communist children's organization, showed only girls in sewing classes and only boys in mechanics classes; sex role socialization began at an early age. And there is no evidence that among well-educated women, those who took full advantage of Soviet equality, the men at home were any more active in homework or child raising than among women in working-class professions.[15] Not only did the conservative and religious remnants of Tsarist society—peasant and working men and women, priests and others—disapprove of sexual liberation. So did such Bolshevik leaders as Lenin.

Kollontai attempted to address their concerns in a series of novels and a pamphlet, "Make Way for the Winged Eros" (*Dorogu Krylatomu Erosu*). She wrote, "The sexual act must be seen not as something shameful and sinful but as something which is as natural as the other needs of [a] healthly organism, such as hunger and thirst." This led to Lenin's criticism that having sex would become like having a drink of water. The so-called glass of water theory, however, was not what Kollontai had in mind. She did not believe in promiscuity but in equality.[16] For Kollontai, the decree of the Council of People's Commissars of December 18, 1917, which enabled divorce simply and without the participation of the church, helped to establish legal equality for women, especially working-class women. The woman might "make herself independent of a brutish or drunken husband" who had beaten her. In so many other ways, too, the former family life, in which "the man was everything and the woman nothing—since she had no will of her own, no money of her own, no time of her own—this family is being modified day by day; it is almost a thing of the past."[17] Why must women become equal in sexual relations as well? "We are used to evaluating a woman not as a personality with individual qualities and failings irrespective of her physical and emotional experience, but only as an appendage of a man," Kollontai explained. "In the eyes of society the personality of a man can be more easily separated from his actions in the sexual sphere. The personality of a woman is judged almost exclusively in terms of her sexual life. This type of attitude stems from the role that women have played in society over the centuries, and it is only now that a re-evaluation of these attitudes is slowly being achieved, at least in outline."[18]

Kollontai wished to see prostitution eradicated, but in any event decriminalized, and she expected that the end of monogamy might lead to an end to prostitution. When Tsarist laws regarding punishing prostitution were abolished by the Council of People's Commissars, no new laws were introduced, and this led to confusion everywhere. In some areas the police still conducted periodic roundups of prostitutes as in the old days, in others brothels existed openly, and in still others the authorities considered prostitutes criminals and threw them into forced labor camps.[19] Kollontai saw a close relationship between the evils of capitalism and prostitution, where "depraved old men" had access to brothels that specialized exclusively in very young girls. Facing greater levels of unemployment than men, women were forced to seek out the "flesh" trade. Low wages, social inequalities, the economic dependence of women, and "the unhealthy custom by which women expect to be supported in return for sexual favors instead of in return for their labor" turned women to prostitution. Kollontai saw bourgeois marriage as similar to prostitution. She wrote, "There is an undeniable element of material and economic, considerations even [in] the most legal of marriages. Prostitution is the way out for the woman who fails to find herself a permanent breadwinner. Prostitution under capitalism provides men with the opportunity of having sexual relationships without having to take upon themselves the responsibility of caring materially for the women until the grave."[20]

The socialist revolution "struck a blow at the former dependence of women upon men." Equal citizens worked for the collective, were equally responsible for it, and could rely on it when needed. This had liberated women from marriage, for a woman "provided for herself not by marriage but by her role in production and her contribution to the common good." Since the social relations had been transformed, what forced women into prostitution? Kollontai pointed out that in the transitional period such factors as homelessness, neglect, bad housing conditions, loneliness, and low wages plagued women.[21]

Tatiana, the Traktoriska

When the Bolsheviks took power, they had not systematically thought about the place of technology in capitalist and socialist society, except generally to equate "technology" with industry, the means of production, tools, and/or the productive forces of the economic basis. Nor had they considered the relationship between women and technology after the revolution, as the foregoing discussion of Kollontai's views would indicate. Rather, after the revolution the Bolsheviks who wrote about women's issues focused on liberation of women from bourgeois institutions of marriage, decriminalization of prostitution, and equality on the shop floor. All of these required new attitudes toward labor among men and women alike. At the same time, as soon as the Bolsheviks took power they made divorce a simple matter and legalized abortion. These laws had a significant and unexpected impact on family life; men much more willingly abandoned their wives and children, and the absence of alimony payments put a significant burden on women. Communal institutions of child raising, day care, and education were supposed to ensure that the burden for work and family was shared among both sexes. But in the anarchy of migration to and from the countryside, disruption of food and fuel supplies, ever-changing fronts of world and civil war, and limited budgets, these institutions barely functioned. Indeed, women and children bore the brunt of the revolution, with millions of orphans left to fend for themselves on the streets and single women often carrying entirely the burden of child raising. The utopian dream of communal institutions fell prey to economic disaster, political uncertainties, and male flight.

In theory and in practice, however, the Bolsheviks made tremendous strides in the liberation of women. Early decrees required equal pay for equal work, equal access to education, and, for women in particular, protection from hazardous work. Unfortunately, and not surprisingly, the authorities did not uniformly enforce the laws, and many male peasants and workers resisted the changes. Still, women seemed to be on the path to true equality, especially when Stalin's five-year plans required significant additions to the labor force of well-educated men and women. Birthrates had begun to decline, as often usually accompanies industrialization and a rise in level of education of females.[22] On top of this, of course, the disruptions, arrests, and dislocations caused by collectivization and the purges lowered fertility rates. (By the late Soviet period, the political authorities and planners grew deeply worried that Slavic women had achieved such low fertility rates to meet zero population growth, while Muslim women in Central Asia had high fertility owing to cultural prohibitions against birth control and abortion and interest in larger families. Would labor inputs to the Slavic Red Army and labor force come from Muslims? What were the implications for the political and social stability of the empire as it became increasingly Muslim?) To combat the decline in fertility, Stalin ordered that many of the laws that defended the equality of Soviet women be abandoned. Stalin sought to reestablish the nuclear family as a pillar of stability. He recognized the need for more women to enter the labor force and also a higher fertility rate. Hence, abortion was illegalized and simultaneously divorce became much more difficult.

Women were crucial to Stalin's industrialization campaign of the 1930s. He needed laborers, millions of them, to fill positions at the thousands of new enterprises being built throughout the socialist fortress; 1,500 enterprises opened during the first five-year plan alone. Peasants left the countryside in droves in search of work, or they were forced to move by the process of dekulakization (the identification and elimination of allegedly hostile, leading elements of the peasantry). As in so many cases of industrialization, men often left wives and children behind, promising to visit when they could and to send money home. They crowded into dorms, barracks, and communal apartments where smoke, drink, and prostitution deadened their thoughts in the evening. Many were later joined by their families. Or, in many cases, young men and women thrust into unfamiliar industrial surroundings found quick romance and comfort in each other's company, had children, and married. For Stalin, the traditional family would be a pillar of the legitimacy of the state and a garden where the praises of the great leader might be nurtured. The mother would give birth to needed labor inputs, get her hungover husband off the sofa and along to work, ensure that children went to school, take care of daily shopping, and work a full-time job, often in an industrial setting.

The Soviet woman worker was buffeted from all sides by political, ideological, and economic winds. Women had made great strides in terms of education, employment, and professionalization, yet on the whole they held inferior positions in industrial, agricultural, party, or government institutions. On top of this, the fact that Soviet women lost many of the advances in marriage and family law under Stalin indicates the truly ambivalent state of their "emancipation." Women were mobilized to industrialize the nation and tied more closely to the family, a process that began in the 1920s when party officials realized that unpaid female labor at home was the cheapest way to raise children, especially given the weak institutional support in terms of day care, kindergartens, communal dining halls, and the like. When soldiers were demobilized and returned to work, women faced increasing job and wage discrimination, no matter that Zhenotdel sought to defend their interests. Even during the first five-year plan, party officials underestimated the value of female labor, and when they realized the essential contribution women could make, they simultaneously eliminated the Zhenotdel, an organization that might have helped to mobilize them for the industrialization effort, on Stalin's orders. By 1935, nevertheless, women constituted 42 percent of all industrial workers. As real wages fell during the 1930s, women streamed to the cities seeking jobs in dining, education, health care, and administration to support their families. But the flow of women workers to various industries was unplanned, chaotic, and ad hoc. In areas where skilled male workers were replaced by women, these policies exacerbated existing deep-seated male prejudices against women workers. Despite party injunctions to hire more women in heavy industry, factory management continued to hire women for the jobs requiring the fewest skills, often in areas entirely unrelated to production, such as haulage, repair, and cleaning. Managers did not want to train women to take on skilled work and hesitated to promote them. On the shop floor, male workers physically and sexually harassed female workers. And with the abolition of the Zhenotdel, there was no other institution that could take up the issue of inequality in the workplace.[23]

The authorities determined to adopt pro-natalist policies overnight. In 1936 they removed many of the rights of children born out of wedlock. Crucially, they shifted child-raising responsibilities from society back to the family. The ideological goal of women being an important part of labor force remained, but women resumed the central role as family anchor. Laws that strengthened the family as the unit of society were intended to end the "frivolous" attitudes of fathers and mothers toward children. Simultaneously, the government increased aid to families for day care and schools, although this aid was entirely inadequate to the task. In terms of legislation and laws regarding family, divorce, and abortion, Pichugina asserted that they had achieved the desired ends of strengthening the family, encouraging marriage, discouraging divorce, and protecting the child: "The law fully achieved its aim—the strengthening of the family. There has been a sharp decline in the number of divorces. For example, in Moscow in 1936, 16,182 divorces were registered, whereas in 1937 this number declined to 8,961. In 1936, 71,073 children were born in Moscow, whereas in 1937, 135,848 children were born."[24] A 1944 law increased aid to unmarried women and pregnant women and established the title of "Hero Mother" to that tireless and vigorous Soviet woman who managed to have ten children. The 1944 law also ended de facto marriages and alimony without real state-recognized marriages. This required women to turn to the state for aid or to register children in an institution, which stigmatized mothers and their children born out of wedlock. The law provided for complete equality of sexes regarding property ownership, including inheritance of pensions. Finally, the 1944 law reversed the confusion that arose with the 1926 law that had made both marriage and divorce so very easy. The new law required that the interested parties go to court for adjudication; divorce was in no way a certain outcome.[25]

This lifestyle was a long distance from what Marxist theorists anticipated after the revolution. They saw no less than complete liberation from patriarchy and the nuclear family. Engels considered the family no less than religion to be a form of enslavement to outdated, outmoded productive relations. In his *Origin of the Family*, *Private Property and the State* (1884) Engels wrote, "Along with [the classes] the state will inevitably fall. Society, which will reorganize production on the basis of a free and equal association of the producers, will put the whole machinery of state where it will then belong: into the museum of antiquity, by the side of the spinning-wheel and the bronze axe." He continued, "Wherever the monogamous family remains true to its historical origin and clearly reveals the antagonism between the man and the woman expressed in the man's exclusive supremacy, it exhibits in miniature the same oppositions and contradictions as those in which society has been moving, without power to resolve or overcome them, ever since it split into classes at the beginning of civilization." He found marriage to be a repugnant institution in spite of its legal façade of equality. Instead, "The modern individual family is founded on the open or concealed domestic slavery of the wife, and modern society is a mass composed of these individual families as its molecules." The monogamous family had to be abolished as the economic unit of industrial society no less than classes would whither away.

