Science and the Soviet Social Order

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Engineers: The Rise and Decline of a Social Myth

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Half the engineers in the world work in the Soviet Union. This fact is a source of pride for Soviet leaders, a source of alarm for some American observers, and a source of perplexity for economists and historians. Why, with all that skilled personnel, does the Soviet economic system perform so poorly? Is the problem with the system or the people? For the social scientist the question is somewhat different: Can the tremendous number of engineers help explain why engineering has been the path to political leadership in the USSR? If engineers play the sort of role in Soviet politics that lawyers assume in America, what does this tell us about the engineers and the society?

The tremendous number of engineers is due in part to the fact that technical training has been a major mechanism of social mobility in Russian and Soviet society. Beginning in the second half of the nineteenth century, and accelerating rapidly in the 1930s, engineering served as a path for individuals from the lower social classes to move first into the intelligentsia and then into the political elite. Social mobility was accompanied by a perception of engineering as a high-status profession, with engineers portrayed accordingly in Soviet literature. But in the past few decades the status and prestige of engineering have declined, and the quality of Soviet engineering is now under sharp attack from internal critics. Engineers are referred to as "the gray people," and prestigious technical institutes experience difficulty filling their freshman classes. To understand fully the rise of engineering as both a mechanism of mobility and a source of prestige, we must also account for its perceived decline.

This chapter sketches the social history of engineers in Russian and Soviet society. I have attempted to trace the same key topics in each

period: engineering education, the work environment, professional identity and activity, social mobility, and the "cultural" image of engineers in literature (and, in a few instances, film). While basically adhering to this outline, I have diverged to stress the key aspects of each individual era. This approach should compensate for the inevitable blurring of historical specificity that results from covering an extended sweep of time.

Russian Engineers

Lenin was correct when he stated that Russia occupied the last place in Europe in terms of technical cadres.[1] But the most serious problem was not simply the shortage of engineers. It was that to compete with other nations, Russia had to catch up with a moving target, a situation with obvious parallels to the era of the "scientific-technical revolution" and Mikhail Gorbachev's reforms. In 1890 perhaps four hundred engineers graduated from the half-dozen higher technical schools in the Russian Empire.[2] During the period 1896–1902, mainly though the efforts of Finance Minister Sergei Witte, the number of technical institutes was doubled and the number of students more than tripled. This growth must be compared, however, to a tenfold increase in the number of American engineering students during the 1890s.[3]

Prior to the 1890s, advanced technical training in Russia predominantly followed a "ministerial" pattern.[4] Each department of the tsarist government sought to train its own specialists for the specific activities under its purview, and most technical personnel spent their entire career within one ministry. This was true of the mining engineers, transport engineers, and military engineers, all of whom were recruited mainly from the privileged classes. Exceptions were graduates of institutes under the control of the ministries of education and finance. It is testimony to the tenacity of the ministerial ethos that new, more flexible institutions were considered "second rank" even after they began to provide an education qualitatively superior to that at the older institutes.

With the development of industry and capitalist economic activity, engineers increasingly played entrepreneurial and other roles. The economic changes cut two ways. New economic organizations provided opportunities for the graduates of the "practical" industrial institutes who were interested in production and entrepreneurship. At the same time, experience in a ministry proved of immense value for subsequent commercial activity, and foreign firms found it essential to employ Russian citizens with government experience to deal with the bureaucracy.[5]

On a small scale beginning in the 1870s, and much more decisively in the 1890s, we see the emergence of engineering generalists. Trained at the Petersburg Technological Institute or in a few cases at other schools, and with experience in Europe, these engineers sought to break the constraints of the narrow ministerial pattern. Prototypes here were I. A. Vyshnegradskii and V. L. Kirpichev, two of the major figures who assisted Witte in the expansion of engineering training.[6]

The anvil for forging the new engineering cadres was the polytechnical institute. Witte established three of these institutions, as well as new mining and transport institutes offering shorter courses and less encyclopedic curriculums than in the existing schools.[7] In 1895 only seven technical institutes conferred engineering degrees; by 1902 there were thirteen. The number of students increased from four thousand in 1895 to thirteen thousand in 1904 and over twenty thousand in 1914. On the eve of the First World War more students were attending the Petersburg Polytechnical Institute than had been enrolled at all Russian higher technical schools in 1900. Although the graduation rate declined even from the disappointing one in ten of the 1890s, the geometric growth in numbers of students produced some increase in the number of graduate engineers.[8]

While hardly on the scale it would assume later, engineering education provided a means of social mobility in tsarist Russia. Russian higher education was more "democratic" in student enrollments than other European systems, and much of the non-noble enrollment was at institutions other than the universities.[9]

With so much emphasis placed on training engineers to staff new railroads and industrial enterprises, less attention was devoted to producing technicians. Support personnel were usually drop-outs from higher education or *praktiki* (practicals) with no formal training. Secondary specialized education was the weakest link in the system of technical training. Through a complex political compromise in the 1880s, technicums wound up occupying an intermediate place in the educational system. By the 1890s they were widely regarded as a dumping ground for poor students, since anyone aspiring to higher education chose a more direct route.

Engineers' professional activity grew with expanded numbers and diversified economic activity, but never broke out of constraints imposed by the tsarist government. Membership in Russian technical societies

was narrowly circumscribed. Most were virtual alumni associations of individual schools, since organization on broader principles was prohibited. A few groups sought to become local or regional organizations, but even these—for example, the South Russian Society of Technologists—were based primarily on a single institute. The only organization asserting a claim to universality was the Imperial Russian Technical Society, which was too diverse in membership and, as its name implies, too closely tied to the state to express effectively the professional interests of Russian engineers.[10]

Engineers made sporadic attempts to establish professional associations based on geography or specialization rather than ties to a state-run school. When the journal *Inzhener* (Engineer) began publication in 1882, it articulated the need for a nongovernment professional engineers' organization, a call it made repeatedly until 1917.[11] Other groups' efforts to establish independent professional associations met resistance from the government.

