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SUMMARY

This paper briefly summarizes the findings of 13 U.S. engineering school deans and faculty who visited 30 post-secondary engineering institutes in Russia, Ukraine and Belarus during November 1991. The paper covers general observations of the system of engineering education, followed by sections on: structure (p.4), secondary education (p.5), breadth of focus (p.6), intensive programs (p.7), staffing (p.9), infrastructure (p.10), computing (p.11), continuing education (p.12), quality (p.12), and the potential for future U.S.-FSU cooperation in this field. On that score the group found poor communications with the outside world a major obstacle to joint projects or collaborative efforts.
The system of engineering education in the USSR was notable for its size and its diversity. Being a complex and varied system, it was understood only imperfectly by outsiders, who never had the opportunity to examine the entire system. In the wake of the USSR's collapse, there exists a highly fluid situation presenting unprecedented challenges and opportunities. On the one hand, there now exist undreamed-of chances to visit institutions, meet with colleagues, and evaluate the programs of study, infrastructure, and products of engineering institutions. On the other hand, the entire educational system, and the economic system on which it was based, are in the throes of massive change. Merely to chronicle the shifts represents a daunting task.

In describing a rapidly changing education system, we should remember that large institutions and complex systems do not carry out massive reorientations overnight. Often, the best guide to near-term future performance will be recent past performance. Despite the stunning changes now taking place, the facilities and programs that already exist will be the most important factors in the future capabilities of individual institutions.

The report that follows represents the first systematic effort by American specialists to evaluate the condition of individual engineering schools in the USSR based on direct observation. During November 1991, thirteen U.S. engineering school deans and faculty members visited more than 30 engineering institutes in three republics of the former USSR (Russia, Ukraine and Belarus). The primary purpose of the visit was to assess the strengths and weaknesses of engineering institutions in terms of course offerings, research areas, and technical and intellectual capabilities. If engineering programs in the U.S. and CIS are to
increase their interaction, it is essential that U.S. participants in joint projects have a
greater understanding of how engineering education functions and how programs compare
to those of U.S. institutions.

Site visits were carried out by two-person teams. Most visits lasted one to two days.
In a few cases, more than one team visited an institute; however, most institutions were
visited only once. In some instances the team members separated to increase the coverage
of institutions or the number of laboratories and departments visited within an institution.

The report is divided into three sections. First, an attempt has been made to summarize
team members' general observations about the system of engineering education in the
former USSR. This is followed by summaries of the findings from visits to individual
institutions. A concluding section, based largely on meetings in Washington, DC April 15-
16, 1992, discusses recommendations for future collaboration.

It is important to note that this report describes conditions encountered in November
1991, before the breakup of the USSR and before liberalization of prices in Russia. As the
April meeting indicated, virtually all the engineering schools are now suffering from the
general economic crisis, and some of the observations recorded here may be outdated.
However, it is important to establish a baseline for evaluating the changes currently taking
place and the efforts at reform.

GENERAL OBSERVATIONS

Engineering education in the USSR was a massive enterprise, involving hundreds of
institutions. The Soviet Union boasted of employing half the engineers in the world.
Western specialists argued at length about whether these engineers were "broad" or "narrow." Following the 1957 launch of the first sputnik, this debate became so fraught that many participants ignored the obvious possibility that the answer might be, "both."

Indeed, we now know that the Soviet technical education system was enormous, diverse, and highly uneven. The institutions visited by the ASEE team were almost all among the elite technical schools, but even here a range of programs and facilities was visible. It would be extremely valuable in the future to expand the range of institutions visited, so that a more complete portrait of the system may be constructed.

The basic engineering degree in the Soviet education system was a "diploma," awarded after 5-6 years of study. The first two to three years involve basic science, followed by specialization in the final 2-3 years.

In the Soviet system there were two types of "advanced" degrees. The Candidate of Science, which generally would be somewhere between the American MA/MS and PhD, is awarded following three years of coursework and a thesis. The Doctorate of Science is a senior degree generally awarded to a scholar in the latter part of his/her career. It resembles the French or German system more than the American.

Since the mid-1980s there has been serious discussion of changing to a "European" or "American" system, with BA/BS, MA/MS, and PhD degrees on the basis of 4, 6, and 8-year programs. At some schools such changes are now being instituted. At others, there is intense resistance on the part of faculty who believe that the way they were educated (five to six years of highly specialized coursework) is the only way to produce a real specialist. Both systems have their merits, and it might not be the worst outcome if different
institutions opt for different types of programs. However, this may cause problems in accreditation and in the structure of professional communities.