The so-called Stalin Constitution (1936) epitomized this conservative attitude toward the citizen. According to the constitution, the citizen's major "right" was as a laborer in support of state programs. The constitution guaranteed a variety of rights, including those of speech. Articles 118 through 121 guaranteed an end of unemployment, the right to work and to be paid according to its quantity and quality, free education at all levels, free medical care, access to health resorts, and a pension and disability insurance. Article 122 concerned equal rights for women:

> Women in the U.S.S.R. are accorded equal rights with men in all spheres of economic, state, cultural, social and political life. The possibility of exercising these rights is ensured to women by granting them an equal right with men to work, payment for work, rest and leisure, social insurance and education, and by state protection of the interests of mother and child, prematernity and maternity leave with full pay, and the provision of a wide network of maternity homes, nurseries and kindergartens.

This language obscures slightly the determination that women had a central role to play in building socialism as producers and as bearers of children responsible for caring for them. Maternity had become a social and political task. The collectivized socialization of child care and domestic labor was subordinated to the state's priority of ensuring a growing supply of labor. In an environment of growing shortages of food and consumer goods and heightened tensions at home and at work because of the Stalinist purges and the pressures of the plan, many of the reforms and communal services (day care, kindergarten) instituted to ease the burdens on women were abandoned. Atomism and individualism replaced collectivism in the family. The unpaid domestic labor of women replaced state-supported child care. And women carried the double burden of family and industrialization, especially because the emphasis on heavy industry meant limited investment in the consumer sector. Whether this was the result of a conscious decision to return to the traditional family or the consequence of economic pressures, Stalinism had a direct, negative impact on women's liberation.

So uninspiring and oppressive was Stalinist "liberation" from the capitalist system that women often joined in work actions against the state, although at great personal risk. They fought collectivization, refusing to join the farms and often descending with their insults and fists on soldiers and police who had come to the village to force the question. They protected their menfolk from physical assault by party operatives in the village.[26] At the factory, they also rejected growing hardships caused by rapid industrialization. Five-year plans were supposed to guarantee rational production and distribution of goods and services, but the massive campaigns of the 1930s plans were anything but rational. Bottlenecks and shortages of iron, cement, and building materials persisted in heavy industry, while shortages of food and consumer goods were endemic in light industry. In 1932 workers at a textile mill in Teikovo in the Ivanovo industrial region, the first place to establish Soviets during the 1905 revolution, went on strike. They struck because of rationing of food at roughly 40 percent of previous levels. In addition, there was little cotton to mill. The volatile combination of hunger and idle time led them to strike. Female employees, mostly spinners and weavers, succumbed to the strike on the third day, joining in marches of up to 4,000 demonstrators to Teikovo's central square. A large percentage of employees in the textile industry were women. The secret police came out in full force to put the strike down. A strike in Stalin's USSR was unexpected in any event because of the likelihood of arrest and imprisonment. But by the sixth day, women brought their children—and their tears—to the strike action. Rossman claims that women were likely to join the strike because of their numbers and the fact that they were socialized to be caregivers and thus felt disproportionately the impact of food shortages, were inclined to riot when food shortages loomed, and finally were willing to take advantage of their stereotypes—they were emotional, predisposed to unruly behavior, and less vulnerable to prosecution.[27]

Hence, while gaining the right to equal pay for equal work, women still lived under socialism as unequal partners to men. They had limited access to leadership positions in a variety of fields, and they now worked a double shift, providing most of the shopping, child-rearing, and homemaking duties while also holding down a job. The counterpart to Rosie the Riveter entered the labor force earlier than the American women who joined the production line when men departed to the armed forces during World War II. In 1934, 32 percent of Soviet workers (or about 3 million) were women, and by 1940, 37 percent of workers (or about 11 million, in service and other industries) were women. Although mechanization lagged significantly behind agriculture, forestry, and industry in the United States—and significantly behind what officials desired—technological innovations on the farm and in the factory made many more jobs available to women by lessening the brute strength required, and these were not temporary jobs. Women constituted roughly 150,000 machine tool workers and 124,000 engineers and scientists on the eve of World War II.[28]

Women also found relatively open access to university and advanced degrees in the socialist nations. This was a complete about-face from the situation in Tsarist Russia, where women were essentially limited to taking lectures in special women's courses organized separately from men at university. They became lawyers, doctors, and other professionals in numbers and percentages far higher than in the capitalist nations. Granted, these high percentages obscure the fact that female professionals encountered a concrete ceiling; in medicine, for example, deans, laboratory directors, and research physicians tended to be male, while females occupied medical service positions with lower prestige. In the sciences, as in the contemporary United States, women tended to have greater success in the social and life sciences than in the physical sciences, where outmoded ideas about women's inability to do mathematics prevailed—and prevail in Russia to this day. In spite of greater opportunity for women to pursue a wider range of careers, gender played a determining role in their employment in a number of fields: medicine, education, sales, secretarial. In 1959 women were 79 percent of medical professionals; in 1973, 73 percent, yet 99 percent of nurses and orderlies. Yet men dominated the more prestigious field of medical research; the Academy of Medical Science is still 90 percent male. Women were 73 percent of those in education and 98 percent of those in early childhood education, 91 percent of sales clerks, 99 percent of typists, yet only 13 percent of industrial managers.[29] And, as in the United States, women took much longer to move into senior positions in science, where they were about half of the scientists, but a higher percentage of the junior personnel. More women than men without advanced degrees in science worked in science, and fewer candidates and significantly fewer doctors of science were women.[30]

Not without foundation, Soviet spokespeople touted the great achievements of women after the revolution. Whether peasants, workers, or minority nationalities, these women had acquired equal rights in so many ways. The Stalin Constitution guaranteed them equal pay for equal work; access to communal day care, education, health care, public dining halls, and other facilities; the right to vote and run for office; and especially the right to labor. Officials claimed that 100,000 women were employed as engineers and technical specialists versus less than 10,000 women engineers in the rest of the world combined, and they noted that over half of the USSR's 132,000 physicians in 1939 were women versus in all 2,000 female doctors in Tsarist Russia. In terms of labor protection for women, Pichugina wrote the following:

> However, labor legislation in the U.S.S.R. takes account of the physical limitations of women and does not allow them to engage in work that is beyond their strength. Thus, for instance, Soviet law forbids the employment of women and young people below the age of 18 in industries which are considered hazardous to health. From the sixth month of pregnancy expectant mothers, as well as nursing mothers during the first six months of feeding their infants, are strictly barred from work on night shifts. Besides the regular annual vacation, working women are entitled to a maternity leave of thirty-five days before birth and twenty-eight days after birth, with full pay. Women collective farmers are entitled to one month's maternity leave before giving birth and one month after, during which time they receive their average earnings. Expectant mothers are transferred to lighter work before they go on their maternity leave, their pay remaining the same. Nursing mothers are given not less than thirty minutes additional time off to feed their infants, at least every three and a half hours.[31]

Yet was this not a kind of patriarchal relationship of the state to women to ensure that women's reproductive roles were protected? In the United States, women's rights activists long worked to remove such protections, succeeding in some sense finally only in 1991 when the U.S. Supreme Court decided in favor of the plaintiffs in "UAW versus Johnson Controls." Johnson Controls prohibited women from working in a lead battery foundry for fear of exposure of a fetus to excessive levels of lead. The United Auto Workers sued to ensure that female employees had access to the same jobs as males and protested the patriarchal attitude of the employer, as if the employer knew what was best for women and their fetuses. The decision barred corporate "fetal protection policies," while serving as a major victory for women's employment rights.[32]

Even if some barriers to employment persisted for Soviet women, the five-year plans for industrialization and collectivization of agriculture brought forth a new propaganda effort to demonstrate the central importance of the woman as manager, industrial worker, and collective farmer—the *kolkhoznitsa*. Before 1930 the kolkhoznitsa rarely appeared alone in posters, but with other appropriate, positive political figures. Then, under Stalin the kolkhoznitsa with the tractor replaced the peasant with the sickle in posters. Poster production expanded rapidly and suddenly with five-year plans; collectivization saw the production of scores and scores of posters with the kolkhoznitsa, each published in tens of thousands of copies. The posters encouraged joining collective farms. Women were front and center in many of the posters, larger than life in a way previously reserved for Red Army heroes. According to the analysis of Victoria Bonnell, they were heroic, youthful, and less fecund, with understated breasts. One-third of tractor drivers in the posters Bonnell analyzed were female. Perhaps one reason that females had a prominent position in posters is that they were centrally involved in the growing resistance to collectivization. Simultaneously, the attack on clergy and religion picked up, and given women's strong religious beliefs, the campaign may have been directed at them. Yet nearly nine of ten collective farms had no tractor, and only one of sixteen tractor operators was a woman. So who was the audience? Bonnell argues that it must therefore have been the urban audience, to generate support outside of rural areas for policies violently imposed on the countryside. Peasants in fact were hostile toward tractors and collective farms. During the retreat in 1934 from harsh collectivization measures, the posters also "retreated," with state farm workers gaining a fuller, more rounded look, with somewhat older, less determined faces, more smiles, pastels replacing the harsher blacks and reds, and still wearing a kerchief, but also clothing with traditional touches. The posters showed family settings to indicate the kolkhoznitsa as both productive and reproductive.[33]