Much of the impetus for growth in organization membership and activity was economic, reflecting increased numbers of engineers and employment difficulties during the economic slump after 1900. In the events surrounding the Revolution of 1905, however, many engineering associations began to pay more attention to broader political questions. In 1904 a group of politically aggressive engineers organized one of the first professional unions, and in 1905 the Union of Engineers played a leading role in seeking to establish an all-Russian professional organization.[12]

Despite a strong desire for unity, neither the Union of Engineers nor any other organization could speak effectively for all Russian engineers, much less all technical personnel. In the highly charged atmosphere of 1905, such an organization was impossible. Groups formed both to the left and the right of the Union of Engineers. Not all engineers were in sympathy with even the mildest forms of political activity. L. N. Liubimov, one of the elite transport engineers, recounted having to run for his life after angering a mob by refusing to doff his cap to the "new freedoms."[13] A reaction typical of many engineers was that of E. O. Paton, who sought to immerse himself in technical problems while remaining neutral politically.[14] For politically active engineers, a key issue was to define their relationship to workers and employers, a question that became even more pressing in 1917.

Electrical engineers played a leading role in organizational activity, reflecting the importance of electrical technology as Russia joined the industrial revolution as well as the influence of foreign colleagues. Their activism presaged significant contributions in the Soviet era.[15] Electrical engineers were among the first to discuss engineering ethics.[16]

Ethical dilemmas reflected new career opportunities as capitalism developed. Rather than remaining subject to the whims of bureaucratic superiors or corporate employers, engineers could work for multiple employers and even engage in that penultimate activity of the professional middle class, consulting. The chemist V. N. Ipatieff recalls in his memoirs the lucrative consulting fees he received.[17] By 1905 engineering societies were drafting model contracts for consulting arrangements with Russian and foreign firms, and Russian engineers were participating in meetings to create an international society of consulting engineers.[18]

The range of engineers' legal incomes, however, varied tremendously. For every talented and savvy expert like Ipatieff there were dozens of engineers barely scraping by. If the rewards of success in private enterprise were enormous, the risks were at least as great, causing many engineers to opt for government positions that guaranteed salaries and pensions.[19]

Young engineers frequently reported difficulty finding "suitable" positions, yet Russian industry remained woefully short of trained personnel. The geometric increase in the numbers of engineering students produced a surplus of engineers in some locations and in particular specialties but did not begin to meet Russia's overall need for specialists. Those with higher education often took jobs outside their field in order to remain in urban areas, while there were persistent shortages of personnel in rural areas, and especially in Siberia.[20]

Many positions that should have been filled by engineers went by default to people who had to learn their skills on the job. These *praktiki*, who were operating going concerns, frequently reacted with hostility to the appearance of institute graduates lacking applied skills. The metallurgical engineer M. A. Pavlov recounted how a lab technician at his first workplace, fearing competition from a school-educated engineer, put sand in Pavlov's test samples to distort the results.[21] The problem of the *praktiki* took on a particular edge in the Stalin era, when political leaders sought to reassert the virtues of uneducated specialists.[22] But these conflicts had a very long history.

If engineers themselves managed to develop a strong sense of identity, this was not reflected in the literature of tsarist Russia. Engineers appear infrequently in novels and short stories, and when they do appear,

their identity as engineers rarely carries special significance. Hermann in Pushkin's *Queen of Spades* is a young officer; his engineering specialty is incidental. Dostoyevskii did initially refer to Kirilov as "The Engineer" in his notebooks for *Devils,* but one searches in vain for some trait that would make his being an engineer rather than his membership in the radical intelligentsia his distinguishing characteristic.

Only with industrialization do characters emerge whose engineering identity is integral to the literary work. N. G. Garin-Mikhailovskii's *Studenty* (1895) and *Inzhenery* (1906) are unique in featuring the milieu of engineering education and professional activity.[23] Tema Kartashev is not really plausible as anything but an engineer, and Garin chose his environment carefully to show the general problems of the intelligentsia as well as specific concerns of engineers. Another major "engineer novel" of the prerevolutionary period is Bogdanov's *Engineer Menni,* but here the Martian engineer is a foil for Bogdanov's utopian visions rather than an example of any existing figures in Russian life. Mikhail Slonimskii's *Inzhenery,* a vivid portrait of prerevolutionary engineers, was published after the Second World War and is really a historical novel reflecting the issues of the later period.

What, then, was the tsarist era's legacy to Soviet engineering? There was an inadequate but growing education system; and while technical training was a path to social advancement, especially for individuals from the lower classes, and also for impoverished noblemen, it was one path among many. Patterns of poor training for support personnel and uneven distribution of specialists were well entrenched. In literature, engineering identity was only beginning to take on social and professional significance. There did exist a highly competent core of engineering professionals and educators, striving to liberate their economic system from foreign control and their professional life from government restrictions so that they might become full-fledged international professionals.

Revolution and Reconstruction

The first decade of Soviet power witnessed a civil war followed by an attempt to repair the damage resulting from seven years of conflict. The Civil War and New Economic Policy established two extremes of a policy pendulum that has characterized Soviet life ever since.

By the outbreak of the First World War, Russian engineers had developed a sophisticated professional consciousness. The main barrier to constituting themselves as a profession on the model of their Western colleagues remained opposition from the tsarist government. While wartime conditions gave the government a rationale for preventing convocation of an all-Russian congress of engineers, the government's handling of the wartime economy also convinced many engineers that the autocracy was a disaster in economic and technical as well as political terms. Few engineers mourned the passing of the Romanov regime.

Following the February Revolution, engineers returned to the professional agenda they had established before the war. They convened an all-Russian congress, sought to establish a unified engineering society, and devoted particular attention to establishing an identity distinct from both labor and management. Although Western experience would lead us to expect engineers to be staunch supporters of a bourgeois regime, many Russian engineers were quite susceptible to the Bolshevik appeal. What there was of a technocratic movement in Russia found significant allure in an ideology promising rapid economic growth and technical transformation. Some saw the Bolsheviks as the only group capable of protecting their property and even their lives in an era of increasing anarchy.[24] Still others believed the Bolsheviks represented the best chance to defeat Russia's enemies.[25] If they did not welcome the Bolsheviks, many engineers were at least willing to give them a chance.

We may never know precisely how much of a toll the war, revolution, and civil war exacted from the technical intelligentsia. Battle casualties, disease, and emigration reduced the number of trained engineers by perhaps as much as half. Aftereffects continued well beyond the Civil War. The opportunity costs of students not trained, skills not shared, and professional communities not perpetuated made the damage far more extensive. The Bolsheviks' task was not merely to take up where the tsarist system had stood in 1913 but to repair massive losses.

