

CAD Education and Science in Ukraine after Perestroika

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Abstract

After the break-up of the Soviet Union and formation of democratic independent countries like Russia, Ukraine, Kazakhstan, etc., the status of science and education changed for the worse. In this review, I will give a brief description of science and education as they were before the collapse of the Soviet Union, and the present situation in Ukraine as compared to Russia. I will base my examples on conditions in technical universities in the Computer-Aided Design (CAD) field, which are representatives of the university scene as a whole.

1. Introduction

In the former Soviet Union, science and education were the forces that determined development of scientific and technological progress. That is why a college undergraduate/graduate degree (Bachelor or Masters) was a must for obtaining a good position. In the last few years before Perestroika and a few years after it, possessing an undergraduate degree alone was no longer sufficient. One must now acquire a degree of Candidate (Ph.D) or Doctor of Science (Ph.D.+) to make oneself marketable. In the Soviet Union, a country run solely by the Communist Party, engineering and natural sciences, and education were the areas less politicized thus more democratic than others. This explains why during the 1960's through 1980's, the most talented youths matriculated to the universities after 10-11 years in school or after vocational school (secondary special education), and further continued their careers in science.

After the break-up of the Soviet Union and formation of democratic independent countries like Russia,

Ukraine, Kazakhstan, etc., the status of science and education changed for the worse. In this review, I will give a brief description of science and education, particularly in the CAD field, as they were before the collapse of the Soviet Union, and the present situation in Ukraine compared to Russia. I will base my examples on conditions in technical universities, which are representatives of the university scene as a whole. This discussion will encompass events taking place in the last twenty years, including 1994.

2. Brief Tour in the Recent History

2.1 Education

The education in the USSR was centralized under direction of the USSR Ministry of Higher and Secondary Specialized Education (MH&SSE). Similar ministries, subordinate to the main ministry of the USSR, were in all 15 of the republics comprising the Soviet Union at that time. For example, the Ukrainian Ministry of Higher and Secondary Specialized Education was operating in Kiev, capital of the Ukraine, while Russian MH&SSE was in Moscow, the capital of Russia, as well as the capital of the USSR. The ministry was responsible for deciding: whether or not to open a particular university; how to divide the budget received from the Central Government between republics; and presidential appointments of the higher educational institutions and universities. [There was a slight difference between universities and higher education institutes. In the rest of this article, all of these institutions will be referred to as universities.] Together with GOSPLAN of the USSR it approved the distribution plans for graduating specialists. While every graduate was guaranteed employment, it

was not necessarily a job of one's choosing, rather, an assignment made by a "Commission on Distribution". The ministry approved the staff requirements of the universities (primarily the number of faculty), and the number and profile (specialization) of Departments within a particular institution. Curricula for students in different areas were also developed by the ministries in accordance with ministry requirements supervising the work in that particular area. For example, curricula for medical students would be developed in accordance with requirements from the Ministry of Health.

The Soviet Union long remained closed from the outside world. Any trips abroad had to be granted by the ministry. These trips were allowed quite rarely, and were based on reviewing a special petition from the republican MH&SSE. A small number of leading universities, such as Moscow State University, Leningrad State University, Moscow Aviation Institute and a number of other schools, were directly supervised by the USSR MH&SSE. All other universities were subordinate to their republican ministries. The USSR MH&SSE housed a number of special commissions for different specialties. These commissions created curricula, composed different programs, and approved the literature which had to be used by universities.

It is apparent that the Soviet educational system was highly centralized and run from the top-down. Everything was dependent on the USSR MH&SSE, which determined the financing of college science. Financing came mainly from the state budget, but also from orders placed by branch ministries and enterprises. A university was not allowed to take more money for the research than was approved by finance distribution. The only exceptions to this rule were for special defense research programs.

Republican MH&SSE (RM) scrupulously wrote all of the instructions guiding activities of a particular university. Any independence was forbidden and punished severely. All publications, even course packets had to be approved by the RM. Once a year, each university was visited by a special commission of the RM who reviewed all activities for the preceding year

and ascertained that the university followed RM plans to the letter. Once a year, the RM approved the plan for development and activity of all universities consisting of approximately 100 chapters. This plan included: guidelines for acceptance of new students, numbers of expected graduates, plans for the work of graduate and doctorate schools, plans for preparation of Doctors and Candidates of Science, plans for textbooks writing and publishing, course pack preparations, etc.