In other ways, Soviet authors contributed to the construction of the heroic dual-career woman. In the Soviet novel, the career woman usually gained employment in a factory or collective farm. In postwar literary works, a new *intelligent* (intellectual or sometimes simply a white collar worker) also became a central figure, not only the politically astute peasant or lathe operator. Reflecting the Soviet proclivity to assign jobs to people, she had just finished her education and left home and friends for a new place and first job. The typical novel opened with the woman meeting authorities at work. She quickly discovers that she must prove something. Writes Gasiorawska, "She lives and works exactly as a man does."[34] She encounters obstacles, no matter her position, and overcomes them. In one novel, as a doctor, she leaves a modern urban hospital to deliver babies in filthy Yakut huts (Valentina in Antonina Koptiaeva's *Comrade Anna*, 1959).[35] As Zina, she is the engineer who improves shipbuilding techniques (V. Kochetov's *The Zhurin Family*, 1952).[36] The intrepid Arinka, a meteorologist, spends stormy nights alone at island weather stations (Iu. Pomozov, *On the Tsimlan Sea*, 1953), while Valia, the engineer whose coworker and husband envies her skills and resents her time in the laboratory to what he sees is the detriment of family life, eventually conquers research and love; her husband eventually sees the light and seeks their happy reconciliation in Iurii Bondarev's *Engineers* (1953).[37] The magazine *Krestianka* (*Peasant Women*) in the early 1950s had a circulation of a quarter million copies, but it no doubt had wider readership since it was stashed in every library, club, and Machine Tractor Station. Made for easy access and understanding, the illustrated magazine used portraits of women whose accomplishments were emblematic of success in the political and economic life of the country. Articles focused on "tester-innovators" in industry, great production achievements, economic development, life in capitalist countries, cooking, and taking care of children to promote independence (feeding them properly, teaching them manners, and directing them to sleep apart from parents).[38]

Sleeping and Eating Together, à la Socialism

Some visionaries saw the communal apartment as an important tool in constructing a radically new society based on a collectivist ethos. The Bolsheviks believed that by changing the entire environment and infusing it with a new spirit of cooperation—the living, working, and eating environments included—they might change human nature overnight. Communal settings would promote altruistic behavior for the benefit of the masses; crime, depravity, and selfishness would disappear. In each sphere of life, planners contrasted old and new, wasteful and efficient, collective and individual, bourgeois and proletarian, including in the spheres of eating and living. Communal living space was a first step in this regard. With nationalization of private property, the state gained the ability to convert formerly single-family dwellings into shared apartments with entire families living in one room, or even sharing with another family a room divided by bookcases and other furniture. This was the *kommunalka*.[39] In many respects officials were forced to place unknown individuals and families in crowded, shared quarters. Housing stock declined precipitously during world war and civil war. Construction of new housing lagged until the end of the Soviet period, with citizens forced for years and years onto waiting lists, and with elite members of society often being advanced to the top of waiting lists out of turn. What was altruistic in that? The industrialization campaign of the Stalin years saw limited investment in housing; barracks and tents were the usual accommodation at new industrial sites throughout the nation. During World War II, something like half of the nation's housing stock was destroyed. After the war, millions of people lived in rubble or underground, once again with representatives of elite strata of society getting housing in rebuilt or new apartment buildings.

Khrushchev recognized the need to improve the housing stock as part of the general effort to raise the standard of living. The apartments went up quickly. They were poorly built and decayed quickly, leading citizens to call them "*khrushcheba*," a play on the words "Khrushchev" and "slum" (*trushcheba*). Yet in spite of their mediocre quality, most citizens welcomed the private apartments as superior to the *kommunalki* in terms of privacy, hygiene, and human nature. The provision of tens of millions of private apartments would mean obviously a decline of communal life and a more atomistic daily life, greater individualism and less collectivism. New apartments would be austere, largely because of costs, but also because of the dislike of bourgeois aesthetics, the nuclear family, and domesticity. And the individual kitchen would replace the communal dining hall.[40] Common areas, including the green park areas around the apartment buildings in new regions, were intended in the absence of the *kommunalka* to promote the collectivist spirit. Officials encouraged privacy yet, through advertisements and other interventions in domesticity, would promote austere tastes and ensure regimentation of life. Reid argues that women were to be the bastion of this attitude to wean the family from domestic acquisitiveness.[41] In any event, at every major postwar construction site, whether a new factory or an entirely new town or city, construction of the factory was completed long before housing, schools, hospitals, stores, and other socially useful facilities, and again families suffered through this inconvenience. What is more, since the Soviets as a rule located housing near production facilities and failed adequately to address pollution and waste disposal in those facilities (see chapter 6), those families also were exposed to dangerously high levels of pollutants.

The desire to preserve aspects of collectivist spirit had deep roots in the 1920s, when communal dining facilities spread rapidly through the cities. Communal dining accompanied the drive for communal living for several reasons. After the revolution, officials sought to replace private restaurants and family kitchens with state dining facilities that were located in confiscated private restaurants, closed churches, new monuments, renamed urban places, and communalized mansions. They believed that state cafeterias and communal kitchens would inculcate collectivist values, at the same time saving human effort, fuel, food, and money. In other words, the Bolsheviks assumed that the advantages of planning would carry over into the area of modern, efficient food distribution. A severe food crisis provided a further impetus to communal eating. Since the Bolsheviks had criticized Provisional Government for food shortages, they needed to overcome them. Food shortages and starvation led the Bolsheviks to organize kitchens. They had come to power clamoring for "Peace, land, bread!" As supply lines to cities during War Communism and the civil war were essentially broken, the state had no alternative but to organize mass feeding. Collective establishments would liberate women from the burden of domestic duties that would now be shared. The Soviet cafeteria (the institutional *stolovaia* or dining hall) contributed to the effort to liberate women from the burden and drudgery of shopping and preparing meals and simultaneously freed them to join the labor force. Innesa Armand and Alexandra Kollontai, the first two directors of Zhenotdel, attacked housework as a bourgeois invention doomed to extinction. The same ease and light, hygiene and beauty, Kollontai said, that previously only the rich could afford became possible in communist society through communal kitchens and dining halls, laundries, clothes-mending centers, and so on. Yet through the years of war, revolution, and civil war the shortages grew worse as the countryside was cut off from the city. Supply was inadequate if sufficient in some places, but only within 15 kilometers of railway lines. Elsewhere it was rationed. Spoiled food and food surrogates found their way into the food supply. A famine broke out that claimed millions of victims. Thankfully, the capitalists stepped in to save lives. Under engineer Herbert Hoover, the American Relief Administration established supply centers and kitchens.[42]

Finally, the *stolovaia* supported not only the ideology of collectivism but an ethos of industrialism that the Bolsheviks embraced. Like its capitalist counterpart, the development of the institutional *stolovaia* accompanied the rise of industry. Under capitalism, the cafeteria was a place for quick-stop inexpensive food and a locus of innovation. The first cafeteria may have opened in New York City in 1885. Horn and Hardart's automated restaurant with coin-operated vending machines, based on Quisina's in Berlin, opened in Philadelphia in 1902, followed by a second Horn and Hardart in New York in 1912. Whether cafeteria or automat, the production and distribution of food were based on the assembly-line concept of mass production and continuous moving operation and on the unfulfilled promise of hot, wholesome food.[43] While canteens and cafes made their appearance at the turn of the nineteenth century in industrial centers of the Tsarist empire, large-scale industrial kitchens and dining halls were a phenomenon of the NEP era.[44]

In the USSR dining halls rapidly became the responsibility of the employer. Every factory, foundry, institute, enterprise, trust, and government office established an industrial feeding facility. To attract employees, eventually each one of these organizations also acquired the responsibility to plan for, secure funding for, and see to the building of apartment complexes for employees. In the Soviet centrally planned economy it was simply easier to assign resources for food and housing in this way, in the absence of a private sector to do so. Soviet cafeteria food was inexpensive and a welcome alternative to hunger. In theory the dining hall was a convenient way to feed hundreds of workers at labor sites rapidly and get them back to work. In reality, workers often had to wait in long lines to be served, which left them little time to eat, and tardiness back to work might be punished severely, especially in the Stalin era.[45] By Soviet standards the dining halls operated efficiently, but the food was noteworthy for being salty and fatty. It consisted of soup and bread, porridge if you liked, perhaps a warm meal of meat and potatoes, and compote (a thick fruit-laden drink). Boney pieces of chicken gave the appearance that the bird in question had six or seven joints, not four. Hot dogs begged for mustard to drown the slightly off flavor and generate a tolerable aftertaste. In a word, the food was usually unappetizing, of dubious origin, texture, and color, and might lead one's stomach to protest. At least the homemaker/worker had been freed from kitchen duty for at least one meal during the day, and I myself have survived many a *stolovaia* with no ill effect, in one case so impressing my hosts that archival access suddenly materialized for this American who held such great respect for Soviet industrial cuisine.

In the Khrushchev era, a period of "peaceful coexistence" with the West, not the inevitability of war, citizens anticipated an improvement in the quality of life in keeping with the rediscovery of constructivist visions for the creation of communism and a shift away from the military sector. Leaders recognized the need to manage consumption of consumer goods to maintain post-Stalinist but socialist society. They likely recognized that the discontent in Poland and Germany in 1953, and in Poland and Hungary in 1956, was due in part at least to the failure of socialist regimes to meet the modest needs of the consumer. Hence, Georgii Malenkov in 1954 promised the Soviet citizen some relaxation of the Stalinist development model with more consumer goods. After first criticizing Malenkov, Khrushchev then adopted the belief that Soviet society must improve living standards, increase housing stock, and reform agriculture for better production. Alongside increased production of consumer goods came the increased role of advertising to promote the "rational consumer." According to Reid, one of the reasons for the postwar rebirth of sociology was to gauge and inform Soviet interests. The sociologists studied family budgets during this period when officials considered whether to introduce a minimum wage to ensure that modest basic living needs were met and to sate pent-up consumer demand for durable goods. Khrushchev promised in 1958 and 1959 that Soviet women would be freed from domestic slavery by means of electrification/mechanization of housework through modern appliances. GUM reopened as the world's largest department store after Stalin's death; it had been an office building.[46] Yet in the USSR the homemaker truly had much more work than promised through her liberation.[47]

The consumer sector grew unevenly beginning with the Khrushchev era, but citizens experienced relative prosperity in the 1950s compared with the depravation of the 1930s.[48] Prior to the rise of a modest consumer culture, Soviet citizens had relied on a box hung outside of the apartment window as a kind of refrigerator. In 1940 industry produced no refrigerators, washing machines, or vacuum cleaners. By the end of 1976, still only two-thirds of Soviet families had a refrigerator or washing machine, and only one-eighth had a vacuum cleaner. In the United States the comparable figures were nearly ten in ten.[49] Yet citizens now had income to purchase durable goods—and light industry produced durable goods. The Soviets published sketchy data on consumer goods, so that it is difficult to determine precisely how many citizens had refrigerators, vacuum cleaners, and so on, let alone what they cost and how many industry produced. Under Khrushchev, production accelerated rapidly, growing two- to threefold for durable goods between 1956 and 1959 alone. The number of refrigerators available for sale in stores increased threefold between 1950 and 1960.[50] According to the seven-year plan (1955–62), washing machine production would reach 4,750,000 units in 1965, versus 4 million units in the United States in 1959, with refrigerator sales reaching perhaps two-thirds of the U.S. level. This was in stark contrast to the fact that in the entire nation there were only 3,600 washing machines in 1953 and 670,000 in 1959, and 50,000 refrigerators in 1953 and 415,000 in 1959. (Keep in mind that freezers worked poorly, if they were available at all, and washers were wringer models with limited capacity.)[51] According to another measure, between 1965 and 1980, production of home market electrical goods, as measured in rubles of production, trebled from 981,000,000 to 3,264,000,000.[52]

Although heavy industry had been largely rebuilt by Stalin's death in 1953, real wage income in 1953 was still lower than in 1928. Khrushchev determined to increase real wages and improve the standard of living. Retail trade grew rapidly, especially in rural regions. Vending machines—thousands of them—were introduced, to speed distribution and sale of many goods, and also "self-service" stores appeared: 1,500 stores were converted to self-service from 1953 to 1960. This was a huge turnaround from the standard store that required individuals to wait in three lines to purchase an item: one line to initiate the sale, a second to pay and acquire a receipt, and a return to the first line to pick up the item. Sales of food rapidly increased; sales of durable goods increased even more rapidly. Even with these machines and improvements in retail techniques, women still needed to wait in long lines at the store and wrestle with rudimentary durable goods at home. And while the citizen might have rejoiced about *Sputnik* and nuclear reactors, said one official's wife, who cares about *Sputnik*s if you cannot produce shoes, underwear, or washing machines of high quality and the right mix?[53] While women may have served the state, technology begrudgingly served them at home—and in the bedroom.