Some of the damage after 1917 was self-inflicted. Revolutionary educational policies adopted in 1918 abolished entrance requirements, grades, and standards in general.[26] Widespread public demand for higher education resulted in many secondary schools becoming higher educational institutions with no significant alteration other than to their title. A report by the Ministry of Education noted that schools "developed for the most part by anarchy, according to local initiative."[27]

The educational process itself was dubious. In a situation of civil war and general crisis, students were more likely to be at one of the various

military or political fronts than in a classroom.[28] A revolution carried out in the name of the working class inevitably gave rise to pressures to reward workers. Preferential treatment for proletarians (and often, but not always, peasants) and discrimination against children from the middle and upper classes were considered to be logical consequences of the Revolution. Discrimination proved much easier to enforce than affirmative action.[29]

There were two major obstacles to preferential treatment for workers in education. One involved the knowledge base. Prospective students lacked both the secondary education and the cultural background needed for advanced study. Even when the higher school curriculum was reduced to the essentials of technical training, most workers found it beyond their capabilities. Workers' faculties were created to provide remedial education to prepare workers and peasants for admission to institutions of higher education. But it was not possible to compensate overnight for decades of cultural deprivation or a lack of basic education.[30]

Overcoming the lack of education among workers was child's play compared to the task of ascertaining just who was a worker. In a situation of revolutionary social flux, in which proletarian credentials could mean the difference between life and death (during the famine in 1920–21 some students continued to receive front-line rations),[31] the individuals able to secure proof of proletarian origins were often precisely those who had the least claim to that heritage.[32] After 1921 the New Economic Policy (NEP) brought a period of relative stability. Yet, as in most instances, a closer examination reveals important fluctuations within a supposedly coherent period. Debates among the leadership resulted in vacillating social policy in the schools, including a purge of the student body in 1924.[33]

Administrative conflict between education and industrial interests carried over from the tsarist era. During the NEP, technical schools remained under the education administration. The emphasis continued to be on higher education for engineers, with short-term courses the norm for workers. Little was accomplished in the area of specialized secondary training, and after 1921 expansion of the education system all but ceased. The new schools that had been established during the Civil War either vanished or continued a precarious existence with inadequate funding and minimal infrastructure. At the best schools the program reverted to the five-year encyclopedic curriculum prevalent before the war.

By the late 1920s the education system appeared to be restored to normal operation. The need for technical cadres was being met to a limited extent by a combination of old specialists, new Red Directors, and a large number of *praktiki*. But the supply of specialists was not adequate, especially if the tempo of economic development was to be increased.

An emphasis on proletarian leadership infused Bolshevik policy toward engineers' professional organizations. Despite the official preference for specialty-based unions uniting engineers, technicians, and workers, however, existing professional organizations continued to function with remarkable continuity during the Civil War. Government conferences in 1918 and 1919 resolved to establish Engineering-Technical Sections (ITS) under the mass-membership trade unions that would be responsible for "material" issues. But the All-Russian Association of Engineers was permitted to continue its activities directed at economic reconstruction and technological development,[34] and the Russian Technical Society continued a precarious existence.[35] Even during some of the darkest moments of the Civil War the government provided financial assistance for these organizations, which suggests that they retained some patrons.[36]

The ITS played a more active role in the mid-1920s. In addition to continuing to support engineers' material interests as economic relationships changed, the sections took on responsibilities in education and cultural work, including raising qualifications and providing training for workers. But the direct interests of members continued to take precedence. In 1923 the central bureaus of the construction and railroad workers' unions were able to set aside a specific number of places at technical institutes for children of ITS members.[37]

Members of the prerevolutionary Russian Technical Society sought to continue their corporate existence and play an independent role in economic and technical policy. Most striking in this regard is evidence that the influence of international technocratic ideas resonated strongly. P. I. Pal'chinskii considered the engineers to be the only "reliable" group in Soviet society, and the sole group capable of negotiating successfully with foreign governments and corporations.[38] These engineers and their technocratic musings hardly represented a significant threat to the Soviet government. Yet their discussions and group activities were more extensive than has previously been believed, and it is obvious what could be made of these activities in a supercharged political environment.

Influential members of the leadership, including Lenin himself, intervened repeatedly to assist engineers and scientists experiencing political

troubles and problems with living conditions.[39] These initiatives were expanded during the NEP. But central policy frequently encountered obstacles from local officials, from workers, and from Party committees. Specialist baiting, while only a temporary government policy under War Communism, proved very difficult to curtail. Harassment, persecution, and even murder of specialists was not uncommon. One specialist recalled the mid-1920s: "In one plant specialists were threatened, cursed with the vilest language as bourgeois and "former people"; in another plant unexpectedly doused with water; in a third trundled out of the factory in a wheelbarrow; in a fourth their apartment windows were broken; in a fifth an engineer was struck in the face."[40]

Measures taken under War Communism and the NEP did little to alleviate the shortage of specialists. Those with education continued to prefer administrative positions, while most of the jobs in production were filled by *praktiki.* The majority of graduates did not actually work in their specialties.[41] The major difference between the mid-1920s and late 1920s in this respect was the degree to which the situation was regarded as a crisis.

Little artistic literature was generated in the desperate conditions of the Civil War. The strongest themes in this period were utopian yearning and antiutopian critique. Representative of the numerous utopian fantasies was Bogdanov's *Engineer Menni,* frequently republished during the early 1920s.[42] The most famous, and best, of the antiutopian critiques was Evgeny Zamiatin's *We,* published in 1922. The designer of the spacecraft in *We* is never described as an engineer, yet his experience mirrors the inner conflicts between technical opportunities and spiritual qualms experienced by many technical specialists in this period. The chaos and devastation of their surroundings drove writers to seek sanctuary in idealized fictional worlds.

Katerina Clark has noted that during the NEP, literature demonstrated an "almost perverse" preoccupation with the war and War Communism. Yet we must remember that novels require time, and often are written after reflection on personal experiences. There is an inevitable delay between events and their recording in fiction. To write about the present moment entails the risk of being overtaken by events—a particularly dangerous situation in the Soviet context.