In the USSR there were two categories of technical universities:

- 1) Polytechnic universities; institutions comprising a large spectrum of technical specialties (e.g. Kiev Polytechnic Institute, Lvov Polytechnic Institute, etc.)

- 2) Specialized technical universities, (e.g. Taganrog State University of Radio Engineering, Leningrad Institute of Precise Mechanics and Optics, etc.)

The leading figure in each university was called a *rector* (somewhat equivalent to a president) and Scientific Board of the institution. Institutions consisted of Faculties (similar to colleges in the United States, e.g. Faculty of Electronic Technique) which were headed by deans. Each faculty had a number of departments (e.g. Computer-Aided Design Department), headed by department chairs. The composition of the university was determined by the number of accepted students. The existing ratio was 12 students per faculty member. Polytechnic universities averaged close to 10-20 thousand students, while specialized universities normally had about 5-10 thousand. The instructors were permitted to vary the course syllabus outlined by the RM up to 20 percent, if it was sanctioned by the department chair. Only a few leading departments had more freedom.

Preparation of the teaching force was conducted inside educational institutions through graduate and doctorate schools. In most of the universities, the students spend 5 years to obtain their degree, although in some technical institutions, it took as long as 5.5 years. Listed is a table which gives typical numbers for different universities:

In many leading universities there were special scientific-research institutes, design bureaus, and experimental manufacture (plants, etc.). These allowed for effective preparation of students for future work and the selection of exceptional students for continued studies in graduate school.

There were three forms of instruction; daily, evening, and instruction by correspondence. Daily instruction was for students who did not work during the day; evening instruction catered to students who worked full-time during the day and could study in the evening; and instruction by correspondence was generally for students from other cities. Here, the students followed a self-study regimen, adhering to the guidelines from letters and course packets, and doing regular homework and tests by mailing in answers. These students made the trek to campus twice yearly to take additional classes and exams.

Graduate school prepared a student for a Candidate Degree (equivalent of a Ph.D. in the United States). In technical universities, the degree conferred was typically that of Candidate of Science. The length of education was usually 3 years for daily instruction, and 4 years for instruction by correspondence. At the end of instruction, a student was required to present a dissertation. If the student received good reviews from a bevy of scholars (10-15) from different institutions, the student would then make their defence in front of the Specialized Scientific Panel (SSP). [In many cases, students needed between two to five additional years to prepare their dissertations. Some of them could never complete their dissertations because of the stringent requirements.] Defense of the dissertation did not automatically result in earning the degree. On the contrary. The degree was difficult in obtaining and was awarded to only the best candidates. After the degree was awarded at the session of the SSP, one could not be considered a Candidate of Science until their degree had been approved by the USSR Highest Attestation Commission; which was an empire of its own headquartered in Moscow. This Committee scrupulously reviewed every Candidate and Doctoral dissertation in the country and approved or rejected all scientific degrees. In addition, the Highest Attestation Committee conferred the title of docent (similar to an Associate Professor in the United States), professor, and senior scientist. The degree of Doctor of Science was awarded to outstanding scholars only. [It is somewhat like Fellow of IEEE, according to Dr. Erik Goodman from Michigan State University. There was no formal graduate study for this degree.] Such a scholar

should have books, manage a research group, be nationally recognized and defend a doctoral dissertation to a Special Doctoral Panel. This is why the average age of those obtaining a Doctoral degree was 47 years of age the natural sciences, and over 50 for the political and human sciences.

Universities conducted research in fundamental and applied science. As a rule, each department had some means for research from the state budget, as well as obtaining grants and contracts from different enterprises. Stringent centralized guidance of the education in the country had its positive and negative sides.

Positive aspects: All graduates had a guaranteed place of work; the education was free of charge; universities

Length of Study	Institutions
4 years	Pedagogical and Foreign Languages Institutes, Universities of Economics
5 years	State Universities, Architectural and Specialized Technical Institutes
5.5 years	Polytechnic and Specialized Technical Institutes
9 years	Medical Institutes

received housing for instructors, staff and students, and equipment and material support. These provided ideal conditions for the development of "pure science", for preparing future specialists and scientists.

