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University of California, Berkeley

POLYTECHNICAL EDUCATION: A STEP

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Robert H. Beck

University of Minnesota

National Center for Research in Vocational Education
University of California, Berkeley
1995 University Avenue, Suite 375
Berkeley, CA 94704

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INTRODUCTION

Relating vocational to academic programs in American high schools is a challenge. Our high schools are comprehensive today, but about the time of World War I educators such as Snedden and Prosser argued that there should be separate high schools for vocational preparation and for the conventional subjects of general education. By 1930 that ambition was clearly rejected. We have been left with the typical comprehensive high school in which the vocational and the academic really do not mesh. What we commonly find is that more academic study in English, a modern foreign language, mathematics, physical sciences, and social sciences are components of graduation requirements while vocational study is squeezed into the electives. This is far from a melding of the vocational and the academic. Some think that a balance of vocational and academic has been struck. What the balance should be is not clear and, at any rate, a balance seems to be a compromise, a mechanical arrangement not a chemical one. By contrast, the goal that motivates us in this and succeeding essays is to achieve an interaction between the academic and the vocational, the product of which is a general education persuasively stronger than what currently exists. This essay is a step toward that end.

The Soviet Union, and countries closely allied with the USSR, have developed a curriculum known as polytechnical education. It is one of the leading efforts to establish a school in which there is what in English writing on education is termed "parity of esteem" of vocational and academic preparation. Soviet polytechnical education is rooted in the Marxist-Leninist ideology, which remains a powerful influence despite a move toward an economy responsive to the market. In spite of this very high degree of support, we do not think that polytechnical education achieves a sufficient integration of the vocational and the academic. It is a long step, but it remains a step. We move from it in two other essays. One, "Vocational Preparation and General Education," will be concerned with what some leading American educators have termed *general education*. The second, "General Education: Vocational and Academic Collaboration," will be a succession of examples taken from some of the areas into which vocational preparation is divided, examples which, if explored *collaboratively* by teachers of both vocational and academic subjects, might well lead to a sound general education of high school youth.

General education and *collaboration* are the operative terms in the essays following this one. Our goal is to advance the cause of a general education for high school pupils

through the collaboration of vocational and academic teachers. Students and teachers in vocational courses recognize that some of the leaders in their fields—for example, in home economics and industrial technology—were at the cutting edge of social reform, responding to economic needs and opportunities. Only consider what the mechanization of work has meant to society and to culture. Or think what literacy, in terms of modern agriculture or business, to say nothing of industry or so basic an institution as the family, adds to one's intellectual resources. While such examples of literacy are not referred to in this essay on polytechnical education, they will be in "General Education: Vocational and Academic Collaboration."

In each of the three essays the enrichment of academic studies will be slighted in discussions of collaboration between teachers of vocational and academic subjects. That does not mean that such a collaboration would have no effect on the quality of the academic student's general education. Students will find academic studies more relevant; as a consequence, they will be less often bored and less likely to drop out of high school before graduating.

Polytechnical education comes close enough to a collaboration to warrant its inclusion in this three-part series of essays. It has gone beyond a balancing of vocational with academic education. The full measure of its accomplishment may become evident in the next pages.

We have chosen to concentrate on the Soviet Union because it has the longest tradition of polytechnical education. Their governing ideology, reenforced by economic realities, has strongly backed the polytechnical approach to curriculum. Other national trials with a polytechnical curriculum have been passed over. This is especially unfortunate with respect to the German Democratic Republic, whose work has not been reported in the literature. The GDR has accomplished a good deal with its polytechnical education, perhaps because the country is small, the population homogeneous, and its traditional schooling has raised the level of achievement. Polytechnical education is a factor in every grade of the compulsory ten-year school. As a result of having had systematic instruction, the graduate can be counted on to be familiar with, and appreciative of, urban and rural production.

We begin with observations on the ways in which the Marxist-Leninist ideology determined the development of polytechnical education. We then discuss the essential

structure of a polytechnical education—both urban and rural—and its implications for selected courses of study. Finally, we conclude by relating polytechnical education to vocational education and to career guidance.

A note of caution is in order. For the most part Soviet essays and speeches will be cited. Until *glasnost* has had an impact on writing in education, the tendency to report success will continue. This reflects the "socialist realist"[1] philosophy of looking forward to a bright future rather than dwelling on present difficulties. Mention is often made of areas needing improvement, but this is always done in the spirit of "building a better future." Consequently, educational reporting has been uncritical of present efforts.

[1]In an address to the First All-Union Congress of Soviet Writers (1934), socialist realism was given its original definition as "the truthful, historically concrete representation of reality in its revolutionary development. . . [the] representation of reality must be linked with the task of ideological transformation and education of workers in the spirit of socialism" (Tertz, 1960).

BACKGROUND

One student of Soviet education describes the years between 1964 and 1984 "as the transitional period in Soviet education during which the school curriculum vacillated between the academic and the vocational" (Zajda, 1984). The press had carried letters critical of the rigidity and obsolescence of Soviet education and critical of its indifference to the varying career hopes of pupils. The first significant move toward reform appeared in a November 1966 decree, "On Methods of Furthering Improvement of the Educational Process in Secondary School." It was followed by the New School Statute published in September 1970, which, after six years of trial, was characterized by prominent Soviet educator Prokofiev in an article by Zajda as "one of the most essential achievements in the history of the Soviet school" (p. 405). Apparently the praise was premature, for in December of 1977 a new educational decree was published which "specifically stated that school syllabuses were not adequate to develop the pupils' moral, ideological and social qualities and prepare them for life and work" (p. 405).

The phrase "prepare them for life and work" was pivotal. Years earlier, in 1958, General Secretary Khrushchev had called for more attention to vocational education.[2] Khrushchev failed to endorse polytechnical education as the way to move general and vocational education into a common curriculum. Instead, he thundered about "strengthening the ties between school and life," the chief accomplishment of which was to reduce the length of compulsory general education and shepherd increasing numbers of youth into vocational schools and industrial production.

Khrushchev's aim was given life in a May 1984 document, "On Further Improvements in Work Training, Education and Vocational Orientation of Students and the Organization of Socially Useful and Productive Labour."[3] In a matter of months, on

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[2] For elaboration of Khruschev's criticisms of Soviet education and his recommended restructuring of the Soviet schools, see Beck, 1962. Years later Shirshova (1981), Khitarian (1981), and Valova (1981) attempted to show how schools in the Siberian Far North, as early as the late 1920s, had moved to make schooling "relevant to life." These three articles suggest the continuity of thought in the development of a portion of Soviet schooling over a half-century.

[3] Cited by *Izvestia*, May 4, 1984, and noted in Zajda, 1984, p. 406. Although child workers are not the principal topic of this study, it may be in order to recall that Marx and Engels were not opposed to children working, but did condemn the practice of using child labor with no concern for the integration of labor and education: "We consider the tendency of modern industry to make children and juvenile persons of both sexes cooperate in the great work of social production, as a progressive, sound and legitimate tendency. . . . In a rational state of society every child whatever, from the age of nine years, ought to become a productive

January 4, 1985, the Communist Party's Central Committee published "Basic Guidelines for Reform in the General-Education and Vocational Schools."

Not all comment was favorable. The negative criticisms targeted the career orientations of pupils. As in the West, young people were choosing between an academic and a vocational-technical future without having recognized that the academic (in particular the scientific) and the vocational worlds were joined. The way was open for an updating of the venerable polytechnical point of view. In 1974, a fully developed conception of polytechnical education was provided by Vasil'ev and Chepelev:

> Polytechnical education is . . . a component part of the upbringing of comprehensively developed builders of communist society. Its mission is to familiarize pupils with scientific principles and current trends in the development of the most important branches of modern production, to give them an idea of the relationship between science and practice in communist construction, and to provide them with skills in the operation of the tools, machines, and mechanical equipment that comprise the base of modern industrial and agricultural production.[4] (p. 80)

Many definitions of polytechnical education exist, but all make the same general points. For example, in the Editor's Introduction to "Polytechnical Labor Education in the Soviet School" (1975), one reads the following: "Refined from Marxist writings, polytechnism means, in brief, combining teaching and learning about economic production with practical work experience. The aim of polytechnical education in the USSR is to prepare youth for a life of productive labor in society and contribution to the construction of communism" (p. 3). These same elements had been present for a generation, attesting to the stability of the definition. For example, Shapovalenko (1965) asks rhetorically what a polytechnical education should be. His answer is "[it imparts] knowledge of the scientific foundations of modern production, [acquaints] students with the most important branches

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labourer in the same way that no able-bodied adult person ought to be exempted from the general law of nature, viz.: to work in order to be able to eat, and work not only with the brain but with the hands too" (Marx & Engels, 1975, p. 188). Marx and Engels go on to say more of what they intend by education: "By education we understand three things. Firstly: *Mental education*. Secondly: *Bodily education* [at other places in their writings bodily education is described as "gymnastics"]. . . . Thirdly: *Technological* [the German text has *Polytechnik*] *training*, which imparts the general principles of all processes of production, and, simultaneously, initiates the child and young person in the practical use and handling of the elementary instruments of all trades." Marx was clearly aligned against what he thought of as excessive child labor (e.g., children as young as nine years old working for sixty consecutive hours with only three hours of rest [pp. 464-467]).

[4]Shapovalenko (1965) raised a novel question when he prodded those teaching general education to be as up-to-date as those who urged technological progress. Incidentally, Shapovalenko contributed an article to the December 1975 issue of *Soviet Education* which was devoted entirely to polytechnical education.

of industry, [arms] them with elementary skills for handling modern implements of labor, [involves] the students in socially useful productive labor, and [develops] in them a communist attitude toward labor" (p. 31).

The ideology of Soviet education has blessed the melding of (1) restructured academic studies, (2) a Soviet interpretation of vocational guidance, and (3) the preparation of students for skilled labor. This requires academic juggling. For most Soviet citizens, status and prestige have lodged with studies that led to advanced education and, subsequently, to careers employing highly trained manpower. The Soviet people, and many teachers and other educational specialists as well, are being asked to recognize that academic subjects, especially mathematics and the sciences, are to be understood both as theoretical statements and as functions in the work-a-day world. Factories, farms, and, presumably, other centers of production, as well as transportation and service, will be asked to associate themselves with schools. If that lesson can be taught successfully, then leading Soviet educators should succeed in winning a substantial number of Soviet youth to think of careers in that same "work-world." The hope is that needed skills will also have been mastered as a result of learning mathematics and the physical, biological, and earth sciences first of all, in partnership with such enterprises as factories, farms, mines, fishing fleets, and so forth. The cooperation of transportation, mining, forestry, and fishing, for example, seems to have been less well articulated.

One other partnership must be noted, though it will not be elaborated upon. Those who contribute to the literature on Soviet education have very different words for describing the formal education of the schools (*obuchenie*) and the upbringing in which the home, the Komsomol [the All-Union Leninist Communist Youth League], and the unions are significant partners of the educators (*vospitanii*) ("V. I. Lenin o shkole," 1949; Petrov, 1946a; Petrov, 1946b; Kachalkin, 1948; Tikhmirova, 1948). When *obuchenie* and *vospitanii* operate in tandem, chances are enhanced for the development of the "good Soviet man and woman" and the "comprehensively developed personality"—phrases that recur in Soviet literature on education. (Too little attention has been paid to Soviet trade unions. For more information on this, see Szekely, 1983).