STRUCTURE. Most of the institutions visited fall into one of two types: specialized institutes focusing on a specialized area of technology, generally meeting the needs of a particular ministry, and polytechnical institutes offering instruction in a range of specialties. In either case, it is common for there to be a close relationship with a ministry and with specific enterprises in the technical fields in which instruction is offered. Universities, which are not members of the Association of Engineering Universities, were not included among the institutions visited on the formal program.

The nomenclature is sometimes confusing due to similarities of names of institutes in a specialty. It is becoming more confusing as education reforms encourage a proliferation of "universities." Many institutions, both to advance a broader pedagogical purpose and also to conform to Ministry-sanctioned changes, are now calling themselves universities, technical universities, or engineering universities. At many of the institutions visited, members of the delegation were told of plans to create "technical universities," lead institutions, and new associations or other combinations of institutions. Basically, every technical educational institution now wants to be a "technical university." This includes many of the specialized secondary schools (similar to our junior or technical colleges), which are slated to disappear under the current education reform. These institutions wish either to reorganize as higher schools, or to combine their resources with those of existing institutes. This fits with the current vogue for broader, more comprehensive institutions.
In some cases, the change reflects nothing more than a new name, at least at the outset. At some institutions, several previously existing institutes are being combined under a single administration to form a university. In other instances, the name change reflects an overhaul of the program of study in an effort to broaden perspectives and cross disciplinary boundaries. It will require close observation and more regular visits of the type carried out by the ASEE delegation to monitor these changes and determine which are substantive and which are cosmetic. [Subsequent to the delegation's visit the Russian government has liberalized prices, and there have been reports that many schools, faced with severe budget difficulties, are exploring ways to combine resources to achieve cost savings.]

SECONDARY EDUCATION AND ADMISSIONS TO HIGHER EDUCATION. The Soviet Union enjoyed a reputation for providing high quality secondary education in mathematics and the natural sciences, particularly physics. This reputation was deserved, but it was not necessarily an accurate description of all the secondary schools in the country. Visitors generally were shown the most advanced schools in urban areas, but sometimes were encouraged to believe these were "typical" institutions. Recently, Russians have been much more critical of their secondary education system.

There is no disputing the high level of math and science preparation at the better schools. Students entering higher education are often far better prepared than U.S. students in math and sciences. However, by the end of higher education these differences appear to be erased. This is attributable to a number of factors, among which the lack of opportunities for independent work in Soviet schools occupied a prominent place. The
difficulties have been recognized, and current education reform plans call for major attention to individualized education and involving students in research.

Admission to higher education is on the basis of competitive examinations. In the post-World War Two period, approximately 16-18% of high school graduates have gone on to higher education—a much lower proportion than in the U.S. (The USSR had some 900 higher educational institutions, compared to 3600 colleges and universities in this country.) Prior to the mid-1970s, competition for admission was keen at most institutions. Since that time there has been a decline in applications to technical schools, and the application to admission ratio varies from near 1:1 at some institutes to as much as 4:1 or 5:1 at others. Location, dormitory availability, and employment prospects all are factors in these variations, as are cultural perceptions and changes. [It will be particularly important to watch the September 1992 admissions situation at various institutions to gauge the effects of the economic crisis.]

NARROW FOCUS. There is virtually universal agreement that USSR technical institutes have a narrow focus. This in large part was a product of the close ties between specialized institutes and industrial ministries. Even when nomenclature seems broader, actual coursework is in fact strongly oriented to the particular industry served by the institute. This is an advantage in that a graduate is usually ready to step right into a job. But the highly specialized programs make it difficult to adapt to rapidly changing technologies.

At some institutes, engineers were being trained using the latest equipment. At others, faculty were continuing to teach students in specialties that are outmoded, and will likely have little relationship to work that they will be doing in the future. Inevitably, alongside
a few engineers developing truly advanced technologies, there were hordes of others involved in mundane aspects of day-to-day industrial activity.

