

# The Four Phases of Russian Engineering Education in the Era of Social Experiments

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## Abstract

We consider some peculiarities in the evolution of Russian engineering education as it underwent two radical paradigmatic transformations during the past century, especially from the viewpoint of restrictions that inhibited access to higher education (HE). The driving forces of this evolution are revealed and some negative results are shown. While the former restrictions are gone, the new ones emerged as regards quality education which in part is related to the general degradation of engineering HE, in part to the stratification of the population. The new limitations can be overcome only within advanced corporations involved in innovation.

**Keywords:** Russia, engineering education, educational policy, sociology of education

## 1. Introduction

P. Chaadaev, the famous Russian thinker of the 19-th century, once wrote “seems like... [Russia] only exists to give some important lesson [to other nations]”, and this thought concerns Russian education, too. Bearing this thought in mind, contemporary educators may consider the peculiar development of Russian engineering education as an edifying example which reveals some dark sides of the growing “mass production” of students in HE that occurs now all over the world.

Over the past century Russian engineering education has undergone the four distinctive phases: 1) the Tsarist phase: (before 1917); 2) the Bolsheviks' phase: (1917 - until about the 1940s); 3) the post-war phase: (the 1950s - 1991); and 4) the current phase: (from 1991 on). Each phase is distinguished, in particular, by the presence or absence of real or ostensible restrictions that inhibited access to engineering education for certain segments of the population.

When considering the first three phases, the excerpts from the book by S. Timoshenko (1959), the outstanding educator and engineer of Russian origin, will be often cited. After emigrating from the USSR in 1922, S. Timoshenko lived in the U.S. and wrote this book after he visited the USSR after the launch of Sputnik in order to get acquainted with the Soviet system of engineering education. In the USSR, this book was hidden from Soviet readers in special depositories, and was first published only in 1996.

Only at the first two phases Russian engineering education can be considered as in other countries where an engineering diploma is of value. At the first phase, when “the engineering profession is one of the most prestigious...and draws attention to” (Timoshenko, 1959), engineering education brought large career rewards. In 1913, the average engineer's salary was 10 times higher than that of an unskilled manual worker, and 2-3 times higher than that of a trained worker (Aref'evs, 2011).

At the first phase the existing social mechanisms were unfair from the standpoint of the least privileged and served the interests of the ruling classes of tsarist Russia. Thus, they should have been abolished. The Revolution of 1917 only expressed most strongly this standpoint and started the process to eliminate those ‘unfair’ social mechanisms. After that the prestige of engineering professions started to diminish gradually, as well as engineers' relative salary. Nevertheless, even in 1940, the average engineer's salary was still 2-2.5 times higher than that of an industrial worker (Aref'evs, 2011).

Restrictions at the last two stages, more precisely, the results of their abolition should be considered in a special, characteristic only for post-revolutionary Russia, manner. One such result at the third stage was the ever reducing payment for engineers' work compared to others, particularly before the collapse of the USSR. In 1985,

the difference in the average salaries of engineers and workers in industry was 10%. Often a skilled worker earned twice as much as a regular engineer.

With the disappearance of restrictions in engineering education its prestige and the motivation to earn diploma was gradually reducing until the phrase 'simple engineer' became synonymous with a 'loser'. Still Soviet engineering diploma had some value: it guaranteed employment to the holder, certain opportunities for development in the workplace, career prospects etc.

Now there are no formal restrictions to earn an engineering degree. Ironically, the new restrictions appeared – now with regard to *quality* education. Besides, diploma guarantees neither employment, nor large wages. D. Medvedev, the former Russian President, admitted last year: "each year about 200 thousand...earn diplomas in technical universities, but only 1/3...work in the specialty."

## 2. The Tsarist Phase: Higher Education for the Most Privileged

Although Tsarist Russia was an archaic type of state structure with the division of the population into hardly permeable social classes, it quickly progressed toward equality in primary and secondary education. In HE successes of democratization were less significant. Only a small percent of children from lower classes could get HE diploma, including the engineering one.

The averaged statistics for social origins of graduates from the major HE engineering institutions in Russia for 1890-1913 years were as follows: 26% of graduates were from the families of hereditary nobility, 23% - of personal nobility and senior officers, 4.8% - of honorary citizens, 6.4% - of the merchants, 21.6% - of the middle class and guilders, 4.8% - of peasants and Cossacks, 4.7% - of physicians, lawyers, artists, teachers, 0.8% - of foreigners (Russia, 1914).