Electricity is the hero of much NEP fiction, not the engineer. There were few models of Red engineers available, and bourgeois specialists, even if temporarily acceptable in the economy, were not permissible role

models. This is perhaps additional evidence for the view that the compromise with bourgeois specialists was never more than a temporary accommodation. Kleist, the old engineer in Gladkov's *Cement,* is hardly a role model. And *Cement* was perhaps the preeminent novel of the NEP, establishing conventions for the entire genre of production novels which occupies such a prominent place in Soviet literature.[43]

Cultural Revolution: The Great Divide

The Cultural Revolution of 1928–1931 was a major turning point. Whatever the reasons for the shifts in policy, an evaluation of the consequences must regard the events of these years as a catastrophe for education and engineering professionalism. Successes in social engineering have to be weighed against long-term costs in the quality of training, the nature of institutions, and the character of the profession.

New technical institutes and mass production of engineering cadres were hardly the primary reasons for or consequences of the Cultural Revolution. But generating new communist specialists was both a chief motive and a major result. While drafting a program of rapid industrialization for the First Five-Year Plan, Soviet planners recognized that the already severe shortage of personnel would be exacerbated. Initial proposals for expansion of the higher education system took account of available resources. In 1928 the government proposed creating forty-seven new institutes. While not meeting all the needs for personnel, this probably represented the extent of what was realistically achievable.[44] Typically the plans provided for 100 percent of the projected need for engineers but only one-third of the required technicians.[45] Secondary technical training remained an orphan.

It quickly became apparent that the specialists to be trained were scarcely adequate to staff the old industrial structure, much less the vast number of new facilities established by the industrialization program. At the November 1929 Plenum, Stalin insisted on accelerating tempos across the board. The number of schools and students was vastly increased; the term of study was cut to four years; and the curriculum was reduced to bare essentials, with narrow specializations suited to specific needs. The main method of creating new schools was to split off faculties from existing institutions.[46]

The student body was increased largely by lowering standards and

adopting a blatant policy of class discrimination favoring party nominees—*vydvizhenie* (promotion). This period has been described at length by others.[47] But it is important to note that achievements in social mobility were accompanied by negative consequences in the quality of education and character of educational institutions that have persisted into the 1980s.

Faced with an impossible task, Stalin and his colleagues typically opted for a solution emphasizing quantity rather than quality. Educational institutions suffered from rapid expansion and competition for scarce resources. Most of the expansion of the school system came in a period of about eighteen months in 1930–31. Under these conditions, faculty, equipment, classrooms, and dormitories were in scarce supply at virtually all schools. By 1935–36 Soviet educational administrators were categorizing the existing institutions as "strong" (*moshnye*), "average" (*srednye*), and "dwarf" (*karlikovye*).[48] The number in the "dwarf" category was far from inconsequential.

In a situation of weak institutions and uneven student quality, education officials gave up any hope of broad training. The goal became to impart basic skills to poorly prepared students in a minimal amount of time. The directors of one leading Moscow institute were typical in concluding that while broad knowledge of science and technology might be desirable and even useful in subsequent work, the limited amount of time available for study made it necessary to "sacrifice knowledge of general value and replace it with deeper specialized education." At its current stage of development the nation's industry demanded "precisely narrowly specialized engineers."[49] A subsequent report noted: "It has reached the point where they train narrow engineers, *on the level of technicians.*"[50]

Each commissariat sought to train its own staff in specialties so limited that they bordered on the absurd. There was an engineering position (*dolzhnost'*) for each specific aspect of production. The Commissariat of Light Industry included engineering specialties for the compressors in each type of machinery. The Commissariat of Heavy Industry insisted on separate engineers for oil-based paints and non–oil-based paints. The Commissariat of Agriculture trained agronomists for individual crops and veterinarians for each type of animal. Each commissariat was afraid to trust specialists trained by another.[51]

Enterprises responded by using students in menial jobs, so that they never learned about production in general but merely how to perform the narrowly specialized tasks for which their education prepared them.[52] Since "direct production practice" was a fundamental aspect of higher education in these years, assigning students to workers' jobs was not only convenient and profitable but also ideologically correct.

Mass production of poorly trained individuals with engineering credentials did more than debase the currency of higher education and undermine professional identity. It exacerbated the already inefficient allocation of personnel. Even before the Cultural Revolution many individuals with engineering educations preferred positions in administration and other forms of nonindustrial employment. Now this flight became an epidemic. Completing secondary specialized or higher education was a path for escaping the pressures of work in production.

At the same time that the engineering profession was flooded with poorly trained *vydvizhentsy,* the atmosphere created by the show trials of engineers in 1928 and 1930 led to the elimination of the older professional organizations. The All-Union Association of Engineers and the Russian Technical Society could not survive the atmosphere of the First Five-Year Plan. Yet the supposed disloyalty of bourgeois specialists is open to serious question. At the April 1928 plenum the Party had approved documents stating that "the great majority of the technical intelligentsia has come over to genuine cooperation with Soviet power."[53] The precise motives for Stalin's assault on the technical intelligentsia still require elucidation.

Despite the declining status of engineers' professional organizations, the suspicion of specialists, and the extolling of practical proletarians, this was a period in which the prestige of an engineering degree soared. But prestige did not automatically accrue to *all* engineers. It is necessary to refine our understanding of the social processes at work in the first five-year plans. Whereas old specialists owed their prestige to their knowledge and the quality of their work, most of the new *vydvizhentsy* derived their prestige from being among the elect: they had been selected for their services to the Party and were destined to occupy important positions after completing their specialized training.

The quality of *vydvizhentsy* education was questionable at best. Despite their inadequate preparation for advanced study, they were expected to take on tremendous amounts of political, agitational, and social activity at their schools.[54] The attrition rate was tremendous, but the survivors formed a fraternity of leaders with special traits—political acumen, blue-collar credentials, and superb networks.

The prestige of engineering resulted from its role in permitting social mobility and political advancement, not its economic significance. And this social sea change carried over through the Brezhnev era. In 1980, 80 percent of the members of the Politburo and 65 percent of Central Committee members had received an engineering education. In the case of the Politburo, most of them were *vydvizhentsy.*[55]

The fiction of the First Five-Year Plan in many respects takes up where *Cement* leaves off. Rapid transformations, utopian aspirations, and accelerated tempos dominated the era. This was not a backdrop against which an engineer could feel comfortable. Like Kleist in *Cement,* and Nalbandov in *Time Forward,* engineers are dubious heroes at best. They manifest an outmoded inability to believe in the great leap. The positive character is the practical man who overcomes the limits imposed by technical rationality. Katerina Clark has noted that critics were harsh on writers who got their technology wrong in this period.[56] At the same time, there was an emphasis on overcoming the limits imposed by old and rational technology.