One might ask whether any differentiation of interests was noted between boys and girls relevant to polytechnical education. Not much pertinent literature exists, but Vasil'ev and Chepelev (1974) did see a difference, dictated by tradition, in the aspirations of the sexes. Boys prefer working with equipment, while girls prefer sewing, drafting, and

typewriting. (Unfortunately, we do not know how well documented this generalization was.) However, Vasil'ev and Chepelev did recognize the ever greater opportunities provided by the service sector of the Soviet economy:

> The social upbringing of children is being more broadly developed and the service sector is growing—hence the illegitimacy of a "narrow domestication" of the labor training of girls. Trends in the development of female labor in the national economy must be examined and the question of differentiation in the content of labor training for boys and girls resolved accordingly. (p. 94)

This addition by the mid-1970s of the service sector to agriculture and industry suggests a greater interest at the planning level in meeting the needs of consumers.

The October Revolution was more than thirty years behind him when Popov (1950) wrote "The Great October Socialist Revolution and the School." Close to the opening of his essay, Popov gave pride of place to Stalin, then General Secretary of the Soviet Communist Party. What Popov quoted from Stalin prepared the way for thinking of polytechnical education as fundamental to the Revolution. The Revolution, Stalin had insisted, had been more than an economic and sociopolitical phenomenon. It had been "a revolution in the minds, a revolution in the ideology of the working class." He felt that the sciences, above all other studies, were pivotal. Stalin's speech to the Eighth All-Soviet Congress of the Komsomol included a martial call: "Before us stands a fortress (called) science with all its multiple branches of knowledge. Youth must take this fortress if it wants to be the builder of a new life" (p. 8). Never again would Soviet educators hesitate to beat the drum for having the content of polytechnical education develop parallel to the new scientifically sired technology (see Razumovskii, 1987).

Having acknowledged the regnant leadership of the Party, Popov turned to the fountainheads of Soviet ideology,[5] Marx and Engels. He argued that by describing the organization of upbringing in socialist society, Marx and Engels had affirmed that only a polytechnical approach would do. Lenin, and then Stalin, had spelled out the implications of what Marx and Engels had identified as the polytechnical (pp. 3-4). In Lenin's words, an ideal of the Revolution is the new possibility that "all the miracles of technology, all the achievements of culture can become attainable to all the people" (p. 5). Polytechnical education would be the key.

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[5] For an overview of the Marxist-Leninist ideology written not long after the 1958 reform of education in the Soviet Union, the so-called Khrushchev reform, see Skatkin, 1963.

These words of Lenin are a very few of the many he wrote and spoke defining and urging the addition of the polytechnical to Soviet education. There were other words, some by Lunacharsky (1980), who, we are told, "shared with Lenin the bitter years of forced exile abroad, the joy of revolutionary battles, the difficulties and successes in building the world's first state of workers and peasants" (p. 8). The idealistic rhetoric of Lenin is familiar, but there was a very practical side to his interest in the polytechnical. Lunacharsky reminds us that Lenin wrote the following:

> Every bit of knowledge one acquires should be accompanied by a demonstration of how it can be applied to the practical needs of society. And this knowledge should be applied in a way that, whilst our young people are getting to grips with real-life problems, we can introduce them to wider knowledge as they go along. (pp. 128-129)

Lenin, indeed, was practical. His chief interest in polytechnical education in those early years was the preparation of those who could help electrify rural areas. Nationwide electrification was a major element in Lenin's success in gaining the support of the rural masses. He sought to raise their level of living through improvements in conditions as well as through education. But Lenin (1963) was not the only powerful spokesperson for a polytechnical direction to Soviet education. There was the strong, if sometimes crude, urging of Krupskaia, his wife. And, as we know, both Krupskaia and Lenin reinforced the educational directives of their longstanding associate, the first Commissar of Soviet education, Lunacharsky. Lenin's wife was more blunt in her practical suggestions: "We are beggars," she wrote in the notes known as "Concerning Polytechnical Education." "We need joiners, metal craftsmen, *right now. Unconditionally.* All ought to become joiners, metal craftsmen, and so forth, *however*, with a certain addition of general education and polytechnical minimum" (p. 230). She also insisted that these craftsmen "*have a polytechnical world view and the fundamentals . . . of polytechnical education*, namely: . . . *fundamental* concepts of electricity . . . concerning the application of electricity to the mechanical production sector . . . also concerning the plan of electrification of the RSFSR [Russian Soviet Federated Socialist Republic]" (p. 230). The directness with which Krupskaia wrote is well illustrated in the sentence that immediately follows the passage quoted: "Develop in detail minimum knowledge (Grin'ko evidently messed up to the point of stupidity, omitting polytechnical education) perhaps in part O. Yu. Shmidt [did this] as well. Correct this."[6]

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[6] An adequate translation of Krupskaia's notes captures the roughness and choppiness of the original. See Lenin, 1963, pp. 228-230.

The Soviets are truly helped in their juggling by urging what is in accord with the words of Marx, Lenin, and all those who later succeeded to political leadership. Their words have clearly demanded that schooling in the physical, natural, and social sciences, as well as in literature and art, be integrated with the utilization of the curriculum in manufacturing, agriculture, mining, or wherever skilled manpower is needed for "socially useful work." This is the essence of polytechnical education, an educational ideal that sees academic education transformed to include the way in which theories are formulated, taught, and learned as they operate in a technological society (Shabalov, 1956). That Marx's and Lenin's worlds did not call on technology to the extent common in highly developed economies does not matter. On this point, a sentence from Lenin's address to the Third Session of the Central Committee of the Communist Party, the Seventh Convocation of September 26-27, 1920, might be translated to read as follows: "Polytechnical education does not require the instruction of everything, but requires the teaching of fundamentals of contemporary[7] industry in general" (Petrov, 1946a, p. 6; see also "Urgent Problems," 1975, p. 6). The thinking of the founders of communist philosophy can be suited to the needs of the day.

When Brezhnev addressed the All-Union Leninist Communist Youth League on the same theme, his talk attracted a good deal of attention and was widely quoted. While Ivanovich, a member of the USSR Academy of Pedagogical Sciences and a perceptive commentator, selected Brezhnev's, noting the mastery of technology useful for increasing agricultural productivity, another critic, Chernik (1975), illustrated the stress that Brezhnev laid on inculcating a "love for labor." Brezhnev had told the Congress that

> the indoctrination of boys and girls in the spirit of respect for and love of labor has always been, and continues to be, the most important concern of the Communist Party and one of the main tasks of the Leninist Komsomol. . . . This is an important governmental priority. Everyone—work collectives, social organizations, the school, and the family—is interested in its proper formulation and resolution. It affects the fate of millions of people and, more than that, the future of our country. (p. 60)

Increasing agricultural production (and factory output as well) was, and continues to be, a major Soviet concern. Chernik caught Brezhnev's hope that the efforts of the Komsomol would supplement general and polytechnical education in this press for greater motivation. This was probably why Brezhnev's address to the Komsomol Congress in Moscow was

[7]"Contemporary" was Lenin's magic word. His statement applies to all levels of technological development because whatever level exists at a given time is "contemporary."

so generally quoted. There was a real push for combining work experience with polytechnical education (see "Urgent Problems," 1975).

A technological society is the challenge. The ideology of the Soviet Communist Party must adapt to an economy that is quite different from the one familiar to Marx or to Lenin. Atutov, who has had a commanding role in recasting a portion of education—the polytechnical education of which we are writing—shows us how well he has limned the character of the production with which the thinking of Marx and Lenin must be found to be, or made to be, compatible:

> Contemporary automated production requires the intensive cadre training of people who are capable of independently monitoring their own work, based on their basic scientific knowledge, and who are capable of resolving complex production-related tasks. For example, the introduction of automation is contingent upon the achievements of radioelectronics, the use of semiconductors, computer and microprocessor technology, and successes in cybernetics. But this assumes worker knowledge not only of mathematics, but of other very diverse fields that may have little in common —biology and linguistics, logic and physics, mathematics and radioelectronics, psychology and chemistry. And this, in turn, imposes increasingly high demands upon the technical and general education training of workers and collective farmers. . . . It guarantees an assimilation of the scientific bases of the production sector and develops inquisitive minds and self-reliant actions. (Atutov, 1987, p. 75; also see Nikolaev, 1975)

The hope that future workers would be motivated to be increasingly productive has always been joined with the repeated call for more study of the sciences in a polytechnically designed education. This has been especially difficult to achieve in rural settings. Nikolaev's (1975) underscoring of the need has been one of the more important because it skillfully blends the desirability of polytechnical education and the increasing need for more science in the curriculum. For example,

> The experience of leading rural schools shows that labor education is successful in solving its problems only if its content and the content of subjects in the natural science and mathematics curriculum are of a polytechnical [character] and [if their] organization promotes realization of the actual interaction between instruction in agricultural labor and study of the fundamentals of science. It was Krupskaia who pointed out the necessity for such a relationship in an article "On Polytechnism" . . . [and] when deprived of its polytechnical basis, labor education acquires a narrow, hackwork character. (pp. 90-91)

The educational reconstruction embodied in the 1984 law on education ordered that there be renewed emphasis on polytechnical education. Other changes were mandated as

well, the most dramatic being that there be preparation for skilled work, along with the clear demonstration of polytechnical education. Then, too, Soviet youngsters were to begin school at six rather than seven. A shortage of skilled workers, similar to that experienced in the United States, doubtless prompted these injunctions. The effect has been to call for schooling wherein educational philosophy reinforces a thoroughgoing tie between the academic and the technical. Contemporary Soviet schooling, either in what is termed incomplete secondary schools, which offer eight years of instruction and graduate young people at the age of fifteen, or in schools offering complete secondary schooling that lasts for eleven or, as in the Baltic Republics, twelve years, very clearly means to honor the idea that school and society are firmly linked.[8] While this ideal is not new, it tilts Soviet schooling away from an academically intensive curriculum, streamlines it, or, more accurately, drops some of the abstractions that have proved overly difficult for many students, especially those in the upper grades. At the same time, this streamlined curriculum has been dedicated anew to polytechnical education and to trying to provide all graduates with vocational skills.

In the discussion that follows, polytechnical education should be understood to include vocational preparation. The success of this preparation reaches beyond career counseling to the actual attaining of skills needed in Soviet production and is judged to be of the greatest importance by the Soviet leadership. That this should be carefully monitored for possible adaptation in American public education is not a farfetched idea. As Pannabecker (1986) and Schurter (1982) have reminded us, this would not be the first time that Russian educational developments have been adapted in the United States. In the late nineteenth century, Russian innovations in a system of tool making and use were an "important turning point" in industrial education (Bennett, 1937). The Moscow Trade School, the best known school offering Russian industrial education, mounted an exhibit at the 1876 Philadelphia Exhibition and stirred the imagination of several men directing American engineering colleges (Luetkemeyer, 1986). It was only a matter of time before this influence moved to manual training in the American high school (Barlow, 1967).

Although the merger of academic and vocational education in the same American school is quite unlikely, at least in the short run, polytechnical education does hold promise

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[8] This may also be satisfied by completion of a combination of the eight-year incomplete secondary school followed by one, two, or three years in a specialized vocational school. Soviet industry often has schooling (fabrichno zavodskoe uchenichestvo) available in non-shift hours for workers who wish to acquire or upgrade skills or to add general-polytechnical instruction.

for American educators concerned with "relevance" and the well-known indifference of so many high school students. The existence of parallel vocational, academic, and general curriculums in the American high school has never been the equivalent of the manner in which polytechnical and vocational education have been viewed in the USSR. American vocational-education teachers have felt that their courses have been used as a "dumping ground" for students regarded as having little academic promise. The justification for such feeling is less important than the fact that a difference in status has been perceived by students as well as by teachers. The question is, would an American adaptation of polytechnical education assist in seeing general education in a new light? We think it would. (For a review of some inadequacies in our views on general and liberal education, see Beck, 1988.) Our reason for making this claim is that polytechnical education has always insisted that an understanding of production is essential to an adequate education. If the concept of production is extended to include the scientific and technical basis of so much of modern civilization, polytechnical education can be useful in restructuring general education as we know it. Here our claim ends. In the more extended discussion of polytechnical and general education, we urge that a recast general education not only respond to an environment continuously shaped by technology but also make clear its concern with the social environment in which the presence of science and technology is at once promising and frustrating. In the Soviet Union, cooperativeness and social production are forever promising; menace is left to the bourgeois, competitive, capitalist world.