Most schools have a specific mission to provide education and cadres for particular industries. This creates a very different academic environment from that common in the U.S., where most engineers are trained in broader university settings. One team member noted that there are some advantages to special-purpose institutes, since humanities and social science courses can be structured to facilitate professional training of engineers. However, others found this a debatable proposition, suggesting that "tailored" social science courses are not genuine social science. Many of the highly specialized schools are spin-offs of older institutions. There was a wave of such activity in 1930, when hundreds of new technical institutes were created on the basis of individual faculties of larger institutions. The practice was continued on a much less ambitious scale after World War II, both to accommodate new specialties and to expand into growing geographic regions.

Many institutes developed contract relationships to provide graduates to industry in return for financial support. This program is now in serious difficulty. It had the advantage of letting people know quite early both that they had a job and where it would be. But it engendered a problem of applied studies being captive of sponsors who demand narrow specialists for current technologies—not a system that encourages innovation. Teaching labs are also highly specialized.

INTENSIVE PROGRAMS. None of the programs at USSR engineering institutions was less than five years, and many lasted 5 1/2 or 6 years. In virtually all the programs, the first two to three years were devoted to general math and science courses, followed by
specialization in the final 2-3 years. While the degree of this specialization varied among institutes, in many cases the specialties were much narrower than those at American schools. This narrow specialization responded to the wishes of Ministerial "sponsors," even when as many as half the graduates did not work in their narrow specialties following graduation. (Discussions with engineers suggest that for many, the need to perform myriad tasks on the job compensates for the narrowness of education.)

Students at most institutions spend an average of 35 to 50 contact hours per week with faculty, compared to 15-18 hours at most U.S. engineering schools. The magnitude of this differential struck many of the American participants. At the same time, it must be noted that American students are expected to do far more work outside the formal class setting. At most of the USSR institutions, students did not regularly use computers, laboratories or other facilities outside class time. When asked direct questions about access to computers during non-class hours, administrators at several institutes seemed surprised at the question. The most positive response was that "it would be possible," or that "such arrangements could be made," implying that it was hardly a normal phenomenon.

(One of the obstacles to permitting use of facilities during non-class time is security. Another is lack of "spare" facilities. Despite the (by American standards) high staff to student ratios at most USSR institutions, it appeared difficult to arrange the extra supervision that would be needed to keep a lab open after hours.

A number of individuals discussed the phenomenon of students "getting tired" by their fourth or fifth year (not to mention their sixth, in cases where it existed). This also helps
to explain the "dissipation" of the benefits of secondary school math and science achievements.

In general, the institutions visited were very strong in military-related engineering systems. However, leadership in some of these areas has been undermined by failure to keep up with technological change. For example, "[They are] perhaps world leaders in electromechanical systems, but many of these systems have been antiquated by the modern use of digital electronics."

STAFFING. The faculty members at institutions we visited were consistently competent, friendly and committed to their work. In many cases, they gave up holidays or weekends to host American visitors. Virtually all members of the ASEE delegation came away impressed by the energy and talent present at these schools.

Staffing at all institutions appeared not only adequate but often excessive. There were also signs that this may be changing. Before 1992, salaries represented a relatively small part of institutional budgets, and faculty-student ratios could be as luxurious as 3:1. The current economic changes are already causing major disruptions of this pattern. As the cost of human resources begins to approximate the world market value of these resources, institutions are being forced to reduce their staffs. Cuts are coming both in the number of teaching personnel, as enrollments at many institutions shrink, and also in the number of researchers who can be supported on a dwindling supply of contract funds.

Contract research represented approximately half the budget at many engineering institutes. In the face of economic dislocations, every institution is scrambling to replace these funds. But as industries face their own economic crisis, they are not inclined to
support long-term initiatives like R&D. Virtually every institution that can do so is seeking foreign contacts and exploring ways to obtain hard currency. While this behavior is fully understandable and probably economically rational, it is also engendering massive dislocations and irrationalities in the education system.

INFRASTRUCTURE. Most members of the U.S. team, including those who had previously visited the USSR, commented on the serious deterioration of infrastructure. Buildings were often poorly maintained and some were in a state of disrepair. Student housing would strike most Americans as substandard. The few exceptions to this general picture stood out in contrast to the similarity in conditions at most facilities. Some of the older institutions in Moscow and Petersburg were in poor condition. But it was the combination of age and poor maintenance, even regarding such relatively low cost items as cleanliness, that struck most delegation members.

We should note that at least one individual did not share this impression: "Classrooms and offices were variable in quality but, in most respects, no worse than those found in many U.S. engineering schools." Even this member of the team, however, noted that in most cases visual aids were limited to chalkboards.