Stalinism

The era of Stalinism following the Cultural Revolution consists of three discrete periods: the second and (abbreviated) third five-year plans, the war, and postwar reconstruction. Although the period should be treated as a whole to emphasize commonalities, we must recognize that there were also important differences.

By 1931–32 even Stalin recognized the damage that had been wrought by the Cultural Revolution. A new administrative body, the All-Union Committee for Higher Technical Education (VKVTO), headed by Gleb Krzhizhanovskii, sought to restore a sense of standards.[57] It provided a central administration but did not have the power to force industrial ministries to comply with its suggestions. Problems of quality persisted, as indicated by repetition of most of the 1932 criticisms in another decree reorganizing the committee in 1936. The narrow specialties developed during the Cultural Revolution manifested tenacious staying power. The specialty list was cut from nine hundred to three hundred categories, and in technical fields it was reduced even further. But within three years many of the narrow specialties had reappeared.[58]

On the eve of the Second World War, *Pravda* noted that in the Soviet

Union there were five times as many higher school students per one thousand population as in Europe. The quantitative problem had been solved. Quality was another matter. Recognition of the need for a smaller number of better-qualified specialists led to reduced admissions beginning in 1939, along with cuts in student stipends.[59] But the war changed everyone's orientation. Once again a crash campaign for more specialists was instituted. In part this was a response to perceived wartime needs, but it was also what the system did best.

Many of the emergency measures adopted during the first two years of the war resembled policies of the Cultural Revolution. Graduations were speeded up, courses were shortened, education was combined with regular work in production, and students were required to add political and military studies while also participating in extensive "social labor." The rapidity with which these measures were abandoned—in most cases beginning as early as 1942—provides a trenchant commentary on how they were evaluated. By 1944 the emphasis on quality was genuine and widespread.[60]

The war also accelerated geographical change in the school network. Educational opportunities were expanded in Siberia and Central Asia, laying the foundations for later development of new scientific centers.[61]

During postwar reconstruction there was again a serious shortage of cadres, and quantitative growth again took precedence. In the first postwar decade the number of higher schools more than doubled—in part a restoration of the prewar institutions, but also reflecting the rise of new institutes and continued geographical expansion. The number of higher schools in the east quadrupled. But once again quantitative expansion took place without adequate provision for teaching cadres, equipment, and housing. Local officials did not always attach the same importance to education as central authorities. The infrastructure of educational institutions was frequently appropriated for other purposes, and even several years after the war, schools were struggling to reacquire scarce building space occupied by local administrative bodies.[62]

Social mobility was a less pressing issue after the First Five-Year Plan. While workers' faculties and preparatory divisions continued to exist, most students came from secondary schools, where academic merit usually counted for more than proletarian origins. Yet one crucial episode of social mobility deserves mention. During and after the war an influx of demobilized veterans into technical schools had a major influence on the student body and subsequent engineering cadres.

Working conditions improved only marginally through the Stalin era, and massive turnover of personnel persisted. During the early five-year plans, engineers frequently "volunteered" to sign pledges that they would remain in their jobs for a fixed period, usually until the end of the current five-year plan. Technical institutes could have a new director four or more times in the course of a year, a pattern that might be repeated year after year.[63]

Technical competence was scarce in the 1930s. Old specialists were under a cloud, and they had acquired their skills on outmoded technology. Many of the new Communist managers lacked adequate training. Commissar of Heavy Industry Sergo Ordzhonikidze complained that the factories had outgrown the managers.[64] One gets the sense that no one was competent, while all were being pushed to the wall by demands for an increased tempo of growth.

The Second Five-Year Plan was supposed to be the plan of "quality," but by the fall of 1935 this began to be undermined by a new campaign for a faster pace. The Stakhanovite movement placed engineers in an almost impossible position, not very different from what they had experienced during the First Five-Year Plan. The pressure was soon compounded by more intrusive police activity, as the inevitable errors and accidents of speed-up were attributed to espionage and sabotage.[65]

The engineer-manager in theory benefited from one-man management (*edinonachalie*). But in reality he was under constant pressure from bureaucrats above and workers below to revise plans upward. Managers lost control over wages, rations, housing, and other incentives, and even a loyal apparatchik who supported the increased tempo was not in a position to be a dictator. Some shock workers (participants in accelerated work) elected their own managers. Engineers were able to participate only tangentially in the informal shop-floor networks that became crucial to success in production.[66] While these factory-floor systems allowed workers to feel a sense of group identity and solidarity, and to protect their interests, engineers were always at the edges. And no efforts to unite engineering or supervisory personnel were tolerated.

After the assault on bourgeois specialists during the Cultural Revolution, old specialists no longer figured prominently in campaigns directed from the center.[67] At the local levels, however, they often suffered from specialist baiting and a general climate of mistrust. At some technical institutes old professors were dismissed in the late 1930s.[68]

Employment patterns reflected the pressures on specialists and their

inadequate preparation. Engineers with diplomas continued to work in administration, while production was overwhelmingly the province of *praktiki* and *vydvizhentsy* without higher education. Soviet enterprises continued to be heavily overstaffed with administrators in comparison to their European and American counterparts.[69]

On the eve of the war in 1941 there were 214,000 specialists with higher educations in the industrial commissariats, of whom only 68,000 (less than 32 percent) worked in production.[70] The situation in regard to technicians was slightly better, with perhaps 50 percent working in production. At individual enterprises the situation varied widely. For example, at the Kiselevsk mechanical plant all twelve engineers occupied administrative posts. But this may have been an exception. The Trud plant had seven of twelve engineers and twelve of seventeen technicians working in the shops; but the plant also had thirty-eight *praktiki* occupying engineering positions.[71]

The character of professional life is demonstrated by the fate of the new All-Union Council of Scientific-Technical Societies. Established in 1933, this organization was not able to convene its first congress until 1959. The "transmission belt" image of organizational activity reached its fullest development in this period.[72]