However much the Marxist-Leninist ideology of polytechnicism is acknowledged, the polarity of capitalism and socialism is not the subject of this paper. That is no cause for regret, since much literature exists on the subject. It would be a pity, however, to allow concern with polytechnical education to eclipse the attempt Soviet political and educational leaders are making to include vocational preparation along with general-academic and polytechnical education.

This has been true from the first years of the Soviet state. One reads the following in a draft of the Russian Communist Party Program for March-June 1919:

> (1) Implementation of free and compulsory general and polytechnical (introduced in theory and in practice with all major branches of the production sector) education for all children of both genders to sixteen years.
> (2) Realization of a close connection between instruction and social-production labor. (pp. 116-117)

This meld has been noted, but not enough attention has been paid to the ideology that makes it persuasive. We have no comparable ideology and are left with what seems to be nothing but social class intrusion into education, that is, an academic course of study for the upper and middle class who are bound for college and "vocational training" for the lower class. The perception may be in error, but it is difficult to dismiss. Our reflection will be confined to a brief historical note on the failure to give vocational preparation a respected place in education, if only a respected life in vocational schools. Respectability would have made it easier to effect an imaginative merger of the academic and vocational-technical. It is just such a merger, a true joining, that we seek. Polytechnical education may show the way.

DEFINITION AND IDEOLOGY

Polytechnical education in the Soviet Union cannot be understood apart from its ideological base. For the first chapter in the history of this firm relationship, we must briefly return to the thoughts of Marx and Engels, together with the policies of Lenin. Here lies the ultimate legitimation of the honored place polytechnicism has in the Soviet curriculum. Yet the ritualistic invocation of the names and thoughts of Marx, Engels, and Lenin, often followed by a reference to their endorsement in the writing or in the noteworthy addresses by whoever is the sitting Soviet Communist Party General Secretary, can be misleading. It would not be true to the living quality of polytechnical education, its up-to-date character, to simply recite its roots in the writings of Marx and Engels, and in Lenin's adaptation of Marxian thought in his speeches and writing. For that reason, we shall cite the modern statements about polytechnical education, which, not surprisingly, almost always include the legitimating references to Marx and Engels and, most certainly, to Lenin.

The most authoritative remarks on the Soviet experience with polytechnical education come from the Scientific Research Institute of Curriculum and Teaching Methods of the USSR Academy of Pedagogical Sciences. While Atutov, Director of the Scientific Research Institute of Labor Training and Occupational Guidance within the Academy, must be heard for his noting of the important part polytechnical education plays in the Soviet equivalent of career development, Mikhailov has pride of place. Mikhailov wrote as an

affiliate of the Academy. With a customary bow to socialist realism and its familiar look to the future, Mikhailov (1975) assures the readers of *Sovetskaia Pedagogika* that education in the Soviet Union will overcome "the vestiges of the bourgeois system for the social division of labor" (p. 96), alerting his readers to or reminding them of the Western educational tradition in which the vocational and academic were kept apart.[9]

Although Mikhailov should be viewed as a modern expositor of the Marx-Engels views on education—on what came to be known as polytechnical education—it is well to remember that Marx and Engels believed social humanism to be fundamental to polytechnical education. This view holds that it is the responsibility of the State and Communist Party to promote the union of work and study. Marx and Engels repeatedly articulated what is captured in the following brief quotations:

> It is impossible to imagine an ideal future society without the union of instruction and production sector labor of the young generation: neither instruction and education without production labor, nor production labor without parallel instruction and education could be placed at that height, which is demanded by the contemporary level of technology and the condition of scientific knowledge. This concept was expressed by the old, great utopianists.
>
> In order to unite universal production sector labor with universal education it is unavoidable, evidently, to entrust upon all [not only upon the poor] the obligation to take part in production sector labor. (Lenin, p. 486)

Marx and Engels may not have known of Robert Owen's utopian colony, New Harmony in Indiana (Lockwood, 1907), but Owen's earlier colony, New Lanark, was well-publicized in England. The favorable impression that Marx and Engels had of the Scottish capitalist and industrialist is noteworthy. In an essay on the educational role that evolved around the concept of "human capital," the educational philosopher and historian Paul Constantine Violas noted, "The theoretical basis of these communities was set out in a tract entitled, *A New View of Society, or Essays on the Principle of the Formation of Human Character, and the Application of the Principle to Practice*, and was but one of many attempts by Owen to persuade his countrymen to apply his ideas generally to society. . . . The tract reflects Owen's classical liberal faith in the power of reason to transform individual men and in the proclivity for reasonable men to develop a just society. For

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[9] As has usually been true in Soviet writing on education, Mikhailov did not make room for Western educational comment. Dewey's argument against this dualism (i.e., in his *Democracy and Education* published in 1916), would have supported Mikhailov's case.

Owen, as for many modern day vocational educators, the key to a just society was increased material welfare for all mankind" ("Reflections on Theories," 1981). In "Anti-Dühring Dialectics of Nature," Engels linked his Marxism to an acknowledgment of Owen's contribution. In fact, what Engels applauded was an industrialized equivalent of what the Swiss educational reformer, Pestalozzi (1746-1827), wished for poor children (see Eby, 1952). In more elegant language, Engels, like Marx, welcomed what might well be thought of as social humanism:

> A population, originally consisting of the most diverse and, for the most part, very demoralized elements . . . he [Owen] turned into a model colony, in which drunkenness, police, magistrates, lawsuits, poor laws, charity, were unknown. And all this simply by placing the people in conditions worthy of human beings, and especially by carefully bringing up the rising generation. He was the founder of infant schools. . . . At the age of two the children came to school, where they enjoyed themselves so much that they could scarcely be got home again. (p. 249)

Somewhat further along in his "Anti-Dühring Dialectics of Nature," Engels subscribes more plainly to what properly can be termed social humanism, a view compatible with social liberalism as it is known in this country today. In one passage Engels quotes from Marx's *Das Kapital*:

> From the Factory system budded, as Robert Owen has shown us in detail, the germ of the education of the future, an education that will, in the case of every child over a given age, combine productive labour with instruction and gymnastics, not only as one of the methods of adding to the efficiency of production, but as the only method of producing fully developed human beings. (pp. 306-307)

The conclusion that only the collective or the social characterizes Soviet humanism would not be altogether true. There is a tension between the individual and the collective, one that has deep roots in Russian cultural history and is reflected in political as well as in Russian Orthodox beliefs. Attention to the development of the individual without reference to society or the state can readily be found in the writing of Marx and Engels.[10]

We return to Mikhailov at the point where he invokes Marx, quoting Marx (and Engels) to the effect that, "To us, communism is not a *state* that must be established, it is

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[10] The Anti-Dühring volume is studded with assertions such as the accusation that manufacture splits up each trade into its separate operations (Part III, p. 278) and that this specialization stunts development. Engels quotes Marx to the effect that this "converts the labourer into a crippled monstrosity, by forcing his detail dexterity at the expense of a world of productive capabilities and instincts. . . . The individual himself is made the automatic motor of a fractional operation" (p. 280; *Das Kapital*, p. 443).

not an *ideal* to which reality must conform. We call the *real* movement that destroys the status quo communism" (p. 96). The status quo to be destroyed is the separation of academic and vocational preparation. According to Mikhailov, this distinction has led to what Marx termed "vocational cretinism" (p. 99). It is worth repeating what soon followed in Mikhailov's article, if for no other reason than that it shows Marx and Engels did not feel their views to be divorced from others who thought of themselves as liberals and not revolutionaries. They felt that the humanistic obligation of political organization was to see to the upbringing of "fully developed human beings," an objective which, Marx explained, meant that

> . . . true "public" education carried out by the state lies in the rational and public existence of the state; the state itself educates its members by making them members, by converting the aims of the individual into general aims, crude instinct into moral inclination, natural independence into spiritual freedom, by the individual finding his good in the life of the whole, and the whole in the frame of mind of the individual.[11]

The ideological grounding of polytechnical education should not be taken for granted; it introduces any number of important statements on educational philosophy and curricular design published in the Soviet Union. For one thing, it has provided stability to Soviet educational reforms. What might have seemed a periodic upheaval in Soviet education has been anchored by the constant of the Marxist-Leninist polytechnical philosophy. And now that Soviet educators are attempting to juggle general or academic education with both career guidance and the development of skills through vocational preparation, polytechnical education plays a key, bridging role.

This last is signaled by the fact that one finds Mikhailov joined with the leading Soviet authority on polytechnical education, Atutov. Atutov is paired with Batyshev (1986), Academic Secretary of the Division for the Pedagogy and Psychology of Vocational and Technical Education at the same Academy.[12]

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[11] Marx, 1975, p. 193. This form of humanism was Marx's answer, which ran in the *Rheinische Zeitung*, 1842, and answered an article in the *Kölnische Zeitung*, which had defended the humanism advocated by the Catholic Church during the 1840s, a humanism that actively campaigned against liberal trends such as those reflected in the *Rheinische Zeitung*.

[12] *Soviet Education* (1986, November) is devoted to essays on polytechnical education by Atutov. The series includes "Polytechnical Education and the Comprehensive Development of the Schoolchild's Personality" (pp. 7-21); "The Content of Polytechnical Education: How It Is Assimilated in Schools?" (pp. 22-42); "The Polytechnical Foundations of Labor Training for Schoolchildren" (pp. 43-56); and "The Merger of Instruction and Productive Labor for Schoolchildren" (pp. 57-86).

The first paragraph in Atutov's "The Founders of Marxism-Leninism on Polytechnical Education" (1987), informs his initial group of readers, those who looked for professional and authoritative discussion of education in *Sovetskaia Pedagogika*, that this jewel in the crown of Soviet schooling was central to the educational views held by Marx and Engels. Atutov provides the most explicit statement of this point:

> The idea of polytechnical education and the combination of [classroom] instruction with productive labor as the basis of comprehensive and harmonious personality development was first formulated by Karl Marx and Friedrich Engels. The distinguished founders of scientific communism took "upbringing" [*vospitanie*] to mean first, *intellectual upbringing*, second, *physical upbringing*, and, third, *technological instruction*, "which provides an acquaintance with the basic principles of all the production processes and simultaneously provides the child or adolescent with the habits needed to handle the rudimentary tools of all production units [*proizvodstva*]." (p. 65)

To this formula, Atutov joined Lenin's contribution, a spate of writing that added "the way in which that principle could be actualized in the Soviet school system, and pointed out the indissoluble link between the school and the activity of the Party and the entire people in communist construction" (pp. 65-66). The phrase "activity of the Party" was not clarified but may well be a constant reminder of the ideological roots and support through the Komsomol, labor unions, the media, and other components of "agitation and propaganda." What was intended by the activity of "the entire people in communist construction" is even less clear but may well be mass participation in "socially useful work" leading to a better future characterized by a higher level of societal development, that is, communism. The modern dress of this production calls for upgrading the young's grasp of science and technology, always learned in farm, factory, mining, forestry, fishing, and other occupational settings—preparation for work in the service sector and office remain neglected. If all of this were no more than a restatement of a familiar ideology, it would be interesting primarily because it demonstrates the continuity of a comprehensive and consistent educational theory. That is no little matter. There is far less continuity, comprehensiveness, and consistency in American public education. Be that as it may, what now attracts us is the pivotal role assigned polytechnical education. True, polytechnical

education has not always seemed essential, but at no time has it been shouldered aside as being of lesser importance.[13]

Appreciating that the ideal and reality of polytechnical education is fundamental to Soviet educational philosophy is nearly impossible for Americans, even American educators, for two reasons. First, we lack a traditional ideology and we have rejected the idea of an education that includes universal vocational preparation. It may be that a common ideology would be too restrictive, overly authoritarian, and exclusive. Even Butts (1980) has not won general approbation for his ideal of a common *civisme unum* within our cultural plurality. As for the metaphorical wall that separates vocational and general education as decidedly as church is separated from state, that wall still stands. Nor is there an equivalent of polytechnical education to provide the tie that binds.

