The Wirszup report:

'Soviet education: so far ahead comparison is meaningless'

In December 1979, Izaak Wirszup, professor of mathematics at the University of Chicago, sent a preview report of an in-depth comparison of the Soviet and U.S. scientific education system to the National Science Foundation. The report exposes one of the biggest scandals in the history of the United States. While American children and youth have been inundated with the drug-rock counterculture, Soviet children and youth have been undergoing what the "Soviets call an 'educational revolution'," which, says Wirszup, is "tantamount to an enormous expansion of the manpower training system, and radical curricular reforms brought about by an unexpected turn toward the individual and the development of his ability to do independent, creative work."

For four months, the Wirszup report stirred reaction at the highest level of government and academia, but it never emerged into the public light. Finally on April 17, Wirszup released the story to the Chicago Sun Times *and the University of Chicago newspaper. Wirszup is regarded as an international authority on mathematics education. He directs several National Science Foundation projects at the University of Chicago and is the author of the book,* Soviet Studies in the Psychology of Learning and Teaching Mathematics.

Executive Intelligence Review *now publishes sections of the report with the purpose to show Americans that its contents must be acted upon in the United States: the drug counterculture afflicting our youth must be immediately stopped and it must be replaced with scientific and moral training of our youth for productive adulthood.*

... My investigations show conclusively that in the last decade the Soviets have made simultaneous quantitative and qualitative gains without equal in the history of their education, affecting the entire young population. They have dramatically restructured and expanded their multi-track secondary educational system, achieving particular success in the development of institutions that combine general education with the training of skilled labor (technical-vocational schools) and middle-level professionals (secondary specialized schools).

For the 98 percent of the school-age population that now completes secondary school or its equivalent, the Soviets have introduced science and mathematics curricula whose content and scope place them far ahead of every other nation, including the United States. Their foremost scholars and educators are engaged in improving the school curricula and perfecting teaching methods in a concerted drive to provide mass education of unmatched quality....

In order to appreciate the scale of Soviet educational expansion, it is worth remembering that during the Stalin era the secondary school graduation rate was as low as 4.9 percent—out of 1000 children entering the first grade in 1930, only 49 completed the tenth grade in 1940. In 1957—the year of Sputnik, and just prior to the Khrushchev reforms of 1958—no more than 1,728,000 students graduated from secondary schools. In June of 1978, however, after years of extraordinary investment and effort culminating in the introduction (1975) of compulsory 10-year schooling, over 5,000,000 students graduated from secondary schools of all types, a success rate of 97.7 percent. (In the United States, by contrast, nearly 75 percent of all 17-year-olds—about 3,150,000 students—graduate from high school.)

The major impetus for the tremendous changes that have taken place was a Nov. 10, 1966 resolution adopted by the Central Committee of the Communist Party of the Soviet Union following the Twenty-Third Party Congress. This resolution, entitled "On Measures for Further Improving the Work of the Secondary General Education School," addressed the demands of the "scientific and technological revolution" for a skilled labor force with a broader general education and a higher intellec-

tual level. The resulting measures represented a total commitment to change in Soviet global educational goals and policies in relation to manpower needs, with particular emphasis on the individual's preparation for maximally productive service to the state.

These changes (which the Soviets call an "educational revolution") are tantamount to an *educational mobilization of the entire population:* an enormous expansion of the manpower training system, and radical curricular reforms brought about by an unexpected turn toward the individual and the development of his ability to do independent creative work.

Responsibility for the reform in general education schools was assigned to the highest scientific and educational institutions of the Soviet Union—the USSR Academy of Sciences and the USSR Academy of Pedagogical Sciences.

A team of scholars from both Academies, headed by A.N. Kolmogorov, has been responsible since 1964 for the entire school mathematics reform. Kolmogorov, one of the century's great mathematicians, worked in close collaboration with such outstanding scholars and educators as Markushevich, Gnedenko, Boltyanskii, Vilenkin, and Yaglom to set the goals of the new program, design the curriculum in every detail, decide on ways of treating various topics, and write the texts and manuals for students and teachers. (Kolmogorov himself is the co-author and editor-in-chief of three volumes on geometry and two on algebra and calculus.)

The result of their 15-year-effort is a program for mathematics instruction that is modern in content, innovative in approach, well-integrated and highly sophisticated. It gives strong emphasis to theoretical foundations and logical rigor as well as to applications. The program culminates in a calculus course taught in grades 9 and 10. Moreover, the extraordinary Soviet research in the pscyhology and methods of learning and teaching mathematics has been applied in the new curriculum, which now surpasses in quality, scope, and range of implementation that of any other country.

In only ten years, the Soviet compulsory program for all students covers the equivalent of at least thirteen years of American schooling in arithmetic, algebra and calculus, and does so much more thoroughly and effectively. The American one-year geometry course offers but a very small fraction of the Soviet 10-year geometry curriculum.