To be sure, the establishment of self-service stores and supermarkets lagged behind the United States not only in the socialist countries but in Western Europe. But the important point is that Soviet officials themselves drew the comparison with the United States explicitly and implicitly, not with Europe where such stores came much later. In the Khrushchev era they set forth the goal of developing the consumer sector and increasing consumption of foods and durable goods precisely to surpass levels in the United States, and they also sought the symbol of modernity and efficiency in the new stores. Another problem arose in the USSR and East Central Europe after they had created networks of such self-service stores as “Morozko” for frozen foods and “Akvarium” for sea foods: they did not continue to develop the infrastructure needed to support them. First, they did not have enough refrigerated trucks to deliver fresh food regularly. Second, the authorities still found it easier to invest in such traditional sectors of the economy as heavy industry. The self-serve stores were not that remarkable except for the clientele. I myself found the one “Morozko” store in Moscow always to be well stocked, primarily with Polish products, but short on staff and customers. The Soviet citizen seems to have believed that frozen foods were not nutritious and preferred the long lines at regular stores. Finally, after the introduction of these stores, engineers, planners, and others failed to follow through to improve their product designs. Just as in heavy industry, innovation lagged.

In one way, the weakness of the consumer sector might have contributed to higher fertility rates had women not had access to abortion services. In the spring of 1989 I visited thirty-seven drugstores in Moscow while conducting a brief sociological research project. Through a combination of bad planning on my part and “cleaning days” in the archives, all of the archives in which I was working were closed unexpectedly for one day. I therefore decided to try to learn something about consumer society in Gorbachev’s Russia. My goal was to purchase condoms. I knew that condoms were in short supply, even in Moscow, the empire’s leading city, the consumer capital of the nation, to which 1 to 2 million nonresidents commuted daily by train and bus in search of goods that were simply impossible to procure elsewhere. Condoms were something else, a greater rarity, of little concern to planners in the latex industry, not to mention of dubious quality. A friend had given me one as a souvenir. It came wrapped in paper that ensured that the low-quality latex quickly aged and turned brittle before use. None of the drugstores I visited had condoms in stock, likely because the salespeople had absconded with their limited shipments to sell on the black market or keep for friends and family.

The technologies of reproduction—the condom, the IUD, the pill—appeared in Russia in numbers sufficient to meet demand only after the fall of the Soviet Union. This required that women use abortion as birth control. According to several accounts, by the late 1920s in Moscow alone the authorities performed 12,000 abortions monthly. A number of the women had as many as five abortions, with one commenting that it was not nearly as painful as a tonsillectomy.[54] As shocking as these figures seem, it should be noted that in the United States at the time, where abortion was illegal, women who turned to illegal abortions faced mortal risk. In the USSR the maternal mortality rate with legalized abortion was one death per 20,000 abortions, while in the United States one woman in eighty-seven perished.[55] Abortion was legalized in the USSR in part to prevent it from being done "by unskilled quacks" at high mortality. With legalization, women turned to gynecological clinics where operations were carried out "skillfully" and with virtually no mortality. Since abortion was the means for birth control, its illegalization in 1936 made fertility rates rise, although how much is unclear.[56]

Abortion was legalized again in the Khrushchev period, and women, especially urban Slavic women, used abortion for birth control, again with many of them having five or six abortions during their reproductive careers. The procedure, conducted in an assembly-line-like fashion in a room with a number of other women separated only by flimsy curtains, denied them any sense of privacy. Worse still, the cumulative effect of the abortions frequently damaged the reproductive system of many women who later wished to have children, making it difficult for them to carry to full term and leading to higher infant mortality. In the 1960s, in fact, unique for an advanced industrial country, infant mortality began to rise sharply and rapidly in the USSR, especially in the Moslem Central Asian republics where medical facilities were not as modern or clean as those in the European USSR.[57] Cigarette smoke, alcohol abuse, and other factors also contributed to rising infant mortality in the USSR. The response of Soviet officials was to cease publication of infant mortality statistics.

Following the liberalization of abortion laws in the USSR, a policy that reversed a twenty-year Stalinist prohibition to encourage high fertility rates, the European socialist countries (except Albania and East Germany) also liberalized abortion in the mid-1950s. This accelerated declines in fertility far beyond that which might have occurred because of economic and educational factors. By 1962 those rates in Czechoslovakia, Bulgaria, Romania, and especially Hungary had fallen to very low levels. These governments therefore considered various changes in social welfare programs and the conditions of female employment to stimulate fertility. As noted, in the most extreme case, Romania in late 1966 abandoned its liberal abortion policy and made it much more difficult to divorce; other countries made abortion administratively more restrictive but still available. The positive inducements included lengthened paid maternity leave, increased family allowance payments (to a great extent in Hungary beginning in 1959), preferential access to housing, and new taxes on childless couples.[58] But rarely did the authorities order larger apartments to be built or the production of more consumer goods to make daily life more comfortable so as to encourage families to have more children.

Another unkindness of the Soviet system for liberated women was the fact that the light products industry did not provide women with any feminine hygiene products. Women used cotton batting if they could find it, or more likely clean rags. This reflected the fact that Soviet officials and managers had a difficult time determining what to do about workers suffering from menstrual cramps and other menstrual discomforts. Lili Korber, an Austrian visitor to the Soviet Union, spent two months in July and August of 1931 working as a machinist in the Putilov Steelworks in Leningrad, known for its armaments production before the revolution and its machine-building and tractor manufacture after the revolution. One day Korber complained of violent cramps that made it impossible for her to continue working. At lunch, she rested, drank tea, and curled into a ball to ease the pain. She determined to return to work since the worst of the cramps had passed. A coworker suggested that she go to the infirmary to be excused from work the rest of the day. But she refused because of embarrassment over her very poor and prominently posted piecework record that she wished to improve, and because she believed that women could never obtain equality if they used menstruation as an excuse. The government had in fact begun to strengthen regulations that gave women the right to paid leave during menstruation. To give this practice a scientific foundation, specialists in labor protection institutes had studied, for example, the seating arrangements for female tractor drivers to understand whether they needed special treatment during menstruation. The Commissariat of Labor issued regulations that stated, "Women tractor-drivers working on wheel tractors without soft spring seats must during menstruation on submission of a certificate from a physician or an assistant be transferred to easier jobs for three days with retention of average earnings, and if not allowed to work at all they shall receive temporary disability allowance." This may have resulted in a large number of woman-hours and woman-days lost to menstrual cramps. Chirkov estimates that the number of female tractor drivers in the Soviet Union rose from only fourteen in 1926 to 18,000 in 1932 and 57,000 by 1937.[59] Yet how many women actually took advantage of the regulation for paid leave of absence is unclear.

Within two years of the fall of the USSR, such products as Tampax were available; Proctor and Gamble opened a factory in 1993 or 1994 to make Tampax outside of Kyiv, Ukraine. During the steep economic decline of the mid-1990s, Tampax on one occasion served another purpose. Because it had no money, the Yarenskii Logging Company near the Arctic Circle paid loggers with boxes of tampons. It had traded its timber to a tampon manufacturer that could not sell its product.[60] It remains unclear whether the loggers were able to barter their tampons for cash, food, or any other necessary products.

Why were feminine hygiene products and other such technologies unavailable in the countries of socialism? Did they alienate the female worker from her labor? Or, did socialist planners simply not bother to think about what true liberation for the woman meant? For Alexandra Kollontai, as for Marx, Engels, and Lenin, the bourgeoisie had enslaved the worker to capital, alienated him and her from the product of labor, yet in a dialectical relationship provided the opportunity for liberation. Combined with socialist productive relations, the productive forces—machinery and equipment, tools, instruments, in a word various modern technologies—enabled freedom from oppressive labor. Filth, noise, darkness, putrid odors, heavy lifting, and physical danger would all disappear in the modern factory. One would also think that consumer goods to enable a better life around the home would be widely available.

Even more, the glorious socialist revolution would liberate women—and children—from traditional patriarchal family relations. First, they would not have to work for low pay in dangerous jobs simply to help make ends meet. Women would experience complete access to previously closed careers. Communal organization of child rearing, educational, food preparation, and other tasks previously associated with "women's work" meant that the productive relations would lose their gender. All members of society equally contributed to the construction of socialism, and modern technology in the factory, in the field, and at home facilitated these unlimited possibilities. Women were doctors, scientists, carpenters, and tractor drivers.

For a variety of reasons, however, socialist technology was no more liberating for women than capitalist technology was enslaving. The Russian Revolution unleashed utopian efforts to free women from the oppression of orthodox religion, the patriarchal factory, the drudgery of labor, even from prudery, which such Bolsheviks as Kollontai explored in the public and in the press. They organized the Women's Department (Zhenotdel) to carry out these ends of liberation. They entered the labor force, the university, and the medical profession as never before in any country. But the anarchy of the civil war and the collapse of the economy at once turned attention away from women's questions toward questions of survival of the regime. Famine, epidemics, and war created millions of refugees, with women and children feeling the worst effects of dislocation.

High levels of unemployment restricted the entry of women into many jobs. New laws and attitudes toward abortion, marriage, and the family without adequate institutional and social support increased the child-rearing burden on women as men fathered children and left. And many peasant men and women refused to abandon old attitudes about the position, responsibilities, and capabilities of women. While by the end of the 1920s economic recovery and political stability enabled a reconsideration of the idealist goals of women's liberation, the rise of Stalinism meant another obstacle to gender equality.