THE POLYTECHNICAL AND HUMAN DEVELOPMENT

Polytechnical education for older youth includes the technical and assumes appropriate academic study in mathematics as well as in the physical, biological, and earth sciences. It has been easy enough for Atutov and his colleagues to argue that, because the economic environment is qualified by science and technology, humans cannot be untouched. After the Soviet fashion, Marx is credited with first sensing this truth. "Under socialism," writes Atutov, citing Marx and Engels, "the development of science as a directly productive force is indissolubly linked with the development of man himself. *The development of science*, of that ideal and at the same time practical asset, is only one of the facets, one of the forms in which *the development of man's productive forces*—the development of an asset, that is—occurs" (p. 66).

When Soviet ideologists write of human development, a good deal more is intended than the slice that narrows to work nourished by acquaintance with science and technology. Atutov is aware of this partiality and adds a paragraph that, except for its reference to the worker, work, and "the productive sphere," has little to do with

[13] Even though polytechnical education has been considered key to modern Soviet secondary schooling, there have been times of intense review. For example, the February 1956 issue of *Sovetskaia Pedagogika* was entirely devoted to polytechnical education.

polytechnical education but tacitly acknowledges that the polytechnical is not the sum of what Marx saw as the school's responsibility. According to Atutov, "Karl Marx linked human development with its objective foundation, with the development, that is, of social relations." Atutov goes on to elaborate on these social relations and the obligations they entail: "In the context of mature socialism, comprehensive development signifies the maturation of man as a worker, a citizen, a social activist, a judicious consumer, and a highly moral personality. It [human development] contains provision for vigorous participation in the management of community affairs, the productive sphere, and the campaign for communist ideals" (p. 67).

Observers of Soviet culture know that the home, media, and any other institution of socialization, are expected to cooperate in the upbringing of a "good" Soviet citizen. Polytechnical education is central to these hopes because it is the avenue by which a young man or woman comes to realize that contemporary development in an economy is scientifically and technically driven to a degree greater than even Marx foresaw. The more elusive goal is to forge this scientific and technical knowledge into a pattern of development that includes flexibility guaranteed by mastery of fundamentals—be they mathematical, statistical, or in logic—wedded to a desire to enter the workplace where it is judged that skill is needed. This last can be phrased to freely choose the work for which someone says there is need. Not all of this can be asked of polytechnical education, for it is not all of upbringing. Nevertheless, such a leading Soviet educator as Atutov pins his hope on polytechnical education on the grounds that it can be made evident that science and science applied through technology is a reality that everyone can understand to be a necessity for his or her own career. This last may well require moving from one job to another.

However much a Soviet ideologist might wish to associate Marx with the contemporary character of polytechnical education, the emphasis in Marx's reflections on polytechnical education was to negate the gap between physical and intellectual work (p. 73). Dewey would have insisted that the gap resulted in a class division and embraced a basically dualistic epistemology that categorized mind separate from body, action-production separate from theory and the ideas that have not been applied. But the relation of Dewey's thought to Soviet life and education has not as yet been recognized in the Soviet Union. In fact, it is more accurate to say that it has not been revived since being thoroughly rejected in the early 1930s. The point we wish to make is that Dewey went beyond condemning the mind-body bifurcation. His insistence that the school be central

in society, not only in the economic sector but in society generally, meant that education would be infused with social problems, which would be essential to the curriculum. This is a matter to which we will return in our reflection on the remaking of American general education.

Following Lenin's lead, Soviet educators have left social issues to the Communist Party. Although the division of academic and vocational education was understood in terms of social class conflict, there has not been the least move to transmute Soviet schools in accordance with Dewey's social reconstructionism. Lenin's path led in a quite different direction.

Believing that the polytechnical principle would always be contemporary, Lenin adopted the Marxian stance with a significant added emphasis on vocational preparation. This last is probably what Atutov (1986) had in mind when he wrote that "Lenin's great service consists in the fact that he defended the principle of combining instruction with academic work against all attacks, and developed it further" (p. 73). Atutov made a telling affirmation of Lenin, one strongly seconded by Lenin's wife, Nadezhda K. Krupskaia, herself intimately associated with the early years of Soviet education. What Lenin said was,

> One cannot even imagine an ideal future society without a combination of instruction and productive labor for the younger generation: neither instruction and education without productive labor, nor productive labor without parallel instruction could ever be placed in the elevated position that is required by the contemporary level of technology and the state of scientific knowledge. (pp. 73-79)

A key person has yet to be heard from, the person who translated his own and Lenin's idealism into directives for the early years of the Soviet school. Lunacharsky (1981), as the first head of the Soviet Commissariat for Education, bridged the distance between the thoughts of Marx and Lenin and the actual curriculum. Because of him, polytechnical education became more than an ideal. It began to assume a practical shape.

Lunacharsky was highly educated and well aware of educational programs in other countries. He was also thoroughly committed to the communist, Marxist-Leninist ideology. In his mind, polytechnical schooling had to be shaped to fit and serve a communist society. Marx had not lived in such a society; neither had Lenin nor Lenin's

wife, Krupskaia.[14] Lunacharsky had the task of fashioning an appropriate form of education and he saw the polytechnical as a key element. For that reason, this largely unheralded leader of the early years of Soviet education can claim an important place in this review.

In his essays and speeches on education, the point is forcibly made that Lunacharsky thought of education as *social* education. Neither Marx nor Lenin could have put this thesis more persuasively. In Lunacharsky's mind, there was no contradiction between individual interests and society's needs (pp. 39-40). Individual talents certainly had a place in a social education system; this is "polyphony combined with unity" (p. 40). This was an interpretation of what we shall come to know as Marx's concept of the "comprehensively developed personality," something Lunacharsky suggests can be found in individuals who have fully realized their own interests and talents, yet are cognizant of their role in the collective of society. For Lunacharsky, general education was very important. Yet individuals are not lost within the vast collective, but are allowed personal expression in their more specialized fields. In his words,

> An educated man is one who knows *all* this [the *common* store of knowledge] in general, in summary, but who also has his own speciality, where he knows his own business thoroughly, and who can say of the rest "nothing human is alien to me." A man who knows the fundamentals and the conclusions in technology, and medicine, and law, and history, etc., is truly an educated man. . . . He must have *his* speciality, *his* work, but at the same time he must be interested in everything and capable of entering any area of knowledge. Such a man hears the whole concert being performed around him; all the sounds are within his range, they all blend together into a single harmony, which we call culture. At the same time he himself is playing one instrument in it, and makes a valuable contribution to the common wealth, and this common wealth is all, as whole, reflected in his consciousness, in his heart. (p. 48)

The Commissar repeatedly found his way to the ideal of developing a whole self by doing socially useful work. The concept of laboring to live a proper life is an old one in Russian peasant culture. Polytechnical education was not far removed from the cultural past. Lunacharsky was not speaking of farfetched and strange ideas when in a speech at the First All-Russia Congress on Education he said, "We accept labour as a subject of study, i.e., study of the full range of technical subjects. We also accept labour as an educational method, for we know that only through collective labour can we inculcate a

[14] The literature does not inform us how Lunacharsky related to Lenin's wife, a forceful person who, as we already have said, was very involved with education. Evidently the two were able to function peacefully.

whole series of qualities of character which are essential if the personality is to be stable and valuable" (p. 22). And he went on to ask the rhetorical question: "Can we limit ourselves to general education only? No, we also need technical education, which will make a man a useful member of society, not only a repository of universal knowledge" (p. 27).

But Lunacharsky went beyond finding a place for technical knowledge in the curriculum. The extracurricular—he called it the "extra-mural"—was to be closely tied to the curricular. When he wrote about teaching the sciences, we are told to remember that "[a] link with life, with working experience, must remain in the case of popularization of scientific knowledge." Then Lunacharsky continued: "Here it is desirable to reduce actual lecturing to a minimum, replacing it with practical work in the laboratory, the factory, etc." (p. 68).

The school itself was not like schools in other, bourgeois countries. The system was to be thought of as "the unified labour school" (p. 97). This type of school "must give the child and teenager polytechnical knowledge, i.e., a grasp, acquired from several examples, of the basic principles, the basic processes of contemporary, highly sophisticated, scientifically organized labour" (p. 253). In his contrast of the bourgeois and the Communist unified labour school, Lunacharsky highlighted the labor for its educational value not for its product. While this thought was not adhered to in the years ahead, the polytechnical principal was not to be grossly altered from Lunacharsky's plan. He would have young children learn to use simple tools, to take care of animals, and so forth (pp. 102, 127). As for the older youngsters,

> At the second stage, starting from age 10-12, we must accustom children to read technical material. At 16 a boy should leave school having some idea of what industry is in general, that he should have a clear understanding of the structure of a factory. . . . It would be desirable, ideally, for every boy or girl leaving school to have already some knowledge of the metal-working industry, the textile industry, and the chemical industry. . . . In the country, the labour school necessarily takes on an agricultural character. (pp. 102-105)

Lunacharsky's rejection of child labor is even more emphatic than that of Marx or Engels, although he attributes his stand to them: "The most acceptable labour processes are those which will never turn a child into an exploited worker but have him executing the work process for the sake of, for the purpose of, his own physical and mental growth. Karl Marx too understood the educational effect of labour on pupils in this way" (p. 127).

It cannot be denied that the years ahead saw a continuous, if unadvertised, tension between those who desired technical training at the secondary school level and those who favored a polytechnical component of general education. The strain was not unlike the dispute in the United States between those who advocated vocational preparation at the secondary level and those who wished somehow to combine knowledge of vocational within a general education. Lunacharsky always sided with those who favored polytechnical education over more intense and specialized technical preparation (p. 127). In a short speech, "Education of the New Man," Lunacharsky remarked the underlying difference between mere vocational or technical education, which would continue to prepare individuals who would be servants of technology, and polytechnical education, which places technology at the command of the individual, who, through its application to the world around, learns working skills while comprehending the sciences (and other disciplines) on a higher level. In this way, the new education system would aim to develop what is termed "The New Soviet Man." In sum,

> We call our school "polytechnical," because we would wish labour to be studied not in one example only. In studying factory history, you study the development of labour relations, you find out what industrial diseases are, you encounter public health, anatomy, physiology—a whole group of medical sciences. There is no group or branch of knowledge which is not somehow woven into that gigantic conjunction of human and natural relations presented to us by a developed industrial center, factory or mill. (p. 162)

But how to avoid superficiality, and what of the pressing need for skilled workers? Compromises must be made, he admits, but they are compromises: "this does not mean beating a retreat ideologically, that we should abandon the idea of the polytechnical school" (p. 131). Lunacharsky, while allowing (as Lenin did) for necessary compromises brought about by contemporary pressures, maintained his commitment to the ideologically based polytechnical education, which trains not mere workers, but, presumably, highly educated workers. This commitment was strong enough to motivate him to continue despite difficulties in organizing the new system. Lest we think of Lunacharsky as essentially like most of his successors, it is well to note that he was a very well-tutored person, and while honoring science and technology, he defended the humanities in a rapidly technologically dependent world. To those who claimed the literary arts superfluous in "practical, militant, technological" times, Lunacharsky replied, "These voices are harmful, this is a damaging deviation, this is desiccation of man's

consciousness, automatisation of man, bringing him closer to the machine, this is . . . not Marxism . . . [this is not] the ideal . . . of the USSR" (p. 203).