From the standpoint of the least privileged the following retrospective social statistics for 8 Russian universities in 1914 also reveals clearly the class discrimination in HE: children of the clergy and bourgeoisie - 43.2%, the nobles and bureaucrats - 38.3%, the top of the kulaks - 14%, workers, peasants and working intellectuals - 4.5% (Elyutin, 1980).

Meanwhile, the engineering profession was very prestigious, highly paid and had high social status. Many engineers though not formally a military, wore uniforms and had military ranks; chief engineers were equal to army generals, etc. That attracted noble youth to the engineering profession, while for boys from lower classes engineering education could play the role of social lift.

On the verge of the XX century up to 10.000 students were trained as engineers (Rozhdestvensky, 1912), and their number grew very rapidly. In 1914, 23.500 students studied in 15 state HE institutions and about 2000 in the private ones. "The number of those...who wanted to get the engineering profession was much greater than the number of vacancies...[4-5 applicants for one vacancy, thus]...to select students usually HE institutions...used competitive entrance exams...students with high mathematical level were chosen...[also] students were selected on the basis of their School Certificates, but the requirements...were still very high...e.g., only applicants who graduated from secondary schools with a golden medal could enter the shipbuilding department" (Timoshenko, 1959).

An average training fee was 100 rubles (50 U.S. dollars) per year, while in the U.S. similar training cost an average of one thousand dollars then. At the same time poor students could study *free of charge*. Moreover, some of them could receive a sizeable stipend (up to 300 rubles a year).

Thus, not the applicants' poverty but their level of knowledge, especially in maths, prevented them from entering engineering HE. Thus, actually, *entry examinations* were the main obstacle for the representatives of lower classes whose parents could not provide them either genetically or financially with sufficient level of development. So, most students were from the privileged classes and outwardly it looked like a *class privilege* in HE, which caused the greatest discontent.

Gender restrictions did not cause so much frustration, although there was very small number of women in state engineering HE institutions (only 40 female students in 1914). For them, there were private institutions, for example, Higher Women's Polytechnic Courses in St. Petersburg.

Limitations on nationality were determined by quotas for representatives of national minorities and usually did not cause great discontent, too. Exception was the minority of the Jewish faith. With 10% of their quota within the Pale and 5% in the rest of Russia, they had only 3% quota in the Russian capitals and laid claims to a larger percentage.

### 3. The Bolsheviks' Phase: Higher Education for the Least Privileged

Once in power, the Bolsheviks called for the abolition of any discrimination, fees and social restrictions for applicants in HE. The 08/2/1918 Bolsheviks' Decree also abolished the *entrance test*: "Every person, regardless of nationality and gender, aged 16, can join...any HE institution without provision of a diploma, certificate or attests to post-secondary or any other school".

At the same time, the Bolsheviks declared the priority of the *proletariat*, on the assumption that "our power [i.e. dictatorship of the proletariat] can open the door [in HE] only for workers and working-class youngsters to be engineers, the commanders of industry" (Larin, 1924). Yet, workers not at once, as planned, poured into HE though after the Revolution, the World and Civil Wars the number of students reduced much and in 1918-1921 only around 1600 engineers graduated (Andreev, 2008).

Workers were not prepared "to be students, not only legally but actually, too" (Pokrovsky, 1922). In order to prepare proletariat and peasantry for academic studies, *Workers' Faculties* were created. They became the class educational institutions, a kind of "proletarian forge cad-ditch" (Vihirev, 1924).

In 1921, with the advent of '*proletarianization*' in HE a working biography became one of the main criteria for admission into HE. Proletarianization meant "involvement in...HE students from industrial proletariat, the real proletarians from machines and workbenches, factories, mills and mines" (Chelyapov, 1921). For long time not *student's ability* but his/her *social background* (from the working class or poor peasants) became the deciding factor for admission to HE (Ivanchikov, 1922).