We are confronted, for example, with the fact that *over 5,000,000 graduates of Soviet secondary educational institutions in 1978 and 1979 have studied calculus for two years, while 105,000 United States high school students have taken a one-year calculus course* (1976). This shocking situation is not ameliorated substantially by study at our institutions of higher learning. In the fall of 1975, only 397,000 American college students were enrolled in calculus courses. The majority of Soviet students at institutions of higher learning are studying engineering or science-oriented disciplines, and more than half of the 1,000,000 entering higher education each year have intensive training in mathematics, starting with a comprehensive course in calculus.

Still another consequence of the 1966 resolution was the emergence of *elective studies* in various school subjects. In addition to the compulsory school mathematics curriculum, which accounts for 6 hours per week in each of grades 1-8 and 5 hours in grades 9 and 10 (a total of more than 2000 class hours over ten years), *over 1.6 million students in grades 7-10 participated in elective studies in mathematics during 1973.* These studies, which extend and deepen the compulsory curriculum, were established primarily to foster habits of independent and creative work.

In addition, hundreds of thousands of youngsters take part in an exceptional range of extracurricular activities—mathematics clubs, circles, and olympiads—or study in unique secondary schools specializing in mathematics and physics—all designed to discover mathematical talent and to train it from the earliest possible age. These programs have been developed and refined by world-famous mathematicians such as I. M. Gel'fand, A. N. Kolmogorov, M.A. Lavrent'ev, and S.L. Sobolev over some 45 years and have proved immensely successful. The programs themselves and the vast and original literature used in conducting them have no equal in the West.

It is quite evident that the successful Soviet experiences and achievements in mathematics education are being applied with extraordinary fervor and commitment to the closely related areas of the computer sciences. The Soviets look upon automation of production and management as a key weapon for overcoming the inefficiency other aspects of their system impose on the economy.

Obviously, great difficulties could have been expected for the Kolmogorov school mathematics curriculum. It is clearly far ahead of any offered on a mass scale—an exceedingly innovative program in a country where the educational traditions are extremely strong, a program accomplishing what is still considered unattainable here: teaching two years of calculus to the entire young generation of a nation of over 260 million. In addition, all youngsters are required to complete five years of physics (including, for example, an introduction to Einstein's special theory of relativity), and four years of chemistry (including a full year of organic chemistry). These are compulsory school programs of the highest quality, which like the mathematics program have been prepared by renowned scientists (Academicians I.K. Kikoin and Ya.B. Zel'dovich) and introduced after years of experimentation. Difficulties were perhaps inevitable if one remembers that this radical school reform coincided with the enforcement of compulsory secondary schooling and the accompanying explosion in the school population. For example, over a fifteen-year period (1960-1975) the

enrollment in grades 9-10 has increased more than four times, from 2.6 million to 10.8 million in all types of general education schools, and from 1.5 million to 6.2 million in the general-education day schools....

I do not doubt that the Soviets will overcome most of the obstacles. The Communist Party and the government are determined to adopt the highest possible educational standards and maintain the scale of mobilization they have recently achieved. The individual youngster, who is earnest, well-disciplined and intensely motivated, will pursue maximum education and training in spite of the dislocations involved. Not only is it the main criterion for success in a society that has become increasingly compartmentalized by educational achievement, it is practically the only safe avenue to a more comfortable standard of living under Soviet conditions.

The persistent elitism of the Soviet educational system can be illustrated by data on admissions to various levels of schools in 1977:

After demanding competitive examinations, 1,017,000 persons were admitted to *institutions of higher learning*, of whom 613,000 entered day-session departments. Only the top 9-10 percent of the 5 million *secondary school* graduates were admitted to day sessions of higher institutions.

At the next level, 1,430,000 students gained admission, again based on competitive examinations, to the *secondary specialized schools (primarily tekhnikums)*, which train middle-level professionals and white-collar technicians. Of these, 925,000 were admitted to the day-session schools, predominantly new graduates of the 8-year and 10-year general-education schools. The Soviet target is to have nearly one-fifth of its youngsters in a secondary specialized school. The adjective "secondary" here is an anachronism. These schools with 3-4-year programs, although designed mainly for graduates of the 8-year school, actually represent a much higher level. An examination of curricula and of text materials used in some tekhnikums indicates that with regard to professional-technical and science-mathematics content, their programs correspond to between 2 and 3 years at U.S. technical institutes or colleges.)

The remaining graduates of the 10-year schools (well over 70 percent), either go directly to work in various branches of the Soviet economy at the lowest qualification and salary rank or enter the technical-vocational school system, which trains skilled workers. In this case, they are assured a higher rank and an opportunity for more rapid job advancement. The young generation is increasingly obliged to follow the road of technical-vocational schooling, and the government's goal is to provide such training for 45-46 percent of Soviet youth.