Shortcomings: Centralization was inhibiting local initiative. Free education was not a good enough stimuli for students to study. The ministry plan, which dictated a certain number of graduates, led to the graduation of even weak students. As a result, the number of engineers with technical specialties was higher than needed throughout the country. Instructors received the same salary for different workloads. All of these factors discouraged progress in science and education.

2.2 Science

The State Committee for Science and Technology directed the scientific research in the USSR. The questions of fundamental science were supervised by the USSR Academy of Science and Republican Academies of Sciences.

An example in the CAD area: First, different enterprises, design bureaus and scientific research institutes discovered a need in automated systems, so they submitted inquiries to the government. As a result, new CAD specialties appeared in universities in different areas; mechanical engineering, electrical engineering, light industry, etc. Professors, through graduate schools started to prepare specialists in the CAD area. Academy of Sciences opened institutes (CAD Research Institute of USSR Academy of Science and VLSI Design Institute (Moscow), etc.). The State Committee for Science and Technology formed a special CAD department and started to finance its research. Plants, Scientific Research Institutes and design bureaus started to order different CAD-oriented research from universities. By the mid 1980's, there were a great deal of Soviet CAD systems developed in all areas of industry.

The theory of CAD developed rapidly. A large number of CAD books, textbooks and other related materials were published. Each year there were about 100 USSR conferences devoted to CAD issues. Especially good results were achieved in the areas of physical and logical design of electronic systems.

The collaboration amongst different republics of the Soviet Union was very successful. In different cities throughout the USSR the scientific CAD "schools" were formed and special CAD manufacturing centers appeared. Despite great theoretical results, the limited technological base and errors made by leadership in the orientation of computer technique, led to the lag of soviet CAD science.

3. Current Situation

3.1. Education

In Ukraine, school and university education fell under the control of the Ministry of Education. The main focus of the new ministry is to convert the entire educational system from that of traditionally Russian to Ukrainian. The Ministry of Education ruled that starting in 1994, all lectures should be delivered only in the Ukrainian language. This is an expensive and time consuming process. For some regions the problem is not a simple

one and cannot be remedied within a short time frame; all of the Russian textbooks and manuals need to be translated into Ukrainian. At the same time, the ministry is licensing both old and new universities, and trying to model the educational system by American standards. These all changes are only superficial however. The stagnated system remains in place:

Emphasis is still placed on lecture and classroom study;
Foreign language preparation remains weak;
Computers and other equipment are antiquated;
National prejudices remain;
Textbooks and professors are old-fashioned;
Specializations are narrow -- the CAD

Department in Kiev
Polytechnic Institute for
example;

An unsound moral atmosphere exists in the universities.

Just as was the case during the Soviet era, there are still no leaders interested in implementing the necessary changes. As before, Ukrainians mimic the soviet system of scientific attestation; the Ukrainian Highest Attestation Commission established in Kiev is analogous to the one in Moscow.

From 1992, the appropriate way to describe the educational leadership in Russia is, "a mess". First, the education was controlled by the Ministry of Higher School, Science and Technical Policy, it was then succeeded by the Committee of Higher School, and finally, by the Ministry of Higher Education.

From the start, an attempt was made to entirely drop the practice of centralized control on education. The rectors of the universities were allowed considerable control over the destiny of their schools. Listed, are some of the changes which have taken place recently:

1. The distribution of students to places of work ceased to exist. All graduates are now required to find work on their own.

2. The plan regulating number of graduates was canceled.

3. The plan regulating number of students accepted to universities remained intact, although the number of students accepted now, especially in technical institutes, dropped significantly. Institutions are allowed to accept any number of students over the number specified in plan if these students can pay for their own education.

4. Curricula and the programs are being developed in

universities now.

5. Almost all universities started to prepare bachelors of sciences in corresponding areas, and the period of education is 4 years in most of the schools now.

6. Now all universities are called Universities or Academies.

7. The leading Universities started to prepare Masters (2-year graduate program after completing bachelors degree) and diploma engineers (1 year after completing bachelors degree).