Instead of entrance exams, the sending of entrants to HE by officials only – sanctioned by the [Bolshevik] Party, the Young Communist League or trade union organizations - was introduced, and admission without sending was restricted or closed. The sending organizations were obliged to be guided by the 'class principle' in the selection process. Yet, entrant's class status was controversial and depended on many factors: the record in his/her identity card, appearance (if he/she looked like a proletarian), strategy of behavior, the class ideas the entrance board had, etc (Fitzpatrick, 1991).

A 'wrong' student's origin could be corrected, for example, by his/her participation in the Revolution or Civil War on the Red side. Later, HE teachers' children were given the option to enroll, then children of those HE institutions' staff (they were called 'working intelligentsia'), then orphans supported by the State, then children of state employees, etc (Order of admission to students, 1923).

As a result, the idea of democratization – a good in itself idea - of admission to HE through the support that the State should provide to persons unable to get an adequate secondary education on their own, was emasculated. Many people with *little learning ability* or even with *no learning ability* started to abuse this idea in order to earn an engineering degree just to secure a place in the sun.

After the collapse of 1918-1921 the number of students began to grow rapidly again, most of them being from lower classes or even declassed. So, the Soviet 'mass production' in HE started, and in 1921-1928 HE institutions produced more than 10.000 engineers annually (Arefevs, 2011).

Having ensured unimpeded access for lower classes, the Bolsheviks deprived so-called 'bourgeois classes' of access to HE. "The Communist Government wished to have intellect workers sympathetic to communism, and...pursued in engineering HE institutions...the policy of class differences" (Timoshenko, 1959). So, the right to study in HE not only outwardly (as before 1917), but formally, too, became a '*class privilege*'. Such a policy meant the inversion of the pre-revolutionary outward discrimination, now against the ruling classes of the past.

Table 1 shows an example of how the class principle was applied to the quota of entrants in an engineering institution (Bezhit'sk Mechanical-Engineering College) in 1928 (Aksenov, 1967):

Table 1. An example of the class principle applied to the quota of entrants

|   |     |
|---|-----|
| 1) Moscow Region: metal-workers from machines   | 20  |
| 2) Western Region, excluding the Red Profintern (Professional International) plant: factory workers, farm laborers, the poor and middle peasantry | 30  |
| 3) Workers from the Red Profintern plant  | 45  |
| 4) Children of the Red Profintern workers   | 15  |
| 5) Children of Western Region professionals   | 10  |
| Total number of students:   | 120 |

The class principle included periodic 'cleansing' of students. In the 1920s there were four 'cleansings', affecting, if necessary, lower classes, too (e.g., cleansing Trotskyites). Students were expelled not only for political reasons (an alien element, political illiteracy) but academic, too (poor performance). For example, in 1924 350 students were expelled from the Leningrad Institute of Railway Engineers (nearly 20% of the total), of which 76 were workers and peasants (Konecny, 1994). 'Cleansing' involved searching 'alien elements' among educators, too. Often, in the revolutionary turmoil the zeal of the least advantaged led to misunderstandings. For example, Markov, the distinguished professor, was purged because was mistaken for a relative of White Guard General Markov.

Officially, 'bourgeois classes' were discriminated against until about 1936 when they actually disappeared and the new Constitution proclaimed the equal rights of all citizens to education. However, the declaration of equal rights did not mean their actual implementation. Children of the dispossessed, deprived of citizenship, 'enemies of the people' could not take advantage of this right. Even in the early 1950s when filling out the applicants had to answer such questions as: "What were your parents before 1917?", "What is your social origin?" etc. Discrimination in relation to some categories continued almost until the end of the USSR.

This does not apply to gender discrimination. Already by 1940, females comprised 58% of the total number of students in HE. In engineering institutions the percentage was much smaller, not because of discrimination but peculiarities of specialties. Yet, this percentage increased steadily, and in the 1980-s around 1/3 of engineering students were females. As for the nationality discrimination, it was peculiar, since representatives of ethnic minorities usually had preferences for admission to HE.

Trying to catch up with technologically most advanced countries, the Bolsheviks proclaimed the priority of engineering education, and the number of HE institutions grew rapidly with the number of students. In 1927 there were 26 HE institutions with 46.9 thousand students. At the same time the quality of education declined, "regular life in HE collapsed...the process of preparing engineers was quickly falling apart...children of workers and peasants often...were not able to perceive lectures...Workers' Faculties...had little success. Most students were not able to get proper training and were forced to leave HE" (Timoshenko, 1959).