Stalinism was essentially an economic program with emphasis on the creation of heavy industry and forced collectivization of agriculture to create a modern socialist powerhouse in one generation. It was an endless campaign to demonstrate the glory of the leader, party, and state as surrogates of the working class through large-scale technological systems. The technological style of Stalinism reflected the political, economic, and ideological desiderata of state power. This required investment decisions based on planners' preferences, not on consumers' desires or needs. Women—and men—would have to make do with rationing, with constant shortages of goods and services widely available to the common worker in the capitalist West, even such necessities as food and housing, let alone washing machines, refrigerators, and clothing that might make daily life more enjoyable. On top of this, Stalinism embraced pro-natalist policies because of its demand for greater labor inputs for the industrialization drive and for greater stability at home through the traditional family at a time of great social turmoil caused by planned—and paradoxically unplanned—migration, urbanization, industrialization, and terror.

In the same way that the Communist Party had declared society to be classless, Stalin declared women's equality to be achieved and eliminated Zhenotdel in 1930. Indeed, women were doctors, scientists, engineers, managers, and officials, but the state provided inadequate funding for schools and doctors, and the party passed a series of labor and family laws that belied the claim of equality. The party remained unrepresentative. In the early 1920s less than 8 percent of party members were women; in 1929, 13.4 percent, and in 1977, 24.7 percent, with only one woman ever serving as a Politburo member and only 3.1 percent of Central Committee membership women in 1981. The socialist woman gained the dual obligation to work with equal pay at an equal job and to maintain the socialist home. She sat on a tractor in posters, but at home the burden of responsibility fell on her to do double labor, and she did not have a tractor to help in the heavy lifting of daily life.

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Notes

INTRODUCTION: Tractors, Steel Mills, Concrete, and Other Joys of Socialism

1. Among the many fine studies of technology under socialism, see Raymond Stokes, *Constructing Socialism: Technology and Change in East Germany, 1945–1990* (Baltimore: Johns Hopkins University Press, 2000); Pal Germuska, *Indusztria buvoleteben: Fejlesztes-politika es a szocialista varosok* (Budapest: 1956-OS Intezet, 2004); Susan E. Reid and David Crowley, eds., *Style and Socialism: Modernity and Material Culture in Post-War Eastern Europe* (Oxford: Berg, 2000); Dagmara Jajesniak-Quast, "In the Shadow of the Factory: Steel Towns in Postwar Eastern Europe," in Mikael Hård and Thomas Misa, eds., *Urban Machinery: Inside Modern European Cities* (Cambridge: MIT Press, 2008), pp. 326–56; and "Entwicklung sozialistischer Planstädte: Eisenhüttenstadt, Nowa Huta und Ostrava Kunèice im Vergleich," in Thomas Bohn, ed., *Von der "sozialistischen Stadt" zur "europäischen Stadt" und zurück? Urbane Transformationen im östlichen Europa des 20. Jahrhunderts* (München: Veröffentlichungen des Collegium Carolinum, 2008).

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8. Kendall E. Bailes, "The Politics of Technology: Stalin and Technocratic Thinking among Soviet Engineers," *The American Historical Review*, vol. 79, no. 2 (April 1974): 445–69.

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CHAPTER ONE: Would Trotsky Wear a Bluetooth?

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9. Fulop-Miller, *The Mind and Face of Bolshevism*, pp. 21–22.

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Sergei Budantsev, "Dneprovskoe stroitel'stvo," *Novyi Mir*, no. 7 (1928): 222–23. See also "American Methods Win Fight to Control Dnieper River." *Engineering News* (23 June 1932): 877; Hugh L. Cooper, "Address before the Society of American Military Engineers at the Engineers' Club, Philadelphia, February 25, 1931," *Engineers and Engineering*, vol. 48, no. 4 (April 1931); and Cooper, "Observations of Present-Day Russia," *The Annals of the American Academy of Political and Social Science*, vol. 138.1 (July 1928): 117–19. See also V. I. Kazarinova and V. I. Pavlichenkov, *Magnitogorsk* (Moscow: Gosizdat po Stroitel'stvu, Arkhitekhture i stroitel'nym materialam, 1961), pp. 10–11. My thanks to Daniel C. Melega, who, as a Colby College senior, wrote a term paper entitled "The Dneprostroi Hydroelectric Dam: American Perception and Assistance towards the Building of the First of the Soviet Union's Great Hero Projects," for sharing the paper and its rich English-language sources with me.

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30. Trotsky, *Sochineniia*, vol. 15, p. 61.

31. Trotsky, *Sochineniia*, vol. 15, pp. 236–37.

32. Peter Kenez, *The Birth of the Propaganda State: Soviet Methods of Mass Mobilization*,

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34. Most of the articles published in the *Herald* were directed toward supporting the spread of the Marxist social sciences. The section for Taylorism offered primarily translations of recent western (German, but also American) literature on the subject of Taylorism, but it ceased in 1923, reflecting Gastev's loss of influence, and the Communist Academy itself was folded into the USSR Academy of Sciences in 1931.

35. Trotsky, *Sochineniia*, vol. 15, p. 85.

36. Trotsky, *Sochineniia*, vol. 15, pp. 92–93.

37. Trotsky, *Sochineniia*, vol. 15, p. 108.

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41. Trotsky, *Sochineniia*, vol. 21, p. 263.

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44. Trotsky, *Sochineniia*, vol. 15, p. 35.

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46. Trotsky, *Sochineniia*, vol. 9, p. 188.

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50. Trotsky, "Radio, Science, Technique and Society" (1926), available at www.marxists.org/archive/trotsky/1926/03/science.htm.

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59. Trotsky, *Sochineniia*, vol. 21, pp. 359–60.
60. Trotsky, *Sochineniia*, vol. 21, pp. 377, 380.
61. Trotsky, "Kultura i sotsializm," *Novyi Mir*, no. 1 (1927): 176.
62. In the open-field system each peasant family might farm several narrow, noncontiguous strips of land in a field at some distance from home.
63. Trotsky, *Sochineniia*, vol. 21, p. 380.
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65. Trotsky, "Radio, Science, Technique and Society."
66. Trotsky, *Sochineniia*, vol. 21, p. 366.
67. Trotsky, *Sochineniia*, vol. 21, pp. 410–11.
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72. Trotsky, *Whither Russia?* pp. 106–9.
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89. G. A. Beresnev and Iu. Gromov, *Ogni Sedogo Volkhova* (Leningrad: Lenizdat, 1967), pp. 12–13, 22.

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CHAPTER TWO: Proletarian Aesthetics

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3. For evidence of this, see various chapters in Gordon Smith, Peter Maggs, and George Ginsburgs, eds., *Soviet and East European Law and the Scientific Technical Revolution* (New York: Pergamon, 1981).

4. See, for example, Leon Trotsky, "Kultura i Sotsializm," *Novyi Mir*, no. 1 (1927): 175–78.

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25. See www.hid-egyesulet.hu/DujvCsefko-a.html.

26. Bob Dent, MS/HS Hungarian Resources Coordinator (dent.b@nk.aisb.hu).

27. See www2.iisg.nl/esshc/abstract2.asp?id=2110. This Web page is no longer active.

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CHAPTER THREE: From *Kimchi* to Concrete

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CHAPTER FOUR: Floating Reactors

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CHAPTER FIVE: Industrial Deserts

Parts of this chapter appeared earlier as "Industrial Deserts: Industry, Science and the Destruction of Nature in the Soviet Union," *Slavonic and East European Review*, vol. 85, no. 2 (April 2007): 294–321. My thanks to the publishers for permitting me this use.

1. For a history of the earlier development of this industry in the United States, see Amy Slaton, *Reinforced Concrete and the Modernization of American Building, 1900–1930* (Baltimore: Johns Hopkins University Press, 2001).

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in cramped, inadequately ventilated living quarters, exposing them to brutal heat in the summer and cold in the winter, to flies and vermin year round, and to prisoners carrying TB, syphilis, and other dreadful diseases. Like in the gulag, the prisons provided inadequate quantities of unhealthy, unsanitary food and brutally treated the prisoners. See also Alex Lichtenstein, "Good Roads and Chain Gangs in the Progressive South: 'The Negro Convict is a Slave,'" *Journal of Southern History*, vol. 59, no. 1 (February 1993): 85–110. In 1995, some fifty years after outlawing the practice, Alabama reinstituted the chain gang, followed by Arizona and Florida, as a terrible reminder of the legacy of slavery in capitalism. On the higher rate of incarceration for African Americans and Alabama's return to the chain gang in the 1990s, see "Criminal Law. Prison Labor. Florida Reintroduces Chain Gangs. Act of June 15, 1995, Ch. 283, 1995 Fla. Sess. Law Serv. 2080, 2081 (West)," *Harvard Law Review*, vol. 109, no. 4 (February 1996): 876–81; and "Frugal Alabama Still Chained to the Past," *Journal of Blacks in Higher Education*, no. 8 (summer 1995): 18–19.

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11. Viatkin, "Chernaia tochka," p. 2.

12. V. Bobrovskii, "Kto zashchitit, esli ne my," *Nauka Urala*, no. 26 (July 2, 1981): 2.

13. S. A. Mamaev, "Pered litsom ekologicheskogo krizisa," *Nauka Urala*, no. 49 (December 15, 1988): 3.

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25. A. V. Koltsov, *Rol' akademii nauk v organizatsii regional'nykh nauchnykh tsentrov SSSR, 1917–1961* (Leningrad: Nauka, 1982), pp. 98–99.

26. B. V. Levshin, ed., *Dokumenty po istorii Akademii Nauk SSSR, 1926–34 gg.* (Leningrad: Nauka, 1988), pp. 195–202; and Koltsov, *Rol' akademii nauk*, pp. 100–105.

27. Levshin, *Dokumenty*, pp. 195–202; Koltsov, *Rol' akademii nauk*, pp. 100–105; and E. Izvarina, "Put' v sem' desiatiletnii: tridtsatye," *Nauka Urala*, no. 1 (January 3, 2002): 1, 4.

28. Koltsov, *Rol' akademii nauk*, p. 103. In addition, while in 1935 there were 54 scientific and support staff, in 1940 there was one academician, 10 doctors and 26 candidates of science, 26 senior scientific assistants, 45 junior assistants, and 45 support personnel.

29. Weiner, *Models of Nature*, p. 29.

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31. By one estimate, on the eve of World War II, there were roughly 100,000 "scientific workers" in the country, most of whom represented rather narrow engineering specialists, and 25 percent of whom were in civil and mechanical engineering crucial to the war effort. These engineers contributed to the rapid construction of mining, metallurgical, and nuclear artifacts. See G. M. Shcherbo, "Razvitie otechestvennoi stroitel'noi nauki v 1941–45 gg.," in B. V. Levshin et al., *Nauka i uchenye Rossii v Gody Velikoi Otechestvennoi voiny, 1941–45* (Moscow: Nauka, 1996), pp. 127–28.