Despite—or perhaps because of—crash education initiatives, the major source of new cadres for production during the war was the transfer of specialists from administrative positions.[73] A second major influx was of females, whose proportion in the student body increased significantly under wartime conditions. In the Soviet cultural context feminization has had a long-term negative impact on the prestige of engineering.[74]

During the war attention was devoted to rationalization and invention, and to improving the organization and productivity of labor.[75] Under wartime conditions genuine scientific research and innovation were even more difficult than previously, and were focused on activities directly connected with military products. Methods used to solve logistical and production problems often required little in the way of research and development. Army quartermaster A. V. Khrulev described the improvements in transport derived from using horses, reindeer, and camels—all better suited to the unpaved roads of the hinterland than modern vehicles, which were in any case unavailable.[76]

It is not surprising that the war encouraged extensive militarization and the expansion of political involvement in science and technology. Political involvement in Soviet science has always been two-edged, consti-

tuting both a disturbing intrusion into the creative process and a means to expedite the realization of high-priority goals.[77] The apparent lack of administrative control before the war was due as much to "undergovernment" as to assertions of independence. The Party simply did not have sufficient trained personnel to exercise close control over scientists and engineers engaged in research and development. To some extent this can also be attributable to a basic respect for natural science in Russian-Soviet culture. Political problems in the Academy of Sciences in the 1920s affected mostly the social sciences, and it is likely that a detailed history of the purge era would show a similar picture.[78]

The political treatment of scientists has generally differed from the treatment of technical specialists. The specialists appear to have been regarded as a greater threat, particularly at the end of the 1920s. It also seems, however, that engineers were sufficiently intimidated by the measures taken against them in 1928–1930 that there was little need for special purges among them in the late 1930s. But their docility was purchased at an enormous cost to the economy. Disincentives to innovation and to work in production contributed to serious technological backwardness in Soviet industry, a condition that has still not been alleviated.[79]

We still know far too little about the identity and collective biography of the victims of the purges, and these questions will remain unanswered until further archive materials become available (if they exist). We do know that virtually the entire group of activists in the engineering-technical section of the metallists' union was purged, suggesting that the terror frequently struck the most active and professionally conscious among the technical cadres.[80]

The capacity to focus talent and resources on high-priority areas of research and development, as opposed to specific construction projects, was mainly a product of the postwar era. Following the war, however, the Party remained desperately short of technically competent members. A solution to both shortages was sought in co-opting the scientific-technical intelligentsia into the Party and fostering a greater Party role in local-level R&D organizations.[81]

The wartime experience helped to change the attitudes of a large portion of the scientific-technical intelligentsia. Many who would not even have considered joining the Communist Party before 1941 became members under wartime conditions.[82] The proportion of Party members with higher and specialized secondary educations increased during the war

years from 39.8 percent to 57.4 percent. By 1945 over one-third of the 1.2 million specialists with a professional education were Party members.[83]

The postwar decade is the least-studied period in Soviet history, and one that requires much more investigation. It was not a time for new initiatives in professional organizations. But, as Vera Dunham has demonstrated in her book *In Stalin's Time,* it was a period when the professional ethos and reliance on scientific professionalism that had emerged before and during the war became part of the Soviet social contract. Dunham has described this as the "Big Deal" between the regime and the new, largely professional middle class. Its wartime origins are seen clearly in Korneichuk's novel *The Front.* Following the war a plethora of popular novels conveyed the same message. The emphasis was on life style and ethos rather than on engineering, but even the production novels of the period feature an acceptance of the engineering professional.

Where the regime had declared war on neutrality and apoliticism during the First Five-Year Plan, it now accepted a much more modest goal. It was more important to say the right things in public than to live the credo to the fullest. Inner emigration might even be acceptable, provided one denied it publicly. The basis for the pervasive apathy of the Brezhnev era was already being laid.

But the significant changes initiated during the postwar period took root only gradually. While Azhaev's *Daleko ot Moskvy* expresses a certain positive attitude toward knowledge, there are still echoes of specialist baiting as the pipeline is built in one-third the time projected by experts.[84]

Literature is also our major source regarding the work environment during this period. Despite the demands of reconstruction, one gets the impression of a much less overwrought tone in industry. Serious, stable, and consistent work are valued, rather than the increased tempos and stunts of the early five-year plans. An engineer who meets the plan and fulfills basic social norms can expect to enjoy the rewards in relative peace. And fulfilling a plan is itself a relatively peaceful process, in comparison to the prewar environment.

But this was still the Stalin era. Even a decorated military engineer might find it impossible to live where he wished, and many continued to labor in the netherworld of special camps.[85]

De-Stalinization and Stagnation

The Khrushchev era witnessed an attempt to escape from the departmentalism that dominated Soviet administration, but the leadership never found the means to end this condition. In education the Big Deal came under attack, as Khrushchev's policies made it clear that the middle-class status acquired by those with education was not necessarily hereditary. New rules for higher education required a period of employment before admission to higher school, and called for education along with full-time work in production. The result was something of a new *vydvizhenie,* with admission preferences given to those with at least two years' work experience and those willing to continue working while in school. Fraud was once again rampant. Since that time class-based education policies have not been abandoned, although they have generally received less emphasis since 1960.[86]

Repeated reforms resulted in fluctuations in the number of schools and students, but overly rapid changes frequently had little or no impact. By the time local education authorities geared up for reforms, they had been superseded. After 1960 consistent expansion resulted in a significant increase in the number of graduates, along with a continuing tendency for engineering graduates to find employment in both administrative and blue-collar positions. Many still avoided production.[87] Growth continued at gradually declining rates until 1983. And the preference was still for higher education, not technician's training.

Expansion strained resources, demoralized the teaching staff, and increasingly undermined the credibility of the education system. Yet the plan had to be fulfilled. This resulted in the pervasive practice of mechanically awarding passing grades to students merely for attending classes. Faculty whose jobs depended on the number of students enrolled had little desire to jeopardize their positions by giving failing grades, and the students understood this game only too well. The social myth of access to higher education for all was maintained by providing evening and correspondence programs. Today these part-time programs continue to account for about 40 percent of Soviet engineering graduates and are widely criticized for their poor quality.