The way had been prepared in acceptable, even authoritative ideological terms, for an up-to-date plan fusing in general polytechnical education, both vocational or skill preparation, and a Soviet equivalent of career counseling (with a built-in socialization of personal choice for individual and social ends). As we repeatedly have said, the literature and remarks on polytechnical education during the 1960s and 1970s always coupled polytechnical education with work experience. In later days, polytechnical education had been coupled more and more with academic subject matter, especially that of science. In Ivanovich's article, however, the stress was on the relation of work with polytechnical education. The work experience Ivanovich cited was the operation of agricultural equipment. At the time during which he wrote, this meant experience with tractors, trucks, and combines. The intellectual challenge of polytechnical education might quickly be lost once operators learned to use these machines. What one suspects is that the perceived needs of the nation, for example, to fill gaps in the agricultural machine jobs, was thought more important than a student's personal interests. This would be congruent with the Marxist-Leninist ideology.

HIGHLIGHTING THE RURAL SCENE

Although most Soviet writing on polytechnical education targeted the urban school, the rural school was not overlooked. After all, a large number of students were involved. When Ivanovich published "Ways to Improve Polytechnical and Labor Education in Rural Schools" (1975), he noted that "more than twenty-two million pupils [were] attending the vast network of rural schools in the Soviet Union" (p. 22), half the total of Soviet pupils. By the beginning of the 1980s, over a third of the Soviet population was rural. Attention to the agricultural sector of the economy was new. The *Sovetskaia Pedagogika* for August 1950 contained Shibanov's "On Polytechnical Education in the Village School." His characterization of Soviet agriculture as an industrial process is especially revealing. This is understandable when one remembers that the Soviet Union was created by a workers' revolution and that Lenin insisted students master the fundamentals of contemporary

industry.[15] As a consequence, agriculture has been viewed as an industrial process and as a branch of overall production.[16] This was the general view, and it pervaded the Soviet pedagogical literature of the early 1950s (see Sukhomlinskii, 1960). An example is Skatkin's "Nekotorye voprosy politechnicheskogo obrazovaniia" (1951). Skatkin clearly depicted Soviet agriculture as taking on the features of industrial production. Because of this, he concluded, polytechnical education is as applicable in an agricultural setting as in an industrial one (p. 17). The same point is made again and again; and it was not limited to the era of Stalin. For example, *Sovetskaia Pedagogika* published the above mentioned essay by Sukhomlinskii in which he makes what became a familiar argument: "Increased mechanization of agriculture has changed the task of the worker significantly. . . . Industrial production is becoming more a part of agricultural production. An individual with knowledge of electrotechnology is very valuable in the agricultural section because of the ability to go from one machine to another." It is in this context that Shibanov noted the demand for knowledge in "agrotechnology," "zootechnology," "agrobiology," and "agrochemistry."

I will return to this in my discussion of the industrial mold into which agricultural polytechnism has been cast. Even the farmer or peasant has been called an "agricultural worker" (see Nikolaev, 1975).

In the literature, no qualitative difference has been distinguishable between the recommendations made for a polytechnical approach in urban and rural schools. The ideological base was, and is, identical. Ivanovich (1975) tapped the ideological mainstream citing not Marx or Lenin, but an address given by then Communist Party Chairman Brezhnev, speaking to the Seventeenth Congress of the Komsomol held in Moscow, December 11-12, 1974. The theme of the Congress was the great importance of developing labor education (most of all work experience) with polytechnical education (see the editorial comment in "Urgent Problems," 1975). Brezhnev told the Congress that "a new type of production worker is maturing in whom manual and nonmanual labor are more and more harmoniously combined. He is a person with a broad vocational outlook, a high

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[15] Lenin's opinion is plain: one has only to read a report on ideology such as Shabalov's "Sravnitel'no-politekhnicheskii metod izucheniia obschcheteckicheskikh osnov proizvododstva" published in the *Sovetskaia Pedagogika* in February 1956.

[16] Although a polytechnical approach is not directly involved, one of the results of viewing agriculture as an industrial process is the effort to rationalize it through planning. However, planning that involves the prediction of crop yields, for example, is difficult because of unpredictable weather, unsuccessful grain-variety experiments, machinery breakdown, and so on.

skill level, and a profound knowledge of the polytechnical principles of modern production, who is capable of rapidly mastering the latest machines and technological processes" (p. 22). The hope was that graduates of the rural schools would wish to, and would be able to, become skilled workers on the state and collective farms. Ivanovich again quoted Brezhnev, this time from his greeting to participants in the jubilee All-Union Rally of Members of Pupils' Production Brigades, held in August 1974: "After completing school, many young people whose labor career started in pupils' brigades have remained on their native collective and state farms, become leading workers, and become heroes of labor and good agricultural specialists" (pp. 27-28).

For Ivanovich (1975) these familiar phrases fitted the rural schools as well as they did the urban. In his words, "Polytechnical training and labor education based on contemporary agricultural production . . . is becoming more and more a particular type of industrialized [mechanized and automated] production [and] provides graduates of secondary rural schools with a wide choice of vocations in accordance with social needs and their individual aptitudes and desires" (p. 23). Rural youth were different only in learning to love the land and being prepared "for creative work on collective and state farms." Creative work, especially for older youth, took "the form of various practicums on tractor driving, the growing of field crops, the growing of vegetable crops, animal husbandry, agrochemistry, forestry [land] reclamation, electrical engineering, and so on" (p. 24). The second half of the 1970s witnessed a rather generous program of new school building in rural areas that would provide up-to-date polytechnical agricultural facilities (p. 25).

The year before Ivanovich's article appeared in *Sovetskaia Pedagogika* (1975), *School and Agriculture [Shkola i sel'skoe khoziaistvo]* was published by the Scientific Research Institute of Labor Training and Occupational Guidance of the USSR Academy of Pedagogical Sciences. In it were present the principles of agrobiology, agrochemistry, and agrophysics, as well as of mathematics and geography—all identified as fields rich in potential for the rural curriculum (p. 24).

But rural education would not have been true to the polytechnical model had there been no attention to "the further development and improvement of the work of pupils' production brigades, school forestry projects, summer work and recreation camps, and other effective forms of combining education with labor" (p. 28). If what Ivanovich writes

is characteristic of more than an ideal—and assessment of this is very difficult—the rural polytechnical includes what could be justified as "experimental activity" along with farm-related work experience. We simply do not know how close to reality is Ivanovich's hope "to have a well thought out system of experimental work for pupils":

> In such a system, the complexity of the topics and tasks of agricultural experimentation would gradually increase from one school year to the next. The content and methods of this work must correspond to the age of the school children. In the elementary grades, the pupils perform rudimentary practical experimental operations relating to sowing and caring for plants; they observe changes in the growth and development of these plants under the influence of various agrotechnical techniques, and conduct rudimentary experiments with them. Schoolchildren in the fourth through seventh grades study the life cycle of cultivated plants, learn how to grow them, and organize simple experiments. In conducting experiments with vegetables, field crops and other crops, the pupils usually produce results that are already known in agricultural science and progressive practice. Unlike them, the upper-graders investigate new questions of significance for science and production. (pp. 28-29)

Ivanovich further illustrated this theme when he referred to "the execution by pupils of a broad complex of projects in plant growing and animal husbandry; the study of agricultural machinery and familiarization with overall mechanization and automation of basic production processes and with the use of electricity in agriculture and animal husbandry; the study of the principles of the use of chemical products and reclamation of agriculture; experimental work by schoolchildren coupled with the use of scientific knowledge and laws that form the basis of agricultural production; the organization of productive labor in agriculture; creative work by pupils in various clubs; and socially useful labor" (pp. 28-29).

In reading these more recent attempts in Soviet agricultural study, one remembers Michurinite biology, favored by Stalin, and warmly endorsed by Skatkin (1951). The Michurinite was based on the work of the Russian horticulturist Ivan V. Michurin, who died in 1935. "Michurinism," as it was called, completely accepted the inheritance of acquired characteristics. Lysenko, a biologist and agronomist, adopted Michurinism and in 1940 became Director of the Institute of Genetics of the USSR Academy of Sciences, a post he filled until 1964. Lysenko's views were enthusiastically endorsed by the most powerful political leaders, which resulted in Lysenko's almost complete control of Soviet biology. Denying conventional genetics, he promised new plant types and increased yields.

Lysenko's views were compatible with orthodox political ideology, which also assured its adherents that men and society could be radically altered, with the alterations perpetuated and improved upon by succeeding generations. The consequences for Soviet agriculture were disastrous. For one thing, careful preservation of gene types was dismissed. This provided no genetic guard against the invasion of a virus; and alternative gene-types that might be resistant were not available. Lysenko's views were finally repudiated and he lost his post. But the political implications of this unfortunate intrusion of Michurinism went largely unnoted. The import for educators is that Stalin, together with other Soviet leaders, felt that "Lysenkoism" was of a piece with their own ideology. Just as the Communist Party created the social (classless), economic, and political environment in which formal education, youth groups, the family, media, and other instrumentalities for human development helped improve successive generations of the "good Soviet man and woman," the Lysenkoists elaborated a doctrine of "the unity of the organism with its environment." The idea was that by careful manipulation of the environment, plants, as well as humans, could be improved. Perpetuating those improvements would allow Soviet society, like Soviet agriculture, to grow "from strength to strength."

Just as the city schools were to be joined to factories, the rural schools were to collaborate with collective and state farms. The rural collaboration might be more vital than the urban. In Ivanovich's (1975) words, "The managers of such collective and state farms perceive the future of their farms to lie in the results of the school's work, and for this reason they become more deeply involved in it" (p. 31). The farm managers concerned with the polytechnical programs hoped that the skills the young people learned would be practiced on their farms when the pupils graduated. The highest levels of the government shared the same hope. In the Report of the Central Committee of the Communist Party of the Soviet Union to the Twenty-fourth Party Congress, Brezhnev commented,

> The appearance of more and more new and complex equipment—powerful tractors, combines, trucks; the improvement in the well-being of the peasants; and the gradual improvement in cultural and living conditions, are making agricultural work more and more attractive and interesting, especially for youth, and are giving youth an opportunity to acquire high skill qualifications. As a result, upon graduation from educational institutions, rural youth are now more willing to remain to work in the countryside. This is a positive trend deserving of support, especially in

view of the fact that the development of agricultural production requires expanded training of skilled personnel for the countryside. (p. 31)[17]

POLYTECHNICAL HIGHER EDUCATION

One of the more striking characteristics of polytechnical education is its pervasiveness. As we have seen, Soviet educators have dealt with polytechnical education in the context of a guiding ideology that does not limit its scope. Not only does polytechnical education reach from the city to the countryside, it also spans all levels of education. Further, it bridges general or academic and vocational education. Although not the subject of this paper, one could make a persuasive case that polytechnical education transcends the gender gap and helps Soviet culture to achieve the gender neutrality which, as I have noted, it has long claimed.