"By 1933, most innovations had been abolished ... (including) special privileges for the children of workers and peasants, and the selection of students by ability was introduced again...after the chaos caused by the revolutionary experimentation...the traditional system was restored by the end of the 1930s" (Timoshenko, 1959). However, the above citation should be commented as a too superficial impression of the man who spent not much time in the USSR and was caressed by officials. In fact, despite the reaction of the 1930s, some revisions, quiet and fast 'cleansing' of 'Red professors' in 1936/37 etc., the traditional system was never restored, and engineering education never returned to normal.

The problem was not only that the manner and structure of teaching and curriculum changed, the main thing was that mental life in HE changed completely after the 'proletarianization'. HE institutions were increasingly crowded with people of quite another sort - the new admin, educators and students - very different from pre-Revolutionary. And as soon as the former spirit of freedom vanished from HE, the development of human spirit was determined here not by divine intervention but by 'Party and Government' decrees. Free development of creative talent was hindered and engineering schools could not grow in a natural way around outstanding engineers, as their development was not determined by the creative talent of those engineers, but by the authority of whoever was in charge.

Meanwhile, the 'mass production' of engineers progressed rapidly, both in the old HE institutions and in the ever-growing number of new ones. By 1940, the number of engineering HE institutions was over 150, and the number of students continued to grow rapidly with almost half of entrants from Workers' Faculties. Although the policy of 'proletarianization' was canceled officially, students did not change essentially. Having become agents of the Soviet regime, they lost traditional status and looked more like 'proletarians'. Student's life 'for himself' was replaced first by life 'for the proletarian society', then 'for the State' that imposed strict liability on students. For example: "lectures are strictly supervised, and students can be punished for any inaccuracy in attendance, as the right to get stipend depends on the regularity of student's work" (Timoshenko, 1959).

In return, students got material concessions, and one of the major was *state stipend* paid regularly since 1922 when it was announced: "stipends are available only for persons of proletarian origin, sent to HE by workers', professional and Party organizations". In 1940, more than 90% of engineering students got stipends of 300-400 rubles a year (the average employees' salary was 396 rubles then).

The status of graduates changed significantly, too. Having guaranteed well paid work, the new regime imposed strict obligations. "HE produced specialists who were expected to progress into corresponding occupations"

(Roberts et al, 2007), wherein graduates were allocated to (one semester before graduation) in accordance with the needs of specific organizations, and sent there as *young specialists* with no right to leave that place for three years. These "initial three years of their working lives in occupations and places to which they were directed" (Roberts, 2006) they not just worked but learned in the workplace *informally* (e.g., Eraut, 2004) and *in action* (e.g., Revans, 1982). That compensated for many HE shortcomings and helped even poorly educated graduates get professional skills, which significantly facilitated their development as industrial engineers.

#### 4. The Post-War Phase: Higher Education for Everyone Who Wishes and is Able to Learn

After a large reduction (2-3 times) in students' number during the World War Two and the first few postwar years the most prolific period for Soviet engineering HE started. Although engineering work little by little began becoming less beneficial, many youngsters still wanted to earn engineering diplomas and until the USSR collapsed the proportion of 'mass-produced' engineering students was never below 40% of the total number of HE students. "As a result of the rapid growth of students' number in recent years, the percentage of professors...is relatively low" (Timoshenko, 1959).

Now HE institutions could make a good choice among applicants. The high level of entrants was provided, first of all, by the high level of secondary education. Comparing it with the level of secondary education in the U.S. at that time, S. Timoshenko could justly write: "with our poor preparation in secondary school, we can hardly achieve what they have today in Russian HE institutions".

In addition, the state ideology managed to support in public opinion the high prestige of engineering work thus ensuring an adequate influx of applicants. Also, professional, scientific and technical inclinations of youngsters fostered in physics-mathematical schools, stations for young technicians etc., in addition to the high level of secondary education allowed forming a reasonably good body of applicants ready for admission to HE and study there.

