ON THE REFORM OF ENGINEERING EDUCATION

Transcript of the report at the ordinary meeting of Polytechnic Society, January 17, 1915

ABSTRACT

Vasily I. Grinevetsky (1871–1919) – Russian scientist in the field of heat engineering. In 1896 he graduated from the Imperial Moscow Technical School (hereinafter – I.M.T.S.) and stayed to work there: since 1900 – professor, since 1914 – director of the School.

As a scientist V. I. Grinevetsky investigated workflows occurring in steam engines, boiler units and internal combustion engines. In 1905, he developed a scheme of boiler thermal calculation, based on correct understanding of heat transfer processes, and in 1906 – theory of economic calculation of a working process of a steam engine. For the first time in the world in 1907 he offered thermal calculation of internal combustion engine still underlying design and analysis of workflows of these engines. Important works were devoted to locomotives. He presented the project of transformation of Moscow Technical School into a higher school of polytechnic type. That meant in fact the reform of engineering education in the country.

Keywords: history, engineering education, technical school, prospects of development, connection with practice, academic structure, reform.

When you have to anticipate a number of years in advance, then, completely ignoring the prevailing public body, it can be predicted much easier and with more confidence than for a Russian engineer ... This is a sore point, but it is not preventable. There is no doubt that if foreign technicians turn to solution of organizational problems in our country, they often get trapped here, because they do not feel enough and take into account our local conditions, economic and technical, then uncertainty and instability of these conditions. It is hard to think that a foreign technician, not familiar with the Russian situation, being in Russia for the first time, could give even with his great technical experience the best solution of organizational problems than the Russian one, though, if we talk about our technicians, they can be assigned the well-known lack of experience, and, maybe, limitation of a technical outlook. It is a perfectly natural consequence of the fact that our technicians had less to deal with an independent full responsibility for the technical work; they had in some ways to create their own, but mostly – to deal with the ready-made solutions. Undoubtedly, the entire scope of technical activities had to affect, more limited in our case. Of course, some very large-scale development of the industry provides a large field for development of capacities than industry of a limited scope. It is clear that at this point in organizational tasks, we had to experience some lack of broad technical outlook of our technicians, a certain lack of experience, and this is combined with insufficiently studied local conditions, economic instability, of course, made organizational tasks more difficult and most poorly resolved in the Russian conditions.

What prospects should be foreseen for the future? Undoubtedly, if your industry is destined to achieve greater autonomy, it should extend its tasks to new areas, and organizational issues are in the foreground here, they are very important, because the matter, organized on erroneous principles, under any circumstances cannot stand firm. Therefore, the prospects for the future emphasize organizational problems not only in the development of new businesses, but to some extent it is necessary to think about the emergence of new industries, such as production of chemical colors of mechanical engineering in some sectors etc. This, of course, brings great difficulties in the tasks organizational nature. Then, for the development of production, an existing one, issues of an operational nature arise, and partly of organizational, although the latter is not as free as the organization of a new production. Then, with the tasks of an organizational nature combination tasks and finally structural problems, especially in the field of mechanical engineering and construction business, are closely linked. All these problems in the development of our industry in a known manner have to impose the requirements for technicians, so, of course, the responsibility of Russian technical tasks has to grow in all types of technical problems and, in particular, towards organizational objectives. Is our training of engineers, our technical education entirely at the level of these requirements? In this regard, we need to look at what we have, how the existing environment can meet the requirements of scientific equipment, which have to be considered as something inevitable-reaching, and the special requirements that arise in connection with the new prospects of our industry.

If we talk about the Russian schools, here we can emphasize only some things. At the Technical School can be seen a certain account of changes in technique in curriculum: a change in teaching in 1906 led to introduction of special courses of a combination nature, for example, course on boiler systems, thermal power stations, electrical installations, then course of partly an organizational nature concerning organization of production on metal technology and fibrous materials. Generally it led to teaching specialization, a certain freedom in this direction, but rather in the form of well-known capacities that, in general, did not allow restructuring of the matter. At other schools these small changes have hardly been done, and some programs remain untouched for 10 years or more. Undoubtedly, that at our school a little has been done and in general, it is not systematic and has a character of well-known add-ons, supplements to the already existing situation and not its restructuring. Here we have to note not only backwardness of technology requirements, but also quite serious retardation from the leading schools of the West, especially some German schools. Why does this happen? How can it count on change?