A place for polytechnical education in the Soviet higher education of engineers has been staked out, although it has not been written about with a thoroughness commensurate with its presence in Soviet compulsory schooling.[18] Even so, we can assume that Kaliatskii's (1978) "The Development and Improvement of High-Level Polytechnical Education" is representative, though a decade old. Time will not have changed the view of Soviet higher education that polytechnical means the preparation of engineers. Kaliatskii makes that clear:

> Let us simply point out that every third institution of higher learning in our country is now a technical institute, handling forty percent of our national higher education enrollment, with an annual graduation of over 300,000 engineers. Technical institutes include sixty-two polytechnical institutions with an enrollment of 700,000 students in 275 technical specialties (of a total of 300). (p. 43)

Kaliatskii thought the first major benefit of polytechnicism in Soviet higher education to be the broad coverage it provided of modern engineering science. The young

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[17] The number of skilled workers in relevant occupations was impressive even in the mid-1970s. "In 1974," Ivanovich writes, "the nation had more than four million tractor drivers, combine operators, truck drivers, electricians, mechanics, master repairmen, and personnel in other occupations having to do with the operation of machinery. At the same time, collective and state farms continue to experience a great shortage of these cadres" (p. 26).

[18] There is a good deal less information available on the effect of a polytechnical philosophy of education in nonscientific branches of Soviet higher education.

engineer was less likely to be confronted with a narrow specialization. As Kaliatskii put it, "The substantial changes that have taken place in the content and nature of the job of the engineer require that today's engineer have thorough basic knowledge and be quite flexible in his functions" (p. 42). This attitude, if widespread in the higher education of engineers and other scientists, would reenforce the curricular philosophy of Soviet lower schools. Having said this, the question remains whether nonscientific, nonengineering portions of Soviet higher education are as affected by the polytechnical approach. In my opinion, they are not. When Kaliatskii writes of polytechnical education, it is in terms of instruction and curriculum in what he calls "polytechnical institutions": "The modern polytechnical institute is a large teaching and research complex providing instruction in many different fields and turning out large numbers of highly trained engineers in specialties that constitute the foundations of modern industrial production" (p. 46). There is no reason to believe that Soviet educators would take exception to his usage.

At least one other characteristic of modern Soviet thought on the relation of the sciences to production should be noted. Shchukin (1975) has developed the idea that mere rhetoric will not close the gap between theories of (physics) and practice. It is helpful to focus on the fact that

> the physical chemistry of the condensed state of matter, in particular, [which can be considered . . . a leading, principal topic . . .because] it is directly connected to virtually all other topics in the physics course, and is saturated with ideas concerning the relationship between the macro- and microworld, molecular and kinetic conceptions, and it is therefore of basic importance to a world view; at the same time, this topic is very closely connected to production. (p. 44)

Shchukin's article underscores both the interrelationship of secondary and higher education in the scientific disciplines and the relationship of scientific disciplines to everyday production. Shchukin rebukes those who neglect unglamorous production such as laying cement saying that the physiochemical processes are interesting. What seems to be of moment only in the more advanced study of science turns out to bear on the lower school. "General polytechnical education," writes Shchukin, "should provide a true picture of how bread is made, how clothing sewn, how houses are built, and, of course, at the same time should depict the design and operation of the automobile" (p. 51).

SCIENCE, TECHNOLOGY, AND POLYTECHNICAL EDUCATION

Polytechnical higher education modifies the hope that polytechnical education relates easily to any study. Perhaps that relationship should be evident, but it is not. The Soviet leadership wishes to have a cadre of skilled workers graduated from a school that makes use of the polytechnical in linking general with vocational education. Because the society in which this school is lodged is driven by scientific technology, mathematics and certain of the sciences are favored.[19] To repeat, this may not be necessary, but it is fact (see Zarretskii, 1946). Even the social sciences, as we understand them, are overlooked—with the exception of economics and history, the latter being understood not as among the humanities but as a social record of the triumph of materialism over idealism and communism over bourgeois capitalism. The revision of Soviet social science secondary-school texts now in progress will probably not affect these basic ideological tenets.

Other facets of recent Soviet school reform will not be commented on—for example, the enrollment of nearly two million six-year-olds in a primary school that a Soviet child formerly began at age seven. However, the introduction of a job training program in the secondary school will be discussed further because it is closely associated to polytechnical education. The idea I underscore is that polytechnical education plays a decisive role, that so much of what the new reforms are trying to accomplish depends on it. In this context, I will outline a few of the emphases in the restructuring of Soviet secondary school science curriculums.

Soviet educational critics of secondary school science have wished to lessen the "overloading" (*peregruzka*) of difficult subject matter (Szekely, 1987), which became burdensome for schools that were supposed to enroll all youth. The reaction against Khrushchev's call for less academic study may have gone too far. Polytechnical education was seen as a way to achieve a sensible balance of understanding basic science while appreciating that science is transforming technology and, therefore, the economy [career opportunities]. The current Twelfth Five-Year Plan (1986-1990) calls for a refashioning of science courses.

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[19] Articles dealing with the new Soviet sciences in schools can be read in *Soviet Education* (1986, August & September) and in *Soviet Education* (1987, March & April). A number of articles have been published on the latest Soviet educational reconstruction (e.g., Szekely, 1986). The following issues of *Soviet Education* were devoted to the reform: March 1985, April-May 1985, November 1985, December 1985, January 1986, and February 1986.

Szekely (1987) notes that the major theoretical premise "around which these curricula, as well as those for the other disciplines, have been constructed is that of generalization [*obobshchenie*], which means arranging subject matter around key concepts. This figures strongly in the concluding, or review, sections of the curricula, where material is tied together" (p. 5).

A noteworthy separation of Soviet pupils should be kept in mind: after the ninth grade, almost two-thirds of the fifteen-year-olds will enroll in a specialized vocational-technical school, where the curriculum includes instruction leading to an occupational skill. For those who remain in the eleven-year general education school (*srednaia obshcheobrazovel'naia trudovaia politekhnicheskaia shkola*) "labor training courses exist to equip them with job skills" (p. 4). This essay will not inquire into the basis for the distribution of young people into these two types of schools. Nor will it explore whether the subjects of study are conceived of differently. The assumption in the Soviet literature is that they will not be significantly different. At any rate, more than eighty-five percent of Soviet pupils are to attend the first type of school, whose course of study will be taken as representative of Soviet general education at the secondary-school level.

Inasmuch as mathematics is essential for the study of science, the polytechnical character of the new Soviet teaching in science should be clear in mathematics instruction. And it is or, more accurately, was a decade before the 1984 reform (Shvartsburd, 1975). As with all expressions of Soviet educational philosophy, Shvartsburd legitimatizes his remarks on the polytechnical orientation of mathematics instruction by calling the reader's attention to the premium put on mathematics by Marx, whose "idea [was] that science reaches perfection only when it is able to use mathematics" (p. 77). Shvartsburd's bow to Marx is followed closely by a more relevant quotation from Lenin, which he refers to as Lenin's formula: "From active contemplation to abstract reasoning and from it to practice—such is the dialectical path in the cognition of truth, in the understanding of objective reality" (p. 77). Speaking for himself and others, Shvartsburd adds that "Mathematics . . . holds great importance for the general development of the mental capacities of pupils, for the formation of their logical thinking habits, and for the development of their imagination and inventiveness" (p. 78). Although Shvartsburd does not provide experimental data confirming these powers of mathematics, it is assumed that his sentiments were, and are, widely shared.

But lack of data did not bar Shvartsburd from offering concrete examples of what a polytechnical orientation to secondary school mathematics instruction meant:

> The radical reorganization of the system of mathematical education envisages the inclusion of material whose content has a clearly expressed polytechnical orientation: elements of approximation calculations, functional material, elements of mathematics analysis and vector calculus, combinatorial analysis with elements of probability theory, elements of computer programming, and so on. This material builds the bridge from secondary mathematical education to mathematics as a science and to its practical applications. (p. 79)

Additionally, Shvartsburd provides the following example:

> Under present conditions, the further improvement of the teaching of mathematics is associated with a higher degree of awareness on the part of the pupils in the assimilation of *algorithms* and the ways of describing them and elements of *mathematical logic*, which, in connection with the introduction of computers in science and in the national economy, has become "applied" and thereby polytechnically feasible. *Elements of the theory of graphs* (their applications) and *probability theory concepts* are called upon to play an important part. (pp. 84-85)

So, the question could be asked, Does the high level of achievement demanded of *all* pupils lead to "overloading"?

> The new curriculum of the algebra course and the fundamentals of analysis in the ninth grade serves the polytechnization of education. It contains the following topics: combinatorial analysis and its relationship with probability theory, limits of a variable, and derivatives. The inclusion of the integral in the tenth-grade course increased the possibility of applying mathematical methods and also alters the procedure and methods for studying certain traditional topics, which means the saving of a certain amount of classroom time. Thus, applying the integral to determine logarithmic functions and, on this basis, the exponential function, saves time since it obviates the need to examine numerous subordinate instances in the study of exponential functions. The study of the integral means a great saving of time in the presentation of measurements of geometrical objects and in the solution of a number of physics problems. (p. 79)

It is crucial that secondary school mathematics educators in this country study the results of the Soviet application of theoretical mathematics to technology.[20] Shvartsburd

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[20] The leading scholar writing on Soviet mathematics education is Izaak Wirszup, Professor of Mathematics, University of Chicago. Wirszup has been director of both the Survey of Recent East European Mathematical Literature (National Science Foundation, Directorate for Science Education) and the Program on Soviet Applications of Computers to Management (National Science Foundation,

actually offers several examples of this application (pp. 84-85), and it would not be difficult to add to his list. The opportunity we have is to learn whether general education in this country can find Soviet secondary school mathematics instruction useful in a polytechnical orientation.

Although polytechnical education in a rural context has been remarked on earlier, the continuous attention to polytechnical education in the USSR is highlighted when one recalls that almost forty years ago Shibanov called for close association of rural education with local machine-tractor stations, with field work, and other practical tasks. In a word, Shibanov recognized how easy it would be to overlook practice in favor of theoretical study of the sciences. While there is little evidence bearing on his concern, it is a fact that years later the same insistence that theory and practice be joined was voiced again and again in Soviet pedagogical literature. After all, as remarked earlier, at least a third of the population in the Soviet Union was described as rural as late as 1979.[21]

At least four years before Khrushchev's attempts to reform Soviet education—a reform that underscored the importance of polytechnical and vocational instruction and experience—*Sovetskaia Pedagogika* aired Lisovoi's "On Polytechnical Preparation of Students of Physics-Mathematics Departments" (1954). In his article, Lisovoi outlined one proposal for a program that trained teachers of physics and mathematics in the practical application of their skills. The work was carried out at the Chernigov Pedagogical Institute. It is interesting that this 1954 review was directed to agriculture and came as a direct result of the pronouncements of the September Plenum of the Central Committee of the Communist Party on the importance of agriculture. Khrushchev simply underscored the same point and revealed how slow Soviet agriculture's response to related sciences and technology had been. (For a useful, though largely uncritical, source of information on the Khrushchev reforms, see Kairov, 1963.)

More than twenty years later the same issue of *Sovetskaia Pedagogika* (1975) that published Shvartsburd's article invited its readers to become acquainted with a similar polytechnical orientation in other sciences taught in the secondary school. We shall sample

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Mathematical and Computer Sciences). Those interested in Soviet mathematics training should consult Wirszup's publications.