The Soviets' current educational mobilization is characterized by intensive investment at all levels, with particular emphasis on the various types of secondary schooling which affect the entire workforce.

The system of *technical-vocational* schools has more than tripled enrollments since 1960, from 1,064,000 to 3,681,000 in 1977. The most modern and advanced of them, the *secondary technical-vocational* schools (3-4 years), offer both general education and technical training: 71 started operation in 1966, and have increased to 3,700 schools in 1979, with an enrollment of over 1,750,000. The technical-vocational system also includes the post-secondary *technical schools* (1-2 years), which show similar growth: 364 schools with 210,500 students in 1970, 1,000 schools with some 1,000,000 students in 1978 (projected admissions to these schools for 1980 will reach 800,000).

The long-established *secondary specialized schools* have also expanded; enrollment rose from 2,059,500 in 1960 to 4,662,000 in 1977-78. Similarly, enrollment in *institutions of higher learning* more than doubled in the period 1960-1977, from 2,396,000 to 5,037,000. (In 1977, 752,000 persons graduated from institutions of higher learning with training corresponding to our master's degree.)

In addition, over 36 million people learned new professions or improved their qualifications in 1977-78, and millions more studied in various establishments for continuing education.

Returns on this educational expansion are already impressive, and they have only begun. During the Ninth Five-Year Plan (1971-75) the technical-vocational schools alone trained some 9,500,000 skilled workers, a figure projected to reach 11,000,000 in the Tenth Five-Year Plan (1976-1980). (2,119,000 skilled workers graduated from these schools in 1976.)

In 1977, the secondary specialized system produced 1,185,800 graduates, 70 percent of whom became professionals in engineering, agriculture, and management.

It follows that some 3 million skilled workers and trained middle-level technicians enter the Soviet economy each year. Their high educational and technical level promises to accommodate manpower needs, both industrial and military, by turning out more versatile and efficient workers for high technology production. This intensive effort is particularly important in view of the impending serious labor shortage in the European part of the Soviet Union.

In 1978, A. A. Bulgakov, Chairman of the State Committee of the USSR Council of Ministers on Technical-Vocational Training, reported on research showing that graduates of the secondary technical-vocational schools are more productive, efficient, and contributive of improvements to technology and production. They (a) advance in qualification rank twice as fast as workers receiving other forms of vocational training; (b) are more likely to learn new or combined trades (50 percent within 2-3 years of starting work); (c) participate more readily in rationalization and invention in their work (40 percent—4 times those without this training); and (d) in-

crease their annual productivity 1.5 times more than their counterparts with different basic training. Bulgakov's data derived from research at two Leningrad plants, need no further comment:

	Trained:		
	By the individual-and-team method	In schools of tech.-voc. education for a period of 1-1.5 years	After completing technical and secondary tech.-voc schools
Production unit output per worker	258.7	320.7	529.2
Cost (in rubles) of mechanically producing one gear	.75	.59	.36

The effect of educational expansion on the labor force is reflected in a 1978 statement by M.A. Prokof'ev, Minister of Education of the USSR. He notes that 80 percent of the workers at the Volga Automobile Plant have completed either higher education, specialized professional, or full secondary education, and the remaining 6,000 workers are studying.

Anyone following the course of the Soviet educational mobilization, which has already achieved great success since its start in 1966, can see that this is just the beginning of a determined drive to achieve scientific and technological supremacy. L. I. Brezhnev has stated bluntly: "The field of scientific and technological progress is today one of the major fronts in the historical battle between the two systems."

It is extremely difficult to compare educational achievements in two countries as fundamentally different as the Soviet Union and the United States. Still, in order to give some idea of what has happened in the USSR in recent years, I would like to offer a preliminary comparative interpretation of Soviet secondary mathematics and science training in light of the three NSF studies.

Virtually the entire young Soviet population has been receiving *10 years of compulsory schooling in mathematics,* comprising:

- 3 years of arithmetic (grades 1-3)
- 2 years of arithmetic combined with algebra (grades 4-5)
- 5 years of algebra (grades 6-10)
- 10 years of geometry (5 of intuitive geometry in grades 1-5; 3 of semi-rigorous plane geometry in grades 6-8; 2 of semi-rigorous solid geometry in grades 9-10)
- 2 years of calculus (grades 9-10; in the future calculus may be taught in grade 10 only)

In addition, the curriculum of the Soviet general education school includes:

- 5 years of physics
- 4 years of chemistry
- 1 year of astronomy
- 5-½ years of biology
- 5 years of geography
- 3 years of mechanical drawing
- 10 years of workshop training

All of these courses are *compulsory.*

The NSF studies on *The Status of Pre-College Science, Mathematics, and Social Studies Educational Practices in U.S. Schools. ... show that of our high school graduates, 9.1 percent receive one year of physics, 16.1 percent one year of chemistry, 45 percent one year of biology, and 17.3 percent one year of general science.* (Over 56 percent of districts responding to the survey indicated that they required no mathematics courses, or only one, for graduation from high school.)