"After...Sputnik...the whole world paid attention at Soviet...education" (Bodrova and Nikitina, 2011). Since then "technological achievements of the USSR [were]...recognized as stemming from their system of education" (Armytage, 1962), and "there [was] increasing interest in the Soviet education system" (Griffin and Bailey, 1994). Triumphs in the nuclear and space projects created for the USSR the image of a great technological power. "It was then that the myth emerged about the Soviet HE as one of the best in the world" (Kostyukevich, 2011) and the U.S. Congress adopted the Law "On Education for National Defense."

*Illusions* about Soviet engineering education ignored the price the USSR paid for successes in strategic scientific and technical areas, as well as special items and services that provided those successes (Kukushkin and Churlyayeva, 2012). As a result, such aberrations emerged as: "my impression is that...Russia almost completely returned to the educational system that existed before the Communist Revolution. The traditions of the old school were very strong, and engineering education destroyed during the Revolution could be restored with help of the remains of the older educators" (Timoshenko, 1959).

It was another superficial impression of a man out of the system. In the spirit and structure the system of engineering education did not change principally after the 1917 break-up of the educational paradigm and was fundamentally different from the pre-revolutionary one. "The remains of the older educators" had nothing to do, dissolved in a big mass of Soviet bureaucracy in education, Soviet educators always ready to execute prescriptions of the 'Party and Government' and Soviet students, always if not ready but compelled to inform the authorities on educators.

Almost till the end of this phase, on the one hand, a fairly strong motivation for engineering education remained, on the other hand, there were no formal restrictions of the previous phase. The only barrier to education again as in the first phase was entrance exams. Again they were the de facto limitations, especially for residents of remote villages, ethnic provinces etc, who usually got in secondary schools knowledge insufficient for admission to HE.

However, the Soviet regime offered special opportunities to this body of applicants. Having a non-sufficient level of knowledge, they could get a pass into HE through Workers' Faculties revitalized in many HE institutions and designed to align the potentials of all applicants at the level of big cities. Also, many companies sent their promising workers to study first at Workers' Faculties, then in HE, so that after graduation they could work in their home companies as engineers or managers.

In addition, for villagers and the former military personnel there were extra concessions. These cohorts could enter many HE institutions without any exams. Thus, although theoretically all were equal, actually, privileged contingents with low levels of knowledge still remained.

An important role in making the opportunities equal for all those wishing to earn HE degree played students' concessions and stipends which did not vary much but were always *comparable* to the subsistence level.

In the late 1950s "monthly stipend for a freshman is...around 300 rubles, and increases each course...(also) if a student has a high score...this suffices for a student to eat three times a day and live in a hostel because of very low rents...such a stipend is enough for a modest student's life...Textbooks are very cheap, and many students can afford to buy them. In addition, HE libraries usually have a sufficient number of required textbooks' copies" (Timoshenko, 1959).

By the early 1980s student's stipend at the graduation course reached the subsistence level (60 denominated rubles a month). Good students received 25% premium, and the excellent ones - an extra allowance of 50%. The proportion of students receiving stipend was about 80%.

Until the collapse of the USSR students also enjoyed many other concessions. Among them was low cost of living in dormitory (5% -10% of an average stipend), cheap meal in students' cafeteria (0.5% - 1% of an average stipend per lunch), reduced fee in public transport (often free); 50% fee discount for air and railway tickets, etc.

If bear in mind other social achievements of the past (free medical care, etc), these concessions allowed anyone, from any social stratum to study in a HE institution with minimal support from parents or even without any support. For some other categories there were additional concessions including free hostel accommodations, free meals, free milk, and even a certain amount of money when difficulties arose. Such benefits could receive, for example, students who got married.

Even more than in typical HE institutions students enjoyed concessions within the so-called *integrated training system* (Kukushkin and Churlyeva, 2011) known since 1906 in the U.S. as "Cooperative Program" (Smollins 1999). Within this system students also enjoyed social privileges and guarantees of employees; their period of work during schooling was added to seniority, etc.

Those who could not study *full-time*, could use "the evening and distance learning...[for] students working in the industry" (Timoshenko, 1959). In this case, however, applicants were restricted to apply to their nearest HE institutions and their work must go with their training in HE.

Other very few (sex & health) restrictions were only for few particular specialties. Also there were restrictions for admission to HE institutions affiliated with the military-industrial complex -- for those who in case of emigration might transfer secrets to foreign countries. Those were mainly persons of Jewish or German nationality many of whom emigrated at that time to Israel and Germany.