[21] According to the All-Union Census of 1979, the percentage of the population reported as rural was sixty-eight percent in 1939 and thirty-eight percent in 1979. While this decline in the rural population is indicative of the flow of the population to the cities, Soviet agriculture has a very rural, non-industrial modern background.

only three—physics, chemistry, and geography (Razumovskii, 1975; Epshtein, 1975; and Matrusov, 1975). Like Shvartsburd, all the authors were members of the USSR Academy of Pedagogical Sciences at the time of the writing. Shvartsburd was a Corresponding Member of the Academy; Razumovskii and Matrusov were affiliated with the Scientific Research Institute of Curriculum and Teaching Methods of the Academy; and Epshtein was a member of the Academy. Incidentally, this high degree of centralization in Soviet educational research may diminish, but, at the time of this writing, it has not.

The first sentences of Razumovskii's article dealing with teaching physics pose the essential function of the polytechnical approach in each of the science subjects:

> In connection with the increasing role that is being played by the science of physics in production, there has been an observable trend away from familiarizing pupils with the application of the physical phenomena and patterns they encounter in their studies to industrial and agricultural production, and toward acquainting them with the basic directions of scientific-technological progress and the physical principles that are involved in these directions. There has also been a tendency to move away from simply enriching the memory of schoolchildren with facts illustrating the role of physics in technology toward developing the abilities of pupils to apply the knowledge they have acquired in the solution of practical problems in technology. (p. 64)

As has been true for restructuring secondary-school mathematics, expectations for what is to be presented in the classroom and textbooks on secondary-school physics have been very demanding. Razumovskii illustrates the point:

> The secondary school physics course provides the necessary theoretical and practical preparation for understanding the operating principles of heat engines. As early as the seventh grade, school children are familiarized with the design of refrigerators, internal combustion engines, and steam turbines, and assimilate the concept of "efficiency of a heat engine"; they later learn how heat engines are used in aircraft, automobiles, tractors, and other agricultural and construction machines as well as in water and rail transport. In the ninth grade, the theoretical information necessary for understanding the operation of heat engines is presented in greater depth: school children gain an understanding of the equivalence of the quantity of heat and work and the first law of thermodynamics, and study the question of the maximum efficiency of heat engines. (p. 67)

The purposes of the physics curriculum are clearly stated by Razumovskii, whose views are not his alone. The article states the main direction taken by physics in technological developments and the way these are to be handled at the secondary school level in studies of mechanization; in dealing with data on the properties of amorphous and

crystalline bodies and their processing; and in the study of electrification, electromagnetic waves, optics, and "Atomic and Nuclear Physics." Again, it is not possible to say how far Soviet teachers of physics in secondary schools actually go. However, a record of the expectations for a general education of secondary school pupils does exist and the question of what can be expected of the average pupil remains. That question is very much alive when one reads in Razumovskii that

> The classroom use of polytechnical material on the major directions of scientific-technical progress makes it possible to communicate the latest research findings on such physical phenomena as superconductivity, low-temperature plasmas, and thermonuclear reactions, which hold great technological promise. Pupils are always interested to learn, for example, that Soviet scientists have discovered superconductivity in a niobium-aluminum-germanium compound at a temperature above 20 [degrees] K, which makes it possible to create a new material that already acquires the properties of superconductivity at the temperature of liquid hydrogen. (p. 69)

Quite apart from the nationalism suggested by Razumovskii's allusion to Soviet discoveries with respect to superconductivity, it is appropriate to wonder about his claims when planning general education and not the schooling of the gifted.

The presentation of the polytechnical principle in teaching secondary school chemistry is not much different from physics. Once again, the expectations are demanding and ask for comprehensive, nationwide tests of achievement. Lacking such evidence, one has to qualify an endorsement for taking a parallel tack in outlining a polytechnical approach to general education in the United States.

Epshtein's (1965) essay on teaching chemistry repeats the familiar allusions to teaching the basic ideas of chemistry in the context of "the most important areas of its practical application." What follows is no less commonplace. A "love of work" is to be instilled; young people are to be aided in "choosing a vocation in accordance with their personal inclinations and the needs of society. The polytechnical principle," Epshtein continues, "requires that the teaching of chemistry be related to life itself, to the building of a new society, and to the creation of the material and technological foundations of communism" (p. 54).

Epshtein is to be thought of as one of the leading Soviet students of the role of chemistry in polytechnical education at a time when the place of science in both general and

polytechnical education was seen to be as a chief partner of labor (1965). Epshtein restated his argument, but shifted the emphasis to the senior grades of the Soviet secondary school (Ivanovich & Epshtein, 1966). Even so, he was never unaware of the importance of vocation in his thinking. His ideas on chemistry in the secondary school *and* in the chemical industry are most clear in an earlier essay, "Polytechnical and Vocational Training for Chemical Trades in the Secondary School" (1964). There was no lessening of Epshtein's attention to his subject. A decade later he published "The Realization of the Polytechnical Principle in the Teaching of Chemistry" (1975). Apparently, there was no objection in the literature to the following claim by Epshtein that there were no significant new concepts of the role of chemistry in polytechnical education:

> The secondary general education polytechnical school has the obligation to acquaint pupils with the basic ideas of chemistry and the most important areas of its practical application. . . . The polytechnical principle requires that the teaching of chemistry be related to life itself, to the building of a new society, and to the creation of the material and technological foundations of communism. This association is manifested in the selection of closely interrelated concepts of theoretical chemistry and the applied sciences. (p. 54)

But we do find a new emphasis on the role of the chemistry laboratory and the recommendation that urban schools might well have a course on "Chemistry in Industry," while rural schools have a parallel course, "Chemistry in Agriculture." Both, Epshtein wrote, "[acquaint] pupils with the basic patterns and general system of the given field, and at the same time [provide] them with a complex of practical skills" (p. 62).

All this has been said and written innumerable times. In a sense, that is part of its strength. Just as there is a common ideological foundation to Soviet education, one that can be adjusted to permit reform, so there is the power of common expectation, purpose, and aim. Of course, the ideological costs of such a high degree of conformity may make it unacceptable in a country where public education is locally controlled and where educational variation, real or fancied, is esteemed.

The thoroughness and depth to which we have become accustomed in these 1975 essays is as evident in Epshtein's notes as in those of his colleagues at the Academy. He writes of "the in-depth presentation of the essence of chemical processes, and the greater attention to the teaching of chemical equilibrium and chemical kinetics" (p. 55):

> At the present time, the familiarization of pupils with the basic concepts of optimization has become one of the significant elements of polytechnical

> education. Pupils are acquainted with general patterns in the optimization of control of chemical reactions during production, depending on the complexity of the reaction, on equilibrium, on the number of phases in the reaction through the use of a catalyst. (p. 56)

Epshtein has no difficulty demonstrating the role of chemistry in technological manufacture, agriculture, and other sectors of the modern economy: "As is evident . . . the realization of the polytechnical principle requires not so much the understanding of the role of various chemical products in the national economy as the mastery of the ability to use chemical science for the solution of practical problems in the study of the production facilities and mastery of the algorithm that links chemistry, chemical technology, and production" (pp. 56-57). Epshtein uses the two basic concepts of chemical equilibrium and chemical kinetics to exemplify how the courses come to grips with the convergence of basic theory and production. Beyond this, Epshtein relies on ideologically inspired commitment to motivate pupils to take up careers in chemical industries. The article ends with his assertion that, "Experience shows that the polytechnical principle of teaching chemistry promotes the formation of a dialectical-materialist world view. A number of pupils develop an enduring interest in chemistry and chemical production and an inclination for employment in a field where chemistry is used" (p. 63). Once again, science, technology, production, and career choice work together inextricably.

The ambitions for secondary school mathematics, physics, and chemistry held for geography and characterized the syllabus for biology (Chief Directorate of Schools, 1987; Miagova & Sivoglazov, 1987). While the official outline of fundamental points in each of the sciences differs a bit, the differences are but shadings. The essentials are the same. In this vein, Matrusov's (1975) article on teaching geography in the secondary school opens with what will be commonplace:

> As we know, the polytechnical education of school-children is based on a solid and lasting mastery of knowledge corresponding to the level of and trends in the development of modern science and the ability to use acquired knowledge for the solution of practical problems. The fulfillment of these conditions will help us to realize the main objective of our school—the preparation of the younger generation for life and for active participation in socialist production. (p. 87)

Underplayed in this inventory of objectives was career motivation. But this was in 1975; a role for the individual's choice of careers was just gaining recognition. The assumption was that a person's interest was a function of his or her understanding in that

"A person takes a more active part in productive labor when he understands and knows its component parts" (p. 88). For example,

> By studying the principles of physical geography, pupils become acquainted with the diversity of the riches of nature, their origin, and their location in individual countries. In the process, they master the concept of "natural resources" and become acquainted with various types of such resources. . . . At the same time, they discover the economic importance that natural resources hold for the development of various types of production and learn of modern types of labor implements that are used in searching for and extracting natural raw materials, processing them in industry, and applying them in agriculture. (p. 88)

The geographical variations evident in the nine major areas of the Soviet Union are exploited in the draft proposals for geography instruction in the Soviet secondary school (pp. 90-91). The purpose of instruction, however, is to increase the pupil's awareness of the economic potential of the physical features being learned:

> The new syllabuses accentuate the study of the integration of production. More attention is devoted to general factors underlying the location of production, such as energy intensiveness, material intensiveness, water intensiveness, and labor intensiveness. . . . Information introduced into the course on economic geography concerning the quantity, quality, conditions of formation of deposits, and cost of extraction of mineral raw materials in various regions of the nation, and different technico-economic indicators of the development of branches make it possible to provide a more substantiated explanation of the principles for locating the main branches of the national economy. (p. 92)

The course of study in geography lends itself to field trips and exercises in which "pupils learn the elementary techniques used in the economic analysis of phenomena: how to read statistical tables, graphs, and diagrams, as well as various cartographic materials" (p. 94). Matrusov, like so many others, assures readers that students in geography will acquire a "concept of the social character of production, a knowledge of the main features of socialist and capitalist organization of production, and an understanding of the advantages of socialist over capitalist organization" (p. 94).

WHERE WE STAND TODAY

The Twelfth Five-Year Plan (1986-1990) mandated vocational training for all students in the compulsory Secondary General Education Labor Polytechnical School (*Sredniaia obshcheobrazovatel'naia trudovaia politekhnicheskaia Shkola*). This addition of required vocational instruction subtly modified the polytechnical program by welding it firmly to both general education—most certainly in mathematics and the physical, biological, and earth sciences—and vocational preparation. The change was subtle: more of emphasis than curricular substance. After all, manpower needs and training had been standard concerns for the Soviet leadership. As already observed, they were most forcefully evident in the Khrushchev years (see Beck, 1962). When semi-skilled and more highly trained personnel have been desperately needed in Soviet factories, as they were in Khrushchev's day, specific job training probably superseded Soviet allegiance to polytechnical education of a more general type. Young people were, and still are, looked upon as a scarce resource.[22]

To repeat, skilled workers have long been in short supply (Zemliannikova, 1983). However, Soviet manpower specialists have learned not only that the workforce needs to be enlarged, but also that it must have members who are flexible, who can change jobs, and who can add skills (Batyshev, 1984, 1986). These abilities have been recognized as key contributions of polytechnical education. The thought is that students will learn the science and technology common to all modern Soviet production. From a pedagogical standpoint, general and vocational education have been interdigitated (see Szekely, 1986).

It is well to keep in mind that in the USSR the polytechnical education is begun in the earliest years and develops in a planned sequence. In the first four grades, Soviet children learn elementary but general techniques used in handling wood, metal, and other materials. For the same grades, techniques that bear on cultivation of crops are introduced in rural areas. And so it goes through the grades until in the last years specific vocational skills are taught. Presumably, the persistent emphasis on what is scientifically and technically general guards against narrow specialization and inflexibility. There is little question that Soviet educational leaders have devoted a great deal of time to interweaving scientific and technical principles with general and vocationally oriented instruction.