Despite persistent problems with cadre allocation, the belief in planning was thoroughly institutionalized. It became impossible to conceive of a solution to personnel problems involving anything other than more

or better planning. Planning had to be more scientific, based on better data, or conducted according to new formulas. It was unthinkable to question the idea of planning itself.[88]

The Khrushchev period did witness the beginning of two trends with long-term import for technical specialists. One was a reorientation in specialty preferences and planning that increased the proportion of students in automation and computing. This was the sole significant statistical shift in specialty distribution in the post-Stalin period.[89]

The other major change was a shift in the ratio of wages for engineers and workers. In contrast to the rapid change in specialty distribution, wage leveling was a gradual but consistent process over more than two decades. By the 1970s it had reached absurd proportions. In construction the average wage for engineers actually fell below the rate for workers. Wage leveling reflected the regime's social policy, as well as the fact that many engineers were trained in narrow specialties more suitable for technicians.

As was the case through much of the period under study, the retarded technical base of Soviet industry meant that workers moving from village to city were simply exchanging one form of physical labor for another.[90] For specialists, technical backwardness had a similar impact on prestige. "Rationalizers and automators" had little to do in an industrial environment where physical labor predominated. As recently as the 1980s production lines with robots used the modern equipment for only limited aspects of the production process, while workers hand-carried products from ordinary lines to the automated sections and back again.[91]

Employment trends reflected the continued fragmentation of specialties, and their debasement. Not only did most institutes, following instructions from their ministerial patrons, continue to train specialists in accord with precise, narrow needs. They also spewed forth an absurd plethora of pseudotechnical specialists such as "engineers for wage and norm setting" and (my favorite) "engineers for socialist competition."

It is hardly surprising that under these conditions the prestige of engineers declined sharply.[92] In part this was a process seen in all industrial societies in the postwar decades. Technocracy and rationalization were not bruited about after the Second World War as they had been in the 1920s. It was also a function of changes in the structure and character of scientific and technical activity. The decline in prestige of engineers and scientists has been a nearly universal phenomenon in the age of the in-

dustrial research lab. Technical improvements have always been the product of multiple input, but now this phenomenon has often effaced the individual inventor completely.

In the Soviet Union the global trend has been accentuated by the economic system's abysmal performance in technological innovation.[93] Incentives for scientific research and invention are weak, but creativity has not been stamped out. Incentives to diffuse innovations, however, are almost nonexistent. Of the new technological processes introduced in the Soviet Union, 80 percent are introduced at a single enterprise. Of the remainder, almost all are introduced at fewer than five enterprises. An appalling .6 percent of new processes reach more than five enterprises.[94]

The decline in engineers' prestige and status has combined with changes in the Soviet social structure to make engineering a less desirable career. Competition to enter technical institutes began to decrease in the 1970s and dropped precipitously in the 1980s, despite an overall increase in the number of applicants to institutions of higher education. Not only are salary and employment possibilities in engineering considered to be bleak, but it is not the career of choice for second-generation students. The applicants to technical institutes come mainly from worker and peasant families, or else desperate students for whom *any* higher school is preferable to the potential loss of intelligentsia or middle-class status. As the Soviet Union becomes increasingly a middle-class society, the difficulty of filling the engineering schools will increase.[95]

Conditions in professional life have reinforced the decline in prestige. Shortly after Stalin's death the government introduced a new form of engineering organization. Once again engineers and workers were combined in a single union. The inevitable effect was to reduce the status of engineers.[96] Without a professional society, it remained very difficult for Soviet engineers to develop group cohesiveness or links with the international community.

Emigrés speak of a palpable increase in the Party's role in science and technology after roughly 1967 or 1968 (the exact timing varies in different geographical areas and specialties, and even among individual institutes). Increased Party activity manifested itself in vetting of personnel, declaring the Party's right of control over research and development institutions, and in the growing number of specialists and managers holding Party membership.[97] Once again political involvement was double-edged. It could result in priority for particular institutions and guarantee

stable funding for significant projects like the space program. But personnel decisions were often made on political rather than scientific grounds.

Ironically, it was precisely when engineering began to lose status among the public that it achieved full acceptance in literature. By the late 1950s the Big Deal was consummated, and expert knowledge became a mark of the hero. In this context scientists and engineers could finally become positive protagonists. The temptation persisted to portray them as proletarians or gadflies, as somehow not typical, but specialized knowledge itself was no longer a stigma.

Cultural images of the engineer in the Brezhnev period came predominantly from two genres: village prose and production novels. In the Brezhnev-era production novel there is some ambivalence about the role and status of engineers. The genuine hero is an engineer who rises from the work force rather than one who is a second-generation member of the intelligentsia. In Kolesnikov's *School for Ministers* trilogy, the academic engineer Karzanov and the upwardly mobile worker Altunin are able to talk frankly about the greater chances for a new invention's being accepted if the worker is involved in its development. And it is the worker Altunin who moves on to the heights of power after struggling through night school. On the very day he receives his engineering degree, Altunin is shifted from production work to management, demonstrating both the promise of education and the shortage of cadres.

In contrast to the production novel, village prose reflects the decline in status of the entire scientific-technical ethos. In works of the village school technical specialists appear infrequently, and when they do they are harbingers of destruction, corrupters of values, or at best providers of Hobson's choices, as in Rasputin's "Farewell to Matera," or the tremendously popular film *Siberiade*. Films provide a significant source of characterizations of engineers in the Brezhnev era. *Pena* is a farce dealing with the threat posed to old-style managers by the scientific-technical revolution. The hero of *Moscow Does Not Believe in Tears* is a practical chap who hand-rigs the apparatus many of his institute's engineers use for their dissertations. While still retaining older ideological elements, the literature and film of the Brezhnev era provide a basis for full integration of the middle class.

Gorbachevshchina

Mikhail Gorbachev inherited a situation in which the quantitative aspect of the technical cadre problem had already been solved. In 1975 the USSR employed three times as many engineers as the United States, and the number was continuing to increase at double the American rate. Not until 1983 was there some indication that the expansion had ceased.[98] Inertia and continuing excess demand for higher education, however, make it difficult to curtail enrollments.