32. S. V. Vonsovskii, "Uchenye Urala—frontu," in Levshin, *Nauka i uchenye*, pp. 48–53.

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43. M. N. Nazarov, "Molodezh' Urala v bor'be za uvelichenie vypuska promyshlennoi produktsii v gody velikoi otechestvennoi voiny," *Iz Istorii bol'shevistskikh organizatsii Urala* (Sverdlovsk, 1960), pp. 105–17; and A. N. Komarovskii, *Zapiski stroitelia* (Moscow, 1972), pp. 122–41.

44. G. A. Goncharov, "Chislennost' i razmashchenie 'trudarmeitsev' na Urale v gody velikoi otechestvennoi voiny," *Promyshlennost' Urala*, pp. 243–71.

45. L. I. Pystina, "Nauchnoe stroitel'stvo v Sibiri v 40–50 gg.," in V. L. Soskin, ed., *Razvitie Nauki v Sibiri* (Novosibirsk: Nauka, 1986), p. 101.

46. Koltsov, *Rol' akademii nauk*, pp. 243–44. See also *Vestnik Akademii Nauk SSSR*, no. 1 (1959): 143–44. A sector of technical economic research was added in 1942, the Institute of Biology in 1944.

47. V. Chemezova, "Usloviia diktuet sever," *Nauka Urala*, no. 16 (April 14, 1988): 2.

48. See, for example, S. V. Klopov, *Gidroenergeticheskie resursy basseina Amura* (Blagoveshchensk: Amurskoe knizhnoe izdatel'stvo, 1958).

49. György Moldova, "A Tale of Two Dams," at www.unesco.org/courier/2001_10/uk/doss05.htm (accessed April 29, 2008). Green protest against the dam provided the impetus to independence from Soviet hegemony in the same way as antinuclear activism in Lithuania, Ukraine, and elsewhere in the former Soviet Union. See Jane Dawson, *Eco-Nationalism* (Durham: Duke University Press, 1996).

50. For a brief discussion of the place of Palekh in Soviet culture, see Svetlana Boym, *Common Places: Mythologies of Everyday Life in Russia* (Cambridge: Harvard University Press, 1994), pp. 106–9.

51. The growth of the cold war nuclear enterprise made billions of rubles available to

establish the Troitsk center of nuclear research, 20 kilometers outside of Moscow; the Joint Institute of Nuclear Research in Dubna on the Volga; and cities associated with nuclear weapons and materials production such as Krasnoiarsk, Cheliabinsk, Tomsk, and Kurchatov.

52. Veniamin Tsukerman and Zinaida Azarkh, *Arzamas-16: Soviet Scientists in the Nuclear Age: A Memoir*, trans. Timothy Sergay (Nottingham: Bramcote Press, 1999), pp. 50–55, 68–69, 75.

53. As Andrei Sakharov noted in his *Memoirs*, the scientists had no doubts that they worked for the socialist motherland in a life-and-death battle with the United States. Their patriotism trumped any concerns about the state of the slave laborers' lives or the environmental costs of their activities. Besides, they lived comfortably, albeit behind barbed wire fences, with access to good foods, delicacies, nice clothing, and comfortable, spacious apartments.

54. T. Artemov and A. E. Bedel, *Ukroshchenie urana* (Ekaterinburg: Izdatel'stvo OOO "SV-96," 1999), pp. 252–55.

55. Artemov and Bedel, *Ukroshchenie urana*, pp. 131, 138, 195, 211–12. At the end of the 1950s and into the early 1960s, Soviet capacities for gaseous diffusion expanded greatly at the new Siberian Chemical Combine at Tomsk 7, the Angarsk Electrolytic Chemical Combine, and the Electrochemical Factory at Krasnoiarsk 45. This required production of fantastic numbers of filters, reaching 66.7 million in 1961 and 1 billion within thirty years, with a total length of 500,000 kilometers. See p. 96.

56. Josephson, *Red Atom* (Pittsburgh: University of Pittsburgh Press, 2005), pp. 28–32, 74–78.

57. Zhores Medvedev, *Nuclear Disaster in the Urals*, trans. George Sanders (New York: Norton, 1979).

58. Josephson, *Red Atom*, pp. 279–80.

59. "Russia: Mayak Radioactive Waste Facilities," www.nti.org/db/nisprofs/russia/fissmat/pumayak/nucwaste.htm (as accessed July 31, 2006).

60. Jeanne Guillemin, *Anthrax: The Investigation of a Deadly Outbreak* (Berkeley: University of California Press, 1999).

61. David Bearden, *Exemptions from Environmental Law for the Department of Defense*, Congressional Research Service Report to Congress, May 15, 2007.

62. Thane Gustafson, *Reform in Soviet Politics*.

63. S. V. Vonsovskii, "1932–82: Poluvekovoi put' ural'skoi nauki," *Nauka Urala*, nos. 16–17 (December 11, 1982): 2; "V Cheliabinskoi laboratorii," ibid., no. 4 (February 3, 1983): 2; Vonsovskii, "Programma 'Ural.' Eshche odin rubezh," ibid., no. 31 (August 6, 1981): 1; Iu. Kliachkin and E. Sapiro, "Programma 'Ural': Kakoi ei byt'?" ibid., no. 2 (January 12, 1982): 4–5; and M. Iurganov, "Realizatsii perspektiv—vseobshchuiu zabotu," ibid., no. 13 (April 5, 1984): 3. The "Ural" economic development program included the economic development of the Perm region, with its rich potassium, magnesium, oil, and gas reserves, its forests, and the water resources of the Upper Kama River basin. The Perm Laboratory of the Complex Economic Research of the Institute of Economics supervised the research activities on three levels: the region as a whole; the Upper Kama territorial complex, especially the Berezniki and Solikamsk industrial areas; and the economic and social development of the city Krasnokamsk. See M. Stepanov, L. Ban'kovskii, and V. Cherepanov, "Ob"ekt issledovanii-ekonomika regiona," *Nauka Urala*, no. 26 (July 12, 1984): 2.

64. T. I. Krauzov, ed., *Svodnaia Skhema Razvitiia i Razmeshcheniia Otrasli Narodnogo Khoziiaistva "Nauka i Nauchnoe Obsluzhivanie,"* 2 vols. (Moscow, 1989), pp. 231, 242. The new institutes included the Mechanics of Continuous Media (1980), Organic Chemistry (1985) in Perm, a Physical Technical Institute in Izhevsk (1982), and Electrophysics (1986) in Sverdlovsk. The number of employees at the Ural Scientific Center increased from 3,160 to 7,186, of whom 2,237 were scientific workers, including 1,073 candidates of science, 173 doctors of science, five academicians, and fifteen corresponding members of the Academy.

65. Two books suggest parallels with *Silent Spring*. Zhores Medvedev's *Nuclear Disaster in the Urals* documented the Kyshtym (Ural region) nuclear waste dump disposal but was published in the West. Boris Komarov's (pseudo. Ze'ev Wolfson) *The Destruction of Nature in the USSR* (White Plains, NY: M. E. Sharpe, 1979), first published *samizdat* (literally "self-publishing," but here underground), came closer to *Silent Spring* in breadth of coverage but also was illegal in the USSR.

66. E. Prokop'ev, "O sud'bakh uralskikh zavodov," *Nauka Urala*, no. 39 (September 23, 1988): 7.

67. S. Vladimirov, "Verkhnekamskii TPK," *Nauka Urala*, no. 38 (October 7, 1987): 3.

68. "Ekologiia i atomnaia energetika," *Nauka Urala*, no. 37 (October 31, 1980): 1, 7.

69. A. V. Gorshkov, "Nauchnyi potential i promyshlennost' Urala," *Promyshlennost' Urala*, pp. 366–84.

70. C. P. Snow, *The Two Cultures and the Scientific Revolution* (Cambridge: Cambridge University Press, 1964).

71. "Kirovskomu rainu Sverdlovska—40," *Nauka Urala*, no. 24 (June 23, 1983): 1.

72. V. Bol'shakov, "Za zelenye skvery, golubye vodoemy, chistyi vozdukh," *Nauka Urala*, no. 21 (June 3, 1982): 1.

73. A. M Cherniaev, "1. Voda: ekologiia i ekonomika," *Nauka Urala*, no. 5 (February 9, 1984): 2, and "2. Voda: ekologiia i ekonomika," *Nauka Urala*, no. 6 (February 16, 1984): 2.

74. L. F. Semerikov, "'Ural-ekologiia': Puti realizatsii," *Nauka Urala*, no. 13 (March 28, 1985): 3.

75. A. Sud'bin, "Molodye uchenye—ob okhrane okruzhaiushchei sredy," *Nauka Urala*, no. 50 (December 6, 1981): 3.

76. Iu. Ignatiov, "Okhrana okruzhaiushchei sredy: vklad studentov," *Nauka Urala*, no. 51 (December 13, 1983): 3.

77. On the history of the All-Russian Society for Nature Protection (VOOP), see Weiner, *A Little Corner of Freedom*.

78. L. Potapova, "Berech' prirodu, okhraniat' ee bogatstva," *Nauka Urala*, no. 11 (March 24, 1983): 2.

79. S. Mamaev, "Ekologiia nauki: razdum'ia i vyvody," *Nauka Urala*, no. 21 (May 30, 1985): 2. See also M. S. Kniazev, S. A. Mamaev, and V. E. Vlasenko, "Reliktovye soobshchestva i populatsii petrofil'nykh vidov rastenii na territorii severnykh raionov sverdlovskoi oblasti i problema ikh okhrany," *Ekologiia*, no. 5 (September–October 2007): 343–49.

80. *Promyshlennost' Urala*, pp. 186–207.

81. For a discussion of the relationship between the rhetoric of war and nature in the United States, see Edmund Russell, *War and Nature* (Cambridge: Cambridge University Press, 2001).

82. Graham, *Ghost of the Executed Engineer*.

83. Judith Shapiro, *Mao's War against Nature* (Cambridge: Cambridge University Press, 2001); and Paul Josephson, *Totalitarian Science and Technology*, 2nd ed. (Amherst: Humanity Press, 2005).

CHAPTER SIX: No Hard Hats, No Steel-toed Shoes Required

Epigraph: State Archive of Arkhangelsk Oblast' (hereafter GAAO), F. 1735, op. 1, ed. khr. 642, ll. 46 ob.–47.