8. New private universities were formed.

9. Plants, Scientific Research Institutes and Design Bureaus froze their hiring process and stopped financing university research due to the decline in their production and economic difficulties. This led to the emergence of a new phenomena of unemployment among engineers. The funding of universities decreased, thus resulting in a downfall of salaries, firing of scientific employees, and a decline in the level of scientific research.

10. All publishing houses started financing themselves, and therefore, stopped printing textbooks and scientific literature resulting in "scientific and educational hunger".

11. The number of students wanting to study technical specialties dropped practically to zero. Almost all high school graduates would rather study economics, accounting, management and foreign languages.

12. The financing universities used to receive for faculty and students housing ceased to exist.

13 (Ukraine). The government and ministry of education have no money to support higher education and research. The general crisis in government can lead to an unpredictable situation in the country. After Crimea's decision to separate from Ukraine and use Russian currency, a military conflict between Ukraine and Crimea looks inevitable.

Many scholars are trying to compete for Soros Foundation grants, but the number of successful applicants is very small.

14 (Russia). The government is trying to support the best scholars through the grants system. After the competition for a grant in a particular area is announced, scholars who have good results, reputation, and interesting ideas are likely to be awarded a one or two-year grant. Receiving a grant gives them an opportunity to somehow support themselves and their colleagues. But

the number of grants is wholly insufficient, thus, the number of recipients is very small.

15 (Ukraine). The assimilation to an American educational system has failed due to the lack of knowledge and experience.

Most professors and students are more concerned with survival than how to improve education.

Most university engineering graduates have no real job prospects in their field.

Most universities lease their premises to make ends meet.

16 (Russia). In many universities, a new system named RHYTHM was deployed. The abbreviation of this system stands for Development of Individual Creative Thinking. The core of it is that the student works much more individually, taking rating tests 2-3 times during a semester and a final rating at the end. A resulting grade is determined after summing all of the scores. So, in a sense, the system mimics the common practice accepted in the USA.

Due to these factors, the number of educational establishments and the quality of the state education in the former USSR declined quickly. All of young talented people who used to go into science now turn to business or private universities. Large numbers of scientists are leaving to work abroad. Prosperous and glamorous state educational and scientific systems are witnessing the last day of Pompeii. In Ukraine, in February 1994, the average salary in the educational field was 2.5 times lower than industry salaries. Moreover, professors and teachers have not been paid since the latter part of 1993. Universities and schools have accumulated enormous debts for heating and electricity. Kiev Polytechnic Institute, formerly the most prosperous among Kiev universities, had no money to pay for electrical service on several occasions and was cut off. Students are now forced to wear coats in the classrooms. In 1993, 97 professors and 500 researchers left Kiev Polytechnic Institute, which is the largest Ukrainian university. This is why nearly all teachers, university professors and students went on strike in the middle of February, 1994. At a time when inflation is skyrocketing, the salaries in the field of education continue to drop. See the table below which shows the university professor salary per month, USD:

3.2 Science

Scientific research in Ukraine is currently being "coordinated" by the Ukrainian Academy of Science and a dozen of newly emerging academies. The state salaries in academic research institutes and special scientific centers are so small, that only real enthusiasts and the elderly (those unemployable elsewhere) still remain. In 1980 Doctors of Science were making an equivalent of \$400, and Candidates of Science an equivalent of \$250 a month. This ratio is now \$25-40 for Doctors and \$20-30 for Candidates, per month! This is far below the minimum standard of living which is estimated to be at least \$50 per person per month. Because of the collapse of industry there is little need for research at all (for example, since January, 1994 Ukrainian banks stopped payments between organizations; in January, 1994 all aircraft plants discontinued operations). As a result, research organizations have almost no industry contracts. Research organizations cannot afford modern equipment, nor keep their facilities operational. Many of these organizations only operate 3-4 days a week, obviously much below their production potential.