If ignore those few restrictions, at this phase HE could be characterized by a stable democratic infrastructure which provided equal opportunities for all who *wished* and were *able to learn*. Around 30-35% of engineering students were children of workers; 30-35% - of teachers, doctors, engineers etc; and only less than 10% were from more advantaged strata (the party bureaucracy, higher managers, etc.) The rest of the student body was formed by villagers.

At the same time inside of this infrastructure an antidemocratic trend developed. It was born in Moscow and gradually spread throughout the country. HE diploma was becoming the main passport into the power which itself was comprised either of older individuals without HE diplomas or younger ones who earned diplomas at the previous phase due to their *social origin*, not *abilities*. And they began to organize round ways into HE for their offspring, if those could not pass entrance exams.

One of those round ways was *patronage*, the other - *tutoring* when the tutors were the same HE educators who then provided their customers with easier pass into the HE institutions they worked in. Those round ways were useless in elite engineering HE institutions (MEPI, MHTS etc.), where students with little learning abilities would be expelled after the very first semester. Yet, there were many ordinary HE institutions where offspring of the local elite could effortlessly earn diplomas.

##### **5. The Current Phase: The Indigent are Taught by the Poor**

If to formally consider the evolution of restrictions in HE, apparently notable progress was made. Firstly, there are no more restrictions of the past. Secondly, one can now learn several specialities at once. Thirdly, from anywhere in Russia one can apply to any HE institution or several institutions (all but few now bear the label of 'universities') at once, and the admission takes place without his/her participation according to the assessments made in secondary school, which theoretically provides equal opportunities for all, etc.

Many people believed "that in the new market economy it will be more important than formerly...in terms of career rewards, to become as well qualified as possible" (Roberts et al, 2007). As a result, from 1989 to 2009 the

total number of HE students increased by 2.6 times - up to 630 students per 10 thousand of the population, which is more than in developed countries. In the situation of "the massive expansion of HE...[administration] extended fee-charging and opened the doors of technical universities wider for economics...banking...law...other new prestige subjects" (Roberts, 2006) and "engineers soon ceased to be the typical products of HE" (Roberts et al, 2007).

Engineering professions lost prestige completely and the most popular became the job of a banker, bureaucrat, etc. Thus, applicants who are good enough in mathematics and science, easily enter a technical university and choose not an engineering specialty but a more prestigious one, e.g., economics or law. Also, since admission to free budget engineering specialties is residual, many engineering students study simultaneously for a fee in other professions (economics, law, etc.) which is didactically unacceptable. The total percentage of engineering graduates drastically reduced from 42% in 1988 to 22% in 2008, whereas the proportion of females among them increased - from 32-38% (in various specialties) in 1991 to 40-50% in 2005.

Meanwhile, the new restrictions emerged with regard to *quality education*. Built within the planned economy matrix and adapted to service its needs, the Soviet system of engineering training would inevitably degrade after the planned economy collapsed. Yet, its current miserable state came to be largely dependent on the educational policy and general strategy. The education quality deteriorated much firstly because "centralized financing of research has decreased [from 1991 to 2005] by more than 30 times in comparable prices" and "since 1991 the renewal of [technical] universities' teaching and laboratory equipment practically stopped" (Smolin, 2004), with "the sorry state of the libraries...limited access to modern equipment...buildings coming to ruins, etc" (Aparina, 2008). D. Medvedev, the former Russian president, admitted last year: "courses and research bases of [technical] universities are out of date"

As "Russian educational standards...continue to deteriorate" (Education Ministry RF, 2010), around 1% of the population -- the rich and super-rich (people mainly from or around the former Soviet elite) -- prefer their children to study abroad. The still unformed "embryo of Russian middle-class (in the Western sense of the term)" (Zaslavskaya, 1997) strives to follow them in hope that their children would get quality education there, too. Yet, the majority of the rest (around  $\frac{3}{4}$  of the population) long ago were deprived of Soviet social benefits and "were pushed beyond the line of poverty and even below the destitution threshold" (Zaslavskaya, 1997). Thus, a significant part of not only Russian students but HE teachers, too, come under the category of poor or indigent, where the new restrictions are active due to many factors. Some of them are mentioned below.