1. According to its Web site, "Since its inception in 1971, OSHA has helped to cut workplace fatalities by more than 60 percent and occupational injury and illness rates by 40 percent. At the same time, U.S. employment has increased from 56 million employees at 3.5 million worksites to more than 135 million employees at 8.9 million sites. In Fiscal Year 2007, OSHA has 2,150 employees, including 1,100 inspectors. The agency's appropriation was $486.9 million." See www.osha.gov/as/opa/oshafacts.html (as accessed December 8, 2007).

2. The U.S. Congress passed the first federal statute governing mine safety in 1891. It was relatively toothless, although it established minimum ventilation requirements at underground coal mines and prohibited operators from employing children under 12 years of age. In 1910, following a decade in which the number of coal mine fatalities exceeded 2,000 annually, Congress established the Bureau of Mines as a new agency in the Department of the Interior. The Bureau was charged with the responsibility to conduct research and to reduce accidents in the coal mining industry, but it was given no inspection authority until 1941, when Congress empowered federal inspectors to enter mines. In 1947, Congress authorized the formulation of the first code of federal regulations for mine safety.

In 1973, the Secretary of the Interior, through administrative action, created the Mining Enforcement and Safety Administration (MESA) as a new departmental agency separate from the Bureau of Mines. MESA assumed the safety and health enforcement functions formerly carried out by the Bureau to avoid any appearance of a conflict of interest between the enforcement of mine safety and health standards and the Bureau's responsibilities for mineral resource development. In 1977 Congress passed the Federal Mining Safety and Health Act, which consolidated all federal health and safety regulations of the mining industry under a single statutory scheme. The Mine Act strengthened and expanded the rights of miners and enhanced the protection of miners from retaliation for exercising such rights. Mining fatalities dropped sharply under the Mine Act from 272 in 1977 to 86 in 2000. The Mine Act also transferred responsibility for carrying out its mandates from the Department of the Interior to the Department of Labor, in the Mine Safety and Health Administration (MSHA). See www.msha.gov/MSHAINFO/MSHAINF2.HTM (as accessed December 9, 2007).

3. Lazar Kaganovich, *The Construction of the Subway and the Plan for the City of Moscow* (Moscow-Leningrad: Co-operative Publishing Society of Foreign Workers in the U.S.S.R., 1934), and *Pobeda Metropolitena—Pobeda Sotsializma: Rech na Torzhestvennom Zasedanii, Posviashchennom Puska Metropolitena 14 maia 1935 g.* (Moscow: Transzheldorizdat, 1935).

4. George Price, *Labor Protection in Soviet Russia* (New York: International Publishers, 1928).

5. A. Iu. Volodin, "Trudy i Dni Fabrichnogo Inspektora v Russii," *Ekonomicheskaia Istoriia. Oborenie*, vyp. 13 (Moscow: Izdatel'stvo MGU, 2007), pp. 9–33; and T. Ia. Valetov, "Fabrichnoe zakonodatel'stvo v Rossii do Oktiabr'skoi Revoliutsii," ibid., pp. 34–44.

6. Francis Bernstein, "Envisioning Health in Revolutionary Russia: The Politics of Gender in Sexual Enlightenment Posters of the 1920s," *Russian Review*, vol. 57, no. 2 (April 1998): 191–217.

7. John Scott, *Behind the Urals* (Boston: Houghton Mifflin, 1942).

8. Loren Graham, *The Ghost of the Executed Engineer* (Cambridge: Harvard University Press, 1992); and Kendall Bailes, *Technology and Society under Lenin and Stalin* (Princeton: Princeton University Press, 1978).

9. Melanie Ilic, "Women Workers in the Soviet Mining Industry: A Case-Study of Labour Protection," *Europe-Asia Studies*, vol. 48, no. 8 (December 1966): 1387–1401.

10. GAAO Otdel DSPI, F. 296, op. 2, d. 169, ll. 16–20.

11. GAAO Otdel DSPI, F. 296, op. 2, ll. 1–2.

12. GAAO, F. 1735, op. 1, ed. khr. 98, ll. 47–50.

13. GAAO Otdel DSPI, F. 296, op. 2, d. 1389, ll. 31–34.

14. GAAO Otdel DSPI, F. 296, op. 1, d. 40, ll. 4–8, ll. 10–11.

15. GAAO Otdel DSPI, F. 296, op. 2, d. 908 1950, ll. 37–38.

16. GAAO Otdel DSPI, F. 290, op. 2, d. 1108. See GAAO Otdel DSPI, F. 290, op. 2, d. 673, entire, on the challenges in trying "to liquidate the technological lag in the forestry and agricultural industries, especially in comparison with heavy industry."

17. GAAO Otdel DSPI, F. 296, op. 2, d. 1942, ll. 36–42.

18. GAAO Otdel DSPI, F. 296, op. 2, d. 1942, ll. 52–57.

19. On Glavsevmorput, see John McCannon's *Red Arctic* (New York: Oxford University Press, 1998).

20. GAAO, F. 1735, op. 1, d. 98, ll. 161–63.

21. GAAO, F. 1735, op. 1, ed. khr. 98, ll. 47–50.

22. GAAO, F. 1735, op. 1, d. 98, ll. 45–46.

23. GAAO Otdel DSPI, F. 296, op. 2, ll. 97–98.

24. GAAO Otdel DSPI, F. 296, op. 2, ed. 192, ll. 40–41.

25. GAAO, F. 1735, op. 1, ed. khr. 98, ll. 47–50.

26. GAAO, F. 1735, op. 1, d. 429. See also GAAO, F. 1735, op. 1, ed. khr. 181 on the loss of the "Sibiriak" in November 1937.

27. On the ideological and other aspects of Soviet aviation, see Kendall Bailes, "Technology and Legitimacy: Soviet Aviation and Stalinism in the 1930s," *Technology and Culture*, vol. 17, no. 1 (January 1976): 55–81; and Scott Palmer, *A Dictatorship of the Air* (Cambridge: Cambridge University Press, 2006).

28. GAAO, F. 837, op. 1, d. 260, ll. 1–10.

29. GAAO, F. 2487, op. 1, d. 6, l. 3, and F. 2487, 1, op. 20, ll. 2–18, 21, 29. The reading included V. N. Argutinskii's *Vzryvnye Raboty v Lesnoi Promyshlennosti Severa* (Arkhangelsk: Sevkraigiz, 1934) and his *Vzryvnaia Zagotovka Pnevogo* (Arkhangelsk: KOIZ, 1934), as well as the *Short Course of the History of the Bolsheviks*.

30. GAAO, F. 2487, op. 1, d. 59, ll. 6, 12–13.

31. GAAO Otdel DSPI, F. 296, op. 2, d. 1389, ll. 47–51.

32. GAAO Otdel DSPI, F. 296, op. 2, d. 908, ll. 31–36.

33. GAAO Otdel DSPI, F. 296, op. 2, d. 1882, l. 99.

34. GAAO Otdel DSPI, F. 296, op. 2, d. 1942, ll. 103–5.

35. Maxim Gorky et al., *Belomor: An Account of the Construction of the New Canal between the White Sea and the Baltic Sea* (New York: H. Smith and R. Haas, 1935); and Anne Appelbaum, *Gulag: A History* (New York: Doubleday, 2003).
36. GAAO Otdel DSPI, F. 296, op. 2, d. 191, l. 16.
37. GAAO Otdel DSPI, F. 296, op. 2, d. 1887, ll. 5–8.
38. GAAO Otdel DSPI, F. 296, op. 2, d. 1882, l. 1.
39. GAAO Otdel DSPI, F. 290, op. 2, d. 315, l. 9.
40. GAAO Otdel DSPI, F. 290, op. 2, d. 1434, ll. 3–6.
41. GAAO Otdel DSPI, F. 290, op. 2, d. 1434, ll. 2–3.
42. GAAO, F. 1735, op. 1, ed. khr. 642, ll. 46 ob.–47.
43. GAAO Otdel DSPI, F. 290, op. 2, d. 1434, ll. 5–7.
44. On the slow course of rural electrification, see GAAO, F. 1239, op. 1, various folders.
45. Louise Shelley, "Law in the Soviet Workplace: The Lawyer's Perspective," *Law and Society Review*, vol. 16, no. 3 (1981–82): 448–49.
46. In his short stories collected as *Kolyma Tales*, Varlam Shalamov (1907–82), a prisoner of the Gulag for many years, more accurately described life in Dalstroi. See *Kolyma Tales*, trans. and intro. John Glad (Harmondsworth: Penguin, 1994).
47. Patricia Herlihy, *The Alcoholic Empire: Vodka and Politics in Late Imperial Russia* (New York: Oxford University Press, 2002).
48. Susan Gross Solomon, "David and Goliath in Soviet Public Health: The Rivalry of Social Hygienists and Psychiatrists for Authority over the Bytovoi Alcoholic," *Soviet Studies*, vol. 41, no. 2 (April 1989): 254–75.
49. Mark Field, "Alcohol, Crime and Delinquency in Soviet Society," *Social Problems*, vol. 3, no. 2 (October 1955): 100–109.
50. Walter Conner, *Deviance in Soviet Society: Crime, Delinquency and Alcoholism* (New York: Columbia University Press, 1972).
51. GAAO, F. 1735, op. 1, d. 98, ll. 66–68.
52. GAAO Otdel DSPI, F. 290, op. 2, d. 162, l. 20.
53. GAAO Otdel DSPI, F. 837, op. 1, d. 217, ll. 11–12.
54. GAAO Otdel DSPI, F. 296, op. 2, d. 1942, ll. 61–65.
55. GAAO Otdel DSPI, F. 837, op. 1, d. 241.
56. GAAO Otdel DSPI, F. 1735, op. 1, ed. khr. 295, ll. 17–19.
57. Zhores Medvedev, *The Legacy of Chernobyl* (New York: Basic Books, 1990).
58. Grigory Medvedev, *The Truth about Chernobyl* (New York: Basic Books, 1991).
59. David R. Marples, *The Social Impact of the Chernobyl Disaster* (New York: St. Martin's Press, 1988).
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62. See www.iihs.org/about.html and www.iihs.org/origins.html, as accessed May 4, 2009.
63. Joel Brinkly, "Bush Overhauls U.S. Regulations," *New York Times*, August 14, 2004. See also the unconscionable—and unscientific—effort of the Bush administration in its final days to add preliminary steps in the effort to slow the regulation of worker exposure to hazardous waste.