A very rough comparison of the content of mathematics programs in the two countries shows the following:

Mathematics programs

USA		USSR
8 years of arithmetic 1 year of general mathematics or business mathematics (essentially a review of arithmetic)	=	the arithmetic and algebra training in Soviet grades 1 through 5 and part of grade 6.
First-year algebra	=	algebra in grades 6-7 and part of 8
One year of geometry	=	geometry in grades 6-7.
Advanced algebra Advanced mathematics Trigonometry	=	algebra in grades 8-10.

If we bear in mind that the upper 60 percent of our high school graduates are college-bound, it follows from the NSF *Studies* that an *average* college-bound U.S. high school graduate (*one in the 70th percentile*), or an entrant to one of our military academies, acquires the following background in mathematics and the sciences:

- 8 years of arithmetic, and possibly 1 year of general mathematics
- 1 year of basic algebra
- 1 year of geometry
- 1 year of advanced algebra or trigonometry
- *at most*, 1 year of chemistry or physics
- 1 year of biology

Allowing that a U.S. high school graduate has acquired in primary school a science background equivalent to the Soviet—

3 years of natural science (grades 2-4)
3 years of geography (grades 5-7)
2 years of biology (grades 5-6)
1 year of physics (grade 6)

we find that a *Soviet secondary school graduate* who is university-bound, or entering a military academy, or one who is a middle-level professional or a skilled worker has, in comparison with his American counterpart, *on the average*, at least (in *years*, not hours):

1-2 years more training in algebra
8 years more training in geometry
1-2 years more training in calculus
4 years more training in physics
3 years more training in chemistry
3-½ years more training in biology
1 year more training in astronomy
3 years more training in mechanical drawing
6-10 years more training in workshop

Many of the Soviets have an additional several years of elective courses and extracurricular activities in mathematics, science, or technical fields in school or at an institution of higher learning and in the Pioneer Houses.

The disparity between the level of training in science and mathematics of an average Soviet skilled worker or military recruit and that of a non-college-bound American high school graduate, an average worker in one of our major industries, or an average member of our All-Volunteer Army (in 1977 only 59 percent of the Army's entrants possessed a high school diploma) *is so great that comparisons are meaningless.* Consider, on the one hand, the Soviet's educational background in mathematics and science (presented on page 9), and, on the other, the American's:

8-9 years of arithmetic
1 year of algebra
1 year of geometry, at most

and no high school level physics, chemistry, biology, or astronomy.

The Soviet Union's tremendous investment in human resources, unprecedented achievements in the education of the general population, and immense manpower pool in science and technology will have an immeasurable impact on that country's scientific, industrial and military strength. It is my considered opinion that the recent Soviet educational mobilization, although not as spectacular as the launching of the first Sputnik, poses a formidable challenge to the national security of the United States, one that is far more threatening than any in the past and one that will be much more difficult to meet.

Novosibirsk tames Siberia with science

Only two decades ago, there was virtually nothing there. Today, what was a vast expanse of desolate tundra, seemingly uninhabitable, is an international symbol of human scientific achievement. A city of 1.5 million has been built in the middle of Siberia: Novosibirsk.

Its creation in the space of two decades is not only the consequence of the Soviet Union's commitment to scientific and technological progress, but to an educational policy that matches. In fact, Novosibirsk might be described as one vast university and scientific laboratory, developing a labor force that can apply the most advanced technologies for the development of the whole of Siberia's resources, and much else besides.

In the mid-1950s, when the Soviet Union had largely completed the reconstruction of its economy from the destruction of World War II, a major expansion of scientific efforts was undertaken, most famously resulting in the 1957 Sputnik space shot. But also included was research into controlled thermonuclear reactions (fusion energy), advanced industrial processing, and economic planning methods.

In 1957, a group of scientists under the leadership of Academician Mikhail Lavrent'ev submitted a proposal to the government for the establishment of a branch of the Moscow Academy of Sciences in Western Siberia. In May, the proposal was approved by the government and in June it was taken up by the Academy Presidium. The objective of the plan was to create an on-site center that could solve the problems blocking the development of the vast resources of Siberia and the Far East.

Complementing the earlier established institutes of Chemicals and Metallurgy, Transport and Power, and their subdivisions in East Siberia, Yakutsk, and the Far East, the Novosibirsk branch of the Academy established an Institute of Mathematics, another for Mechanics, and others for Physics, Hydrodynamics, Automation, Geology and Genetics, Economics and Statistics, and a com-