Lab equipment was often outmoded, and frequently housed in cramped, poorly-lit and poorly-maintained facilities. Despite these conditions, faculty and students were conducting worthwhile research at many of the installations. For many members of the American team, it was a humbling experience to observe what was being accomplished with limited resources in environments that most American engineers would consider "impossible."
COMPUTING. Many specialists consider computing to be the Achilles Heel of Soviet science, and this visit did little to alter the impression. In general, there are not enough computers, and those that exist are on average 5 years or more behind comparable university facilities in the U.S. Hardware available to most students appeared to lag that at U.S. institutions by a good 5-10 years, but they did appear to be making good use of whatever was available. Even more striking was the lack of peripheral devices and access to electronic communications.

Delegation members noted a generally adequate number of machines in laboratories, but far fewer in individual offices. Overall there was an impression of much interesting work being done on software applications and teaching tools, making use of a very limited supply of computers. "Key people are severely limited in their ability to perform in the modern world. E-mail, the many other advantages of networked computers, and the computational power of even a stand-alone PC seem to be unavailable to the technical staff except in a laboratory setting." (comments by a team member who visited institutions mainly in the Far East)

In many cases the improvement in availability of equipment was of quite recent vintage—personnel at several institutions noted that they had only recently acquired a significant number of machines either through purchase or from a special Siemens Corp. program. The newness of these facilities might account for both the significantly "spiffier" appearance of computer labs at some of the institutions visited, and also for the apparent lack of full utilization. In some instances, they are still becoming adjusted to the availability of this equipment and learning how to make better use of the hardware. It
would also help explain the lag in installing peripherals or making more use of the communication potential of the computers (which will also require major improvements in the telecommunications system).

They need far more computer literacy, and a lot more networking. They also need to improve the overall level of computer equipment if they are to get anywhere with CAD/CAM and new technologies. Virtually all the sophisticated PCs we saw were imported. The best configurations of Soviet-produced computers were 286 machines with 256K. These were woefully slow when running graphics programs. The fall of the ruble will make it infinitely more difficult for them to purchase advanced systems from abroad. They should probably devote the available hard currency to improving their domestic production lines, but the existing track record suggests that this will not be easy and could be a disaster. It may also be unrealistic, as institutions increasingly take an "every department for itself" approach.

CONTINUING EDUCATION. Although current higher education reform plans call for major emphasis on "lifelong" education, several team members noted the weakness of the system of continuing education. It is not adequately funded, and did not seem to provide the upgrading of skills required to keep specialists up to speed in their fields.

QUALITY. The quality of the facilities visited varied, as it does in any education system. The ASEE delegation for the most part visited "elite" institutions, but this was not universally the case. In the judgement of team members who chose to express the situation in these terms, many of the institutions visited would have merited 3-year or 6-year ABET
accreditation periods. Most graduates would be prepared to enter U.S. graduate school programs, provided the language issue could be solved.

POTENTIAL FOR FUTURE COOPERATION. Experiences varied in terms of hosts' chief interests. Some were genuinely striving to get some sort of accreditation, and were under the mistaken impression that the visiting team would be making a recommendation along these lines to some competent organization. Others were far more interested in contacts and prospects for future collaboration. These initiatives include student exchanges, faculty research activities, and commercial linkages. All of these varieties of contact should be explored further at follow-on sessions and return visits.

Even before the switch to "liberalized prices" in Russia, every institution was seeking ways to obtain hard currency. This has now become a desperate effort. Every Institute Rektor wants cooperative agreements, money to purchase equipment, etc. Deals that bring in hard currency are not only mandatory when the ruble is plummeting, but also have a tremendous symbolic importance. Given the importance of American partners, it is incumbent on us to make the most informed choices possible.

Some team members returned home convinced that the single most important area where assistance is needed is in communications. This is an extravagant claim, when the case could easily be made that food, transportation, medicine, or any of a dozen other needs should be addressed on an urgent basis. However, improving the communications system is unquestionably the key to most institutions being able to find partners and sources of assistance. This is particularly the case for institutions outside Moscow and Petersburg. Unless their contact with the outside world becomes less tenuous, joint
projects and collaborative efforts will be too daunting for any but the most dedicated partners. In particular, Westerners motivated by the profit motive rather than humanitarian or personal concerns will simply put their efforts elsewhere. And without the profit-seekers, there will never be enough outsiders with the needed business skills.