64. Robert Pear, "Bush Aides Rush to Enact a Rule Obama Opposes," *New York Times*, November 29, 2008.

CHAPTER SEVEN: The Gendered Tractor

1. Among the many fine studies on women in the Soviet Union on which I heavily rely and draw, see, for example, Wendy Goldman, *Women at the Gates: Gender and Industry in Stalin's Russia* (Cambridge: Cambridge University Press, 2002); Goldman, *Women, the State, and Revolution: Soviet Family Policy and Social Life, 1917–1936* (Cambridge: Cambridge University Press, 1993); Gail Lapidus, ed., *Women, Work, and Family in the Soviet Union* (Armonk: M. E. Sharpe, 1982); Lapidus, *Women in Soviet Society: Equality, Development, and Social Change* (Berkeley: University of California Press, 1978); Beatrice Farnsworth, *Russian Peasant Women* (New York: Oxford University Press, 1992); Elizabeth Wood, *The Baba and the Comrade: Gender and Politics in Revolutionary Russia* (Bloomington: Indiana University Press, 1997); Melanie Ilic, ed., *Women in the Stalin Era* (New York: Palgrave, 2001); Barbara Evans Clements, *Bolshevik Women* (Cambridge: Cambridge University Press, 1997); and Richard Stites, *The Women's Liberation Movement in Russia: Feminism, Nihilism, and Bolshevism, 1860–1930* (Princeton: Princeton University Press, 1990).

2. K. E. B., "Soviet Family Legislation," *Soviet Studies*, vol. 2, no. 2 (October 1950): 192–201. G. M. Sverdlov of the prestigious Institute of Law of Soviet Academy of Sciences published his *Sovetskoe Zakonodatel'stvo o Brake i Seme* (*Soviet Law on Marriage and Family*).

3. Melanie Ilic, "Soviet Women Workers and Menstruation: A Research Note on Labor Protection in the 1920s and 1930s," *Europe-Asia Studies*, vol. 46, no. 8 (1994): 1409–15.

4. Michael Teitelbaum, "Fertility Effects of the Abolition of Legal Abortion in Romania," *Population Studies*, vol. 26, no. 3 (November 1972): 405–17. For a decree endorsing the "success" of Ceausescu's pro-natalism, see "Romanian Population Policy: [The Executive Political Committee of the Central Committee of the Romanian Communist Party]," *Population and Development Review*, vol. 10, no. 3 (September 1984): 570–73. On the long-term effects, costs, and new policies post-Ceausescu, see Brooke R. Johnson, Mihai Horga, and Peter Fajans, "A Strategic Assessment of Abortion and Contraception in Romania," *Reproductive Health Matters*, vol. 12, no. 24, Supplement: Abortion Law, Policy and Practice in Transition (November 2004): 184–94. See also www.ceausescu.org/ceausescu_texts/overplanned_parenthood.htm (as accessed May 7, 2008).

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7. Frances Oswald discusses the "advantages" of the California law in "Eugenical Sterilization in the United States," *American Journal of Sociology*, vol. 36, no. 1 (July 1930): 65–73; while Julius Paul discusses a rebirth of interest in sterilization in the United States in the 1960s to prevent more children among "welfare mothers" in "Population 'Quality'

and 'Fitness for Parenthood' in the Light of State Eugenic Sterilization Experience, 1907–1966," *Population Studies*, vol. 21, no. 3 (November 1967): 295–99.

8. Loren Graham, "Science and Values: The Eugenics Movement in Germany and Russia in the 1920s," *American Historical Review*, vol. 82, no. 5 (December 1977): 1133–64.

9. Graham, "Science and Values."

10. Two excellent biographies of Kollontai are Barbara Evans Clements, *Bolshevik Feminist: The Life of Alexandra Kollontai* (Bloomington: Indiana University Press, 1979), and Beatrice Farnsworth, *Alexandra Kollontai: Socialism, Feminism and the Bolshevik Revolution* (Stanford: Stanford University Press, 1980).

11. Alexandra Kollontai, Speech to the Third All-Russian Conference of Heads of the Regional Women's Departments (1921), available at www.marxists.org/archive/kollonta/1921/prostitution.htm (as accessed May 4, 2008).

12. On Zhenotdel, see Elizabeth Wood, *The Baba and the Comrade* (Bloomington: Indiana University Press, 1997). See also Barbara Evans Clements, "The Utopianism of the Zhenotdel," *Slavic Review*, vol. 51, no. 3 (autumn 1992): 485–96; and Gail Warshofsky Lapidus, "Political Mobilization, Participation and Leadership: Women in Soviet Politics," *Comparative Politics*, vol. 8, no. 1 (October 1975): 90–118.

13. Clements, "The Utopianism of the Zhenotdel," pp. 485–96; and Eric Naiman, "When a Communist Writes Gothic: Aleksandra Kollontai and the Politics of Disgust," *Signs*, vol. 22, no. 1 (autumn 1996): 1–29.

14. Kollontai, "Sexual Relations and the Class Struggle," available at www.marxists.org/archive/kollonta/1921/sex-class-struggle.htm (as accessed May 4, 2008).

15. Janet Schwartz, "Women under Socialism: Role Definitions of Soviet Women," *Social Forces*, vol. 58, no. 1 (September 1979): 67–74.

16. See www.kirjasto.sci.fi/kollont.htm (as accessed May 4, 2008).

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25. K. E. B., "Soviet Family Legislation," *Soviet Studies*, vol. 2, no. 2 (October 1950):

192–201. See also Pichugina, *Women in the USSR*, available at www.marxists.org/subject/women/authors/pichugina/women.html (as accessed April 30, 2008).

26. Robert Conquest, *Harvest of Sorrow* (New York: Oxford University Press, 1986).

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29. Janet Schwartz, "Women under Socialism: Role Definitions of Soviet Women," *Social Forces*, vol. 58, no. 1 (September 1979): 74–76.

30. Schwartz, "Women under Socialism," pp. 78–79.

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32. Carin Ann Clauss, Marsha Berzon, and Joan Bertin, "Litigating Reproductive and Developmental Health in the Aftermath of 'UAW versus Johnson Controls,'" *Environmental Health Perspectives*, vol. 101, Supplement 2: Impact of the Environment on Reproductive Health (July 1993): 205–20.

33. Victoria Bonnell, "The Peasant Woman in Stalinist Political Art of the 1930s," *American Historical Review*, vol. 98, no. 1 (February 1993): 55–82.

34. Xenia Gasiorawska, "The Career Woman in the Soviet Novel," *Russian Review*, vol. 15, no. 2 (April 1956): 102.

35. Antonina Koptiaeva, *Tovarishch Anna: Roman* (Moscow: Gosizdatkhudozhlit, 1956).

36. V. A. Kochetov, *Zhurbiny: Roman* (Leningrad: 1953).

37. Gasiorawska, "The Career Woman," pp. 100–109.

38. Dorothea Meek, "A Soviet Women's Magazine," *Soviet Studies*, vol. 4, no. 1 (July 1952): 32–47.

39. On the smells, tastes, and sounds of the kommunalka and the origins of this Soviet institution of shared pubic and private space, see Svetlana Boym, *Common Places: Mythologies of Everyday Life in Russia* (Cambridge: Harvard University Press, 1994), pp. 121–67.

40. Ruth Oldenziel, Karin Zachmann, and others investigate the cultural and political meanings of the kitchen in terms of developments in private and industrial technology, individual and collective consumption, and state and private consumption, all in the context of the cold war. In her work, for example, Zachmann considers the kitchen as a site of negotiation between women citizens and the East German state, asking how a centrally planned economy tried to resolve the contradiction between centralized production decisions and individual consumption decisions. The German Democratic Republic supported a short-lived but influential Central Working Group on Household Technology to ensure input of women citizens into kitchen design. This indicated that in the socialist DDR "mechanization of the home had become an issue of essential social and political importance." Analyzing the Bulgarian case, Rayna Gavrilova argued that the shared kitchens of communal apartments during communism were central to crafting an unhealthy and subservient relationship between the populace and the state. See http://hsozkult.geschichte.hu-berlin.de/tagungsberichte/id=844&count=42&recno=5&sort=subject&order=up&geschichte=84 (as accessed May 5, 2008). See also Ruth Oldenziel and Karen Zachmann, eds., *Kitchen Politics of the Cold War: Americanization, Technology, and European Users* (Cambridge: MIT Press, 2009).

41. Susan Reid, "Cold War in the Kitchen: Gender and the De-Stalinization of Consumer Taste in the Soviet Union under Khrushchev," *Slavic Review*, vol. 61, no. 2 (summer 2002): 244–45.

42. Bertrand M. Patenaude, *The Big Show in Bololand: The American Relief Expedition to Soviet Russia in the Famine of 1921* (Stanford: Stanford University Press, 2002).

43. On the allure of "Horn and Hardart's," see Lorraine B. Diehl and Marianne Hardart, "The History, Recipes, and Allure of Horn & Hardart's Masterpiece," at www.theautomat.net (as accessed May 1, 2008).

44. Mauricio Borrero, "Communal Dining and State Cafeterias in Moscow and Petrograd, 1917–1921," in Musya Glants and Joyce Toomre, eds., *Food in Russian History and Culture* (Bloomington: Indiana University Press, 1997), pp. 162–76.

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46. Reid, "Cold War in the Kitchen," pp. 211–43.

47. On the "paradoxes" of household technology in American society, see Ruth Schwartz Cowan, *More Work for Mother* (New York: Basic Books, 1983).

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49. Igor Birman, *Personal Consumption in the USSR and the USA* (New York: St. Martin's Press, 1989), pp. 87–91.

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51. Marshall I. Goldman, "The Soviet Standard of Living, and Ours," *Foreign Affairs*, vol. 38, no. 4 (July 1960): 625–37.

52. *Narodnoe Khoziaistvo SSSR 1922–1982 gg.* (Moscow: Finansy i Statistika, 1982), p. 472.

53. On the challenges of developing light industry and a consumer sector—even if your industry has the ability to carry cosmonauts into space—see Marshall Goldman, " 'From Sputniks to Panties': Is Economic Development Really That Easy?" *Business History Review*, vol. 37, no. ½ (Special Illustrated Fashion Issue, spring–summer 1963): 81–93.

54. Maurer, "Recent Trends in the Soviet Family," pp. 245–46.

55. "A Functional Study of Existing Abortion Laws," *Columbia Law Review*, vol. 35, no. 1 (January 1935): 93.

56. Maurer, "Recent Trends in the Soviet Family," pp. 244–47.

57. Christopher Davis and Murray Feshbach, *Rising Infant Mortality in the USSR in the 1970s*, United States Bureau of the Census, Series P-95, no. 74 (September 1980).

58. Robert McIntyre, "Pronatalist Programmes in Eastern Europe," *Soviet Studies*, vol. 27, no. 3 (July 1975): 366–80.

59. Korber and Chirkov, as sited in Melanie Ilic, "Soviet Women Workers and Menstruation: A Research Note on Labor Protection in the 1920s and 1930s," *Europe-Asia Studies*, vol. 46, no. 8 (1994): 1414–15.

60. Beth Knobel, "Trading Trees for Tampons in Russia," *Fortune*, November 14, 1994.

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