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[22] A declining birth rate encouraged this valuation (see Szekely, 1983).

The partner of all this is vocational guidance. It is almost impossible to report its extent and success in the Soviet Union; however, the idea pervades the literature on polytechnical education. All this comes together in a 1987 review by Polyakov, a Corresponding Member of the Academy of Pedagogical Sciences of the USSR, Deputy Director of the Scientific Research Institute for Labor Education and Vocational Guidance of this same Academy, and Scientific Secretary of the Committee for Technical and Vocational Education of the USSR Commission for UNESCO. His review is one of the more comprehensive that is readily available—especially useful for its attention to vocational education.

Polyakov's first point is that a combination in everyone's schooling of general and vocational training bound together by polytechnical education is the best guarantee of the flexibility that has been distinguished as a *sine qua non*. His essay specifies that years (grades) ten, eleven, or, where it exists, twelve are for the "acquisition of the most common skills required for industry and the service sector. . . . Thus, by the end of their secondary education, pupils must have acquired a specific skill and have taken qualifying examinations" (p. 116).

Polyakov distills years of trial by remarking that the following "lines of approach" have proved worthwhile:

> (a) learning about the scientific bases of various occupations during lessons on general subjects;
> (b) illustration of the natural and social phenomena and laws under study by means of examples from people's work, particularly in manufacturing;
> (c) the inculcation of practical abilities and skills during the study of all academic subjects and in optional classes and directed activities; and
> (d) the application of knowledge, abilities and skills in socially useful productive work. (p. 116)

How effectively Polyakov's remarks have been carried out is a matter of conjecture. What one can say is that his article offers a precise description of the "stages in vocational training and its link with general secondary education." To this he adds, "An important part . . . is played by the Labour and Vocational Training Course to which two hours per week is allocated in the first to seventh years, three hours in Years 8 to 9 and four hours in Years 10 to 11 ([or] 12)" (p. 117). Reference has already been made to this course, and it should be assumed to have an important place in Soviet school development. A skeletal

review of the program has been offered, but this will now be elaborated for the excellent summary that such detail can afford of what Soviet education hopes to accomplish:

> In the first four years, pupils learn basic everyday techniques for handling different materials (paper, cardboard, textiles, natural materials, etc.) and elementary skills relating to the cultivation of agricultural crops; they become familiar with the component parts of machinery by assembling mock-ups and models from construction kits, they practice bookbinding and make simple repairs to visual teaching aids as well as making toys and various useful items for schools, kindergartens, the home, etc. . . .
>
> In Years 5 to 7, pupils receive more substantial general labour training. They acquire knowledge and develop practical skills in metalwork, and woodwork, and work with textiles and other materials. They are introduced to electrical engineering, metallurgy and technical drawing and obtain a multi-technical view of the main branches of the economy. They carry out simple design and experimental work, acquire essential economic concepts and apply them in practice. They also learn elementary household economics. (p. 117)

Polyakov goes on to explain that the "content of education in the fifth to seventh years is based on standard principles in town and village schools but differs to a certain extent in accordance with the industries round about" (p. 117). As he explains, the standard program "includes six alternative study plans, three each for urban and rural schools. Each of these variations can be adapted to local conditions" (p. 117). Polyakov does not write more about the "six alternative study plans." We do not know specifics about each or whether their pupils make choices. That vocational guidance is in the picture becomes immediately evident.

We learn that there are two, presumably interrelated, "stages" in the schooling of pupils "in Years 8 to 11 (12). . . . First," Polyakov writes, "a course entitled 'Introduction to Industry: Choosing a Career' is studied in Years 8 to 9 (sixty-eight hours) and pupils receive instruction in the specializations which they have selected." There are more than thirty such areas of specialization: "The particular specializations and skills studied by pupils in Years 8 to 11 (12) are determined by the executive committee of the local Soviet in consultation with the base enterprises and schools, taking account of pupils' interests" (p. 118). The degree to which pupil interest prevails is difficult to say. Soviet manpower forecasts may be a weighty factor in decisions, but how influential they are cannot be specified here.

In explaining the course "Introduction to Industry: Choosing a Career," Polyakov indicates that the instruction provides "an introduction to the trends of scientific and technological progress in modern industry and the role and position of the worker in industry" (p. 118). Polyakov believed that the course "contributes to the development of a lasting vocational interest in specific types of work and the knowledge and ability to make the correct choice of specialization and career on the basis of personal interests, inclinations and the specific needs of the region or town" (p. 118). It would be interesting to those concerned with education in the Soviet Union and certainly to Soviet educators to see data on what exactly has resulted from such a course.

As Polyakov describes it, each of the more than thirty specializations has a general and a specialist component:

> The general part of the programme covers planning, the organization of work, notions about work and industrial processes, general technical information about modern machinery and equipment, information about jobs, the basic elements in industrial organization and economics and scientific and technological progress in the sector. This part of the programme is intended to build on the general labour training which pupils received in the first to seventh years.
>
> The specialist section of the program provides knowledge about the objects of labour, plant and processes typical of a specific kind of work, such as programming, electrical installation work or house painting. It also provides the skills and abilities necessary to skilled work in a specific area and leading to the acquisition of given skills on completion of lower secondary education. (p. 118)

Little is said in "the generalization of vocational education in the USSR" about vocational training programs for pupils in Years 10 to 11 (12) other than that these programs "reflect standard requirements for specific jobs and take account of the distinctive features of different types of educational institutions" (p. 118). A good deal more appears under the heading of "Methods and forms of instruction" (pp. 121-122). We know that classes are held in school workshops, laboratories, and "industrial training situations," but Polyakov is more detailed in reporting on teaching methods and what he terms "organization of study" (pp. 121-122).

Leaders in American vocational education will not be surprised by Polyakov's comments on organization and teaching methods. On the other hand, his notes on "New forms of co-operation between schools and enterprises" (pp. 122-123) is enlightening. There is reason to believe that this liaison of school and industry (if not farm and other

productive enterprise) has not been a happy one. Factories faced with production quotas were not pleased with having to take time out for monitoring students who were slow and unfamiliar with machines. One suspects the damage rate to have been high. Now, as Polyakov sees it,

> The relationship [between school and industry] primarily takes the form of joint activity by schools and base enterprises, regulations for which are laid down in a special decree on Base enterprises for General Educational Schools, approved by the Soviet Government. Base enterprises set up sub-branches in school in the form of workshops, training units, etc., establish separate work posts for pupils and provide technical and administrative back-up for these sub-branches and the repair of premises. They allocate whatever is necessary for the work-study process, assign specialists and work as instructors and check their work, organize the pupils' work, set assignments, keep track of production, see to its sale and remunerate the pupils' work. They also award certificates to students. (p. 123)

For many years students of Soviet education have read that it is necessary "to establish closer ties with production" (Raiskin, 1961).[23] These are not Polyakov's words; any number of Soviet writers on education could have said them. In fact, they were written by Raiskin when discussing the goal of councils established in 1959 by the administration of the Donetskaia Railway.

The final section of Polyakov's article is "Scientific research work," in which the research of several Soviet educators is acknowledged.[24] It is notable that Polyakov has not felt that his observations had to be legitimated by reference to the thought of Marx and Lenin. This may suggest that the contemporary Soviet undertaking in education is more subject to empirical than to ideological standards. Nonetheless, there is an impressive continuity in Soviet thought on education. Shibanov (1962) spoke for generations of Soviet educational specialists in saying, "Sometimes it is worthwhile to glance back at the past in order to move forward with great certainty and speed" (p. 29). In this spirit, Shibanov, Deputy Director of the Institute for Production Training of the RSFSR (Russian Soviet Federated Socialist Republic) Academy of Pedagogical Science, cited Lenin, Krupskaia, and Lunacharsky.

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[23] The pay of students for productive work has been taken seriously in the Soviet Union. One of the better studies of the subject, although brief in its published form, was done over thirty years ago by Iakovlev (1960).

[24] For example, the research undertaken by Atutov on "the functional nature of polytechnical knowledge"; and by Batyshev on the "stage-by-stage theory of technical and vocational education." Other research is acknowledged in the footnotes to Polyakov's article.

I do not want to leave the impression that educational literature in the USSR is uniformly laudatory of what is done in the name of polytechnical education. From time to time efforts are "viewed with alarm." Specialization, as we have seen, is a favored bête noire. "There is grave danger," wrote Skatkin, Stavskii, and Shastov (1961), "that, while our schools will continue to be called polytechnical, they will gradually develop along narrow professional and vocational lines" (p. 33). More specifically, and in the lower grades especially, the authors describe the work training as all too frequently monotonous, lacking in requisite equipment, and generally unimpressive (p. 46). The inefficiency noted by Skatkin et al. has remained a significant problem in the USSR. Often it results from a lack of incentive among workers. Presumably, a goal of properly implemented polytechnical education would be to instill an inner incentive in the worker, thereby helping to reduce the amount of inefficiency.

A FINAL WORD

Although Soviet educators have had years of experience with modifications of polytechnical education, they have not completely solved the problem of how and when to distinguish between skill development and a general education that includes an understanding of how production has been transformed by science and technology. But this much can be said. The Soviets seem determined to make some degree of productive skill a goal of compulsory general education. In the United States we have not done that. True, what the Soviet educators include in productive skills is not clear. For example, it is not likely that business and distributive education or home economics education are part of the curriculum. There may be other omissions. Nonetheless, the Soviets have managed to fuse an academic with a vocational perspective and have added a Soviet variant of career counseling (Dunstan, 1987; this is a useful overview of the Soviet drive for housing both vocational and general education in the same school). A friendly ideology has helped, and we will have to succeed, if succeed we do, without that aid.

Chief among the obstacles to a general education in the United States is our unclear idea of what a general education is and how it differs from a liberal education and a vocational education. Part of our difficulty is semantic—troublesome indeed, but resolvable. There is nothing in the history of the language that makes it necessary to refer

to vocational *training* as distinguished from general and liberal *education*. Not only would clarity be gained by removing that distinction, but we would appreciate that the distinction has been invidious. Granted, there may have been reason for the social class differentiation suggested by setting education and training at polar opposites, but that historical dualism need not persist. It has grown into a nasty matter of social and mental grouping. One other matter of terminology, *vocational education*, should be seen as including vocational, technical, and professional education. This abridgment has the advantage of helping one to understand that preparation for earning a living is equally true for the development of very high level (i.e., professional) skill and for lesser levels of skill. Acceptance of this fact militates against the social class separation that leaves the lower levels of skill as requiring vocational training but perhaps not the technical and, it is argued, surely not the professional.

These divisions of status have been successfully circumvented by modern Soviet polytechnical redefinition of basic education. And this is the challenge to us. Will we be able to redefine our secondary general and liberal education in a manner that truly obviates the polarity of general and vocational education? Answering affirmatively is not a foregone conclusion. The French have defeated all attempts to reduce the distinction between *collèges d'enseignement général* and *collèges d'enseignement technique* (Weiler, 1988). And this despite the appeal of the Minister of Education, Jean-Paul Chevènement, in 1986, to reform French secondary education. As Weiler puts it, "Concerns with international competition, with mastering modern technologies, and with making the most of France's 'human resources' loomed large on Chevènement's policy agenda" (p. 260). No one can say that the United States will succeed where France has failed, and it is manifest that the educational literature in the United States has not been rich in suggestions on how to bridge the gap.

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