Students' stipends (not paid to all students) are far below the subsistence minimum, while the income of their parents usually barely exceeds it. The introduction of tuition fees makes the situation even worse. Although by no means all students pay for education and fees are much lower than in prosperous countries, many students have to undertake part- and full-time employment, leaving them little time for study. Working full-time students can not learn adequately. What is worse, their current jobs as a rule, are not related to their future profession, so that gaining work experience in areas not related to their studies is usually of little use.

"The attempt to shift the financial burden from the budget to nonbudget funds...has become a common practice. It destabilized the socioeconomic balance in HE, making it inaccessible to young people from low-income families" (Russian Federation-HE, online). At the same time, the new rules for admission based on the results of the Unified State Exam means that anyone can be accepted in HE either accidentally or by fraudulent means. Thus, the learning ability of students declines due to the low level of the applicants, especially on account of the deterioration of secondary education. In the PISA 2009 study, Russian pupils took only 38th place (24th place in 1999) in math's literacy and problem solving. The study also found out that 71.5% of them reached only the 2nd (threshold) level of 6 levels, and the proportion of gifted children (who can solve difficult tasks) was only 5%.

The quality of educators deteriorated, too. In particular, "since 1991...more than 300 thousand most qualified scientists and educators left HE institutions, some of them left Russia" (Smolin, 2004). New people, often not necessarily qualified for the post, took their places. "HE is experiencing a dramatic shortage of qualified specialists" (EACEA, 2010).

"Low salaries and lack of social protection have significantly lowered the prestige of the teaching profession" (Larionova and Meshkova, 2007). Due to low wages many educators have to work in several (often 3-4) universities at once – actually "run shows back and forth between different HE institutions to increase their income". Worse yet, some educators supplement their low income with bribes from students and applicants: "accusations of widespread bribery in grading and admissions [are] rampant" (Ritter, 2005). Even the best ones can not "do a little more than is required for teaching their students" (Lucas and Nasta, 2010) - consult students, educate themselves, monitor scientific and technological progress in the areas they teach, etc. Instead, they have

to spend much more time than before on senseless reports for the growing army of HE bureaucrats - continually changing and filling so-called 'working programs', 'working plans', 'graphs of the educational process and students' self-education', 'students' ratings', 'didactic-methodical complexes of courses', etc.

## 6. Conclusion

After the destruction of the tsarist engineering education, the Bolsheviks at the price of enormous efforts -- literally sweat, blood and tears -- managed to create a unique system of *mass engineering training* within the planned economy matrix. In due course in that system the dream of the least advantaged -- to earn an engineering degree without any restrictions -- seemed to come true. After the USSR collapsed that system started to deteriorate together with industry, and instead of the former restrictions the new ones appeared -- now with regard to quality education.

Besides, having chosen the course towards a raw-material economy, Russia was doomed to the role of a raw-material resource for other nations which means no serious motivation for engineering education. And as Moscow reformers in HE try to join the Bologna Process, in practice, their so-called 'reforms' will only mean "the final breaking down of the Soviet system of engineering training created within the planned economy matrix and essentially incompatible with either authentic market or what is understood by market in Russia" (Lukyanenko et al, 2012).

In 1959 the "weakness of [American] engineering training [was]...obvious, so in order to offset this shortcoming many large industrial companies...such as General Electric or Westinghouse create[d] their own engineering schools where engineering graduates from HE...receive[d] further training in selected areas of engineering" (Timoshenko, 1959). Nowadays in Russia, too, one can only hope for more or less effective training of engineers within the systems of *continuing professional training* that exist at industrial corporations involved in innovation. A good albeit rare example is the Information Satellite Systems Joint Stock Company - Russia's leading Space Company specializing in design, development and manufacture of high performance spacecraft and satellite systems (ISS JSC, 2012).

Here engineers are prepared through the 'School-HE-Company' chain with pre-education (in affiliated schools, colleges etc), pre-selection of promising students, training targeted students in affiliated HE institutions, and training engineers in the workplace - all interconnected and controlled by the Company. The positive features of this system remain inherited from the Soviet epoch, with many benefits for those who wish and have the capacity to learn by allowing them to avoid the many shortcomings of current higher and secondary education (Churlyayeva and Kukushkin, 2013).

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