The new leadership has demonstrated a willingness to confront the plethora of difficulties in engineers' training and employment. The Basic Directions for Restructuring of Higher and Specialized Secondary Education, approved in 1987, cite a long list of problems, most of which are familiar from the 1932 decree on the same subject. The State Committee on Education has stated its intention to deal with uninterrupted and unwarranted increases in numbers; a level of education that does not meet contemporary demands; fragmentation of specialties; overloaded curriculums; overcrowded classrooms; poor knowledge of new technology; failure to appreciate the role and value of secondary specialized education; lack of teaching cadres and basic infrastructure; low pay for teaching; serious shortcomings in employment of specialists; and anarchy in plans for the number of specialists developed by departments with no accountability for the figures.[99] Boris Eltsin even noted the constant repetition of the same problems over several decades (although he did not look back to 1932).[100]

Thus far the major accomplishment has been a Confucian one: things are finally being called by their proper names. This is a crucial first step, but the next moves will be more difficult. The February 1988 plenum of the Central Committee adopted a resolution consolidating the several strands of education reform and placing all education under a single bureaucratic agency for the first time since the 1920s. It remains to be seen, however, how the new State Committee for Education will handle relations with the industrial ministries which are being called on to finance much of the projected improvement in educational facilities.

Aside from the education reforms, there have been other initiatives, including measures to increase salaries for some engineers. This will not affect all engineers but rather will be limited to those with important jobs in productive enterprises or sectors. It reflects the new regime's acceptance of major income differentials, and has already had a positive impact in a limited number of instances.

A significant development in a number of professions has been public appeal for new professional organizations, including inventors, designers, and education workers. There has even been a call to establish a new union of engineers and scientists—quite a claim in a society that has experienced purges of supposed technocrats. It is striking that Soviet professionals frequently tend to pick up the threads of the professional programs articulated by their prerevolutionary predecessors.[101]

It will be interesting to see how these changes are manifested in literature. Thus far we have not really seen the full cultural results of perestroika, only those of glasnost. The novels, plays, and films released during the first few years of Gorbachev's term of office represent the cultural product of earlier periods that had been denied public release. The literature of perestroika is only beginning to appear and is still limited to memoirs and journalism.[102] Perhaps in the 1990s we will see literature reflecting the changes of the 1980s.

The ambiguities surrounding engineers' status, numbers, and varied roles in Soviet society become less challenging when we separate out the component parts of the scientific-technical intelligentsia and refine our understanding of the term *engineer.* A great many of the individuals called engineers in the Soviet Union would not have that title in Europe or America. The criteria for membership in the engineering elite are of at least two types: technical and social-political. Since the 1920s professional leadership has not been in the hands of those selected by the engineers themselves, or those who have the greatest claim to international professional recognition.

Soviet higher education perpetuated many attributes remaining from the nineteenth century, including departmental orientation, encyclopedic programs of study, and poor success rates. Neither tsarist nor Soviet administrators were able to resolve whether technical training should be the province of educational or industrial administrators. The problem of supply was resolved not so much by providing adequate numbers of cadres as by debasing the meaning of an engineering degree. Formal rationality pervaded the system from 1929 to the mid-1980s, and the poor quality of many of the cadres graduated during that half-century was the result.

A corollary of the problems in engineering training is the persistent orphan status of secondary technical training, with the related shortage of technicians. In this respect Soviet education and industry reflect characteristics of their Russian precursors, exacerbated by the emphases of

the Soviet educational and economic systems and individual preferences. A shortage of auxiliary personnel, the tendency of educated specialists to avoid production, and an excess of supervisory personnel have persisted for over a century.

Providing second-rate higher education to a large number of people and calling them engineers might not in itself constitute a major problem. But the practice brought with it a decline in professional standards, wages, and identity that has been devastating. Recent measures to raise wages and status for *some* engineers constitute a plausible corrective. It does not matter if everyone is called an engineer, as long as the "real" engineers are given genuine incentives and the opportunity to perform.

There are, of course, superb specialists in the Soviet Union. Even during the Cultural Revolution skilled engineers graduated from the top institutes. But there have never been enough of them. To this day all but a few of the elite institutions can trace their lineage to prerevolutionary higher schools. Resources are scarce, and engineering has consistently been called on to play multiple roles, providing technical specialists and managers as well as the political elite.

Throughout the period under study engineering has served as a means of social mobility. Before the Revolution this was a gradual process. During the Civil War, the Cultural Revolution, and again under Nikita Khrushchev, efforts were made to force the pace. Since the mid-1960s the principle of advancing workers and peasants has remained, although it has not been applied on a mass scale. The constant in this story is engineering as a first step up the social ladder: it continues to represent social mobility for individuals from peasant and proletarian backgrounds. In the 1920s and again in the 1930s, engineers sought to provide privileged access to technical institutes for their children. Only scattered efforts of this sort have been evident since the Second World War.

Thus technical training emerges as the transitional stage between worker and intelligentsia, or between working-class and middle-class status. As we have seen, as the Soviet Union becomes a largely middle-class society, the difficulty of finding qualified candidates to enter engineering schools will increase.[103] This is another modern problem hardly unique to the Soviet Union. But it is more alarming in a society that prides itself on planning.

Here again the Soviets appear trapped by their own formal rationality. For a century *praktiki* have occupied important positions in the shops, while a majority of technical specialists have been employed in administration or other positions outside direct production. Many other engineers have been employed as technicians and production workers, and so there continues to be a very poor correlation between individuals' training and status. The real issue here is that the Soviet authorities insist on making it an issue. Planners and bureaucrats become upset when their charts of positions and responsibilities are contravened, and when scientific planning of people's education and career patterns fails to correspond to actual behavior. Yet the genuine problems in education and industry lie elsewhere. The solution has always been cast in terms of more or better planning, rather than a sense that the labor market might need to operate with a degree of freedom similar to what some have proposed for the entire economy.[104] It is time to consider the returns on general investment in human capital, but new financing mechanisms based on contractual relationships point in the opposite direction.

Finally, a return to the tantalizing question of the political role of engineers is appropriate. Technical training in the USSR has led more often to political leadership than to political dissidence. The scientific rather than the technical intelligentsia has been the more vocal force in dissident activity. Despite a shift in preferred elite career patterns from engineering to economics, law, and international studies, and young people's stated preferences for careers in science and the humanities, technical training remains a major route to high party positions. Yet the myth is in decline, and we may be witnessing a struggle between engineers and economists for the soul of the Soviet system.