The situation in Russia is *slightly* better, although they suffer from the same epidemic; a faltering of educational institutions. Scientific research in Russia is currently being coordinated by the Ministry of Science and Technical Policy and the Russian Academy of Science. The ministry is trying to shield the leading scientists by creating a few special scientific centers which focus on applied problems. Pitifully, the salaries they receive could scarcely be considered salaries at all. In 1980,

Year	Ukraine	Russia
1960	\$700	\$700
1970	\$500	\$500
1980	\$300	\$300
1990	\$40	\$30
1992	\$30	\$40
1993	\$250	\$100
1994	\$20	\$100

Doctors of Science were making an equivalent of \$500, and Candidates of Science an equivalent of \$300 a month. This ratio now is \$100-150 for Doctors and \$70-100 for Candidates, per month. The minimum standard of living is estimated to be \$70 per person per month. This means that Russian scientists are unable to support themselves or their families. The system of special salary bonuses, aimed at supporting different leading scientists and stimulating their activity, is also in place. For example, the department chair, may receive a bonus of 25 percent; a Degree of Doctor or Candidate of Science may receive 50 percent; if you have graduate students, your bonus is 10 percent; for publishing articles, books and patenting inventions, the bonus is 5 percent; for developing new technologies, the bonus is 10 percent; and so on... Unfortunately, most of these bonuses are still forthcoming.

Universities and research institutes of both these countries are allowed to open small and joint businesses using the premises and equipment of a university, and particularly, departments within it. The purpose of these enterprises is to allow scientists to receive some extra money by getting orders from the customers. This will hopefully prevent some of the straying from science. The formerly influential Academies of Science which used to control the development of theoretical science, have lost almost all of their power. The reasons for this are several: Firstly, the members have become very old. The average age of academicians is 70 years, and member-correspondents are in their 60s. Secondly, elections of Academics are no longer democratic (real scientists do not have an opportunity to be elected). As a counterbalance, the scientists of Ukraine and Russia created a number of public Academies of Sciences unsupported by the government. The members of these Academies are supposed to be the best young and middle-age scientists that can still be considered "real" scientists and who can still make a contribution to the development of science. Currently, Ukraine has 4 state and about 20 public academies, to Russia's 59 Academies of Sciences. Unfortunately, these new academies are also riddled with corruption. Members include real scholars, "pseudo-scientists", and those who buy memberships simply for prestige associated with Soviet lifestyle.

Due to high inflation and a decrease in the allotments for science and education, many budgeted Scientific Research Institutes of Academy of Science are on the brink of closing. Scientists are changing their careers and leaving the institutes *and* the country. By and large, the

situation is far from idealistic. The only ways to ameliorate the further impoverishing and degradation of science and education is through: increases in production; a healing of the economy; society's need for science; and a change in the attitude of the government and president towards science and education.

4. Conclusion

The situation in Ukraine is critical. I do not think that Ukraine can cure all of these problems on its own. As President of International Solomon University (ISU), a newly formed non-profit institution, I know that there are means of collaboration between universities and foreign organizations that are mutually beneficial.

We have received two grants from the Soros Foundation, and grants from the Rich Foundation and JOINT. We are expecting additional grant support in the future. We have submitted joint proposals to the NSF, USIA and other organizations. Several of the ISU professors were awarded grants by the International Science Foundation to support their team research. Some of our professors receive specialized training in the United States and Israel. Several professors from the United States, United Kingdom, Israel and other countries teach at ISU (in English). We receive textbooks and other literature from many supporting organizations. In these difficult times for Ukraine, I think that ISU is a model of cooperation .

I believe that our western partners a considerable contribution, by funding specific institutes, universities, and scientists, rather than giving money for education via the government. In addition, joint projects can be

developed, where scientists participate in combined research. Equipment, books, and journals can be distributed among schools and universities, and new student scholarships and stipends can be established. The government and organizations of the United States and other countries can provide money to their own scholars who wish to conduct special research, education, and industry projects in the countries of the former Soviet Union. Both parties will benefit. Many good specialists are unemployed due to corporate downsizings, and would welcome this type of opportunity. In turn, the specialists participating in such programs will help in accelerating technical and economic progress in the country they choose to work in.

All of this needs to be accomplished under close surveillance to insure that support reaches the proper recipients and not those who control distribution. Scientists and students can be invited to conduct research and studies in the United States and other countries and/or be given the resources to conduct their work in the former Soviet Union. The Soros Foundation is a good example of an organization that facilitates all that has been described above. Unfortunately, this is merely a drop of water in the ocean; in fixing the existing situation. Occasional international conferences in the United States and former Soviet countries should become more frequent. This would help to integrate "Soviet" science and scientists into the world system of science and education.

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