If we talk about the teaching contingent, it should be noted that our teaching contingent is very small in number compared to those that can give the German Technical School. There one teacher accounts for 8–10 students, rarely more, and at our schools one teacher accounts for 20–25 students: the number of teachers is twice less. The lack of professors is even more significant. In Germany, if you take the average figure, we have 25–35 students per professor at the Petrograd Institute of Technology – 80 students, in I.M.T.S. this number ranged from 160 to 120. These comparisons speak for themselves, underscore that the interaction between teachers and students, which should serve as a field for development of the latter, at the Russian technical school is significantly reduced. Russian school does not have enough teaching forces. Then we have to deal with the overload of work of the teacher, and hence inevitably develops lag in technology and well-known

pedagogical routine. This congestion is caused not by a lack of personnel, but also meager reward for the majority of activities, extremely backwardness of staff.

I must admit that our teachers have to carry a heavier work than it is at foreign schools. Then, it must be noted that the relationship of the teacher with engineering practice is weak and random. Is it important from the point of view that I express? This, of course, is extremely important, because only proximity to life will allow to catch new trends and allow the use of new technical material, since literature, even the newest, does not provide the new; it gives only what is fixed and what is new, what is just going on, has not appeared yet, it is possible to capture only through direct contact with practical activities. However, we should speak of the fact that it weakens technical orientation of teachers, because Russian equipment does not suffer from the desire to report all of their work in the literature; it is possible to get only part from the literature; from the contact with practical activities can be found much more. In fact, Russian teachers, who are cut off from practice, have to lag behind to a greater extent than the teachers, who are closely related to it. For teachers who are not connected with practical activity, the main source is foreign literature, which hardly deals with the special Russian interests; this entails a substantial weakening of vitality of teaching and technical backwardness. Then a very strong impact is the difficulty of conducting research, caused by teaching congestion, and that laboratory is overloaded. Sometimes with great difficulty, you can put the work of a scientific nature, interesting for a teacher, sometimes it is even possible to find a room, but you cannot find money: the laboratory is too poor. Finally we have to say that staff for these scientific works is often also more or less available, that those individuals who work in the lab, so burdened with educational work that cooperation in scientific work is not always possible. Literature is also one of the factors of scientific work, and this main factor is also weakened. If you look at the conditions of training of our scientific forces, there are, so to say, degrading factors. These factors are unsteadiness of academic structure, and then see the effect of a local nature, complicating the matter. In this regard, you can draw a sharp difference between the schools of the capital, which are less affected, and provincial, especially so remote as Tomsk Technological Institute. There is no doubt that in this area we have still a lot of defects of a purely local character, which must be fought and that impede development of our technical schools. It is possible to build a technical school anywhere, but to put it so that it meets all the requirements, is not possible everywhere in Russia. It definitely shows the history of provincial schools.

From the point of view of our school teaching staff we must admit that we have a lot of disadvantages, which are still difficult to cope with, in part it is possible to fight against them, but they still very much influenced the situation of our school matter.

If we talk about our training structure, we can give even more disadvantages, but these disadvantages are still generally represented so terrible, because evolution can change quite quickly some of the adverse sides. But it is impossible to get teachers on demand, suddenly. Change the operating mode of teaching we have, once significantly enhance teaching tools – this problem cannot be solved quickly; prompt decision can only be bad. Issue of educational system is a question amenable to rapid evolution; although there are many difficulties and some are purely archaic, ... still some chance to correct it, than for a quick refreshment of academic staff. If we talk about shortcomings of our educational system, encyclopedic nature of our programs should be put in the foreground. In individual subjects and the aggregate of all subjects that are mandatory, it is, in any case, beyond the pedagogically reasonable limits, and that teachers always have to assure themselves. Undoubtedly, for each individual subject in the scope of our programs known temporary digestion is possible, but not solid, thorough; actually we obtain knowledge to a much lesser extent than the school is trying to put in its program, so from this point of view in our training plans and programs there is a lot of excessiveness, subject to substantial revisions. Encyclopedic nature, both within each branch, in particular for a large number of those branches, to which our attention should be divided is a disease that must have known better days; it is a matter of time, it may not be particularly long. Lack of coordination of different programs and, therefore, unproductive academic work is a factor that is also easy to overcome because the object scattered into many hands will inevitably lead to such inconsistencies, it arises due to purely accidental circumstances – as far as teaching was developing new subjects grew gradually, were added to the the old –and in part may be because here it is necessary to consider the complexity of the Russian technical conditions.

Then we have to note that our schools, in general, are affected by the fact that the basic subjects, scientific are insufficiently linked to technical subjects, which are based on them. Taking into account all that we have, we have to reproach our curricula in sufficient immobility; it is a natural consequence of our technical and academic backwardness and the external immancles that are holding school plan. There is no doubt that to achieve any programmatic changes at one time was extremely difficult; then a well-known relief came. Now ... it's also pretty hard, so that the immobility of our plans is the result of some internal conditions, and partly the effect of our technology, and partly the conditions associated with organization of central departments. This immobility of the plan, of course, fits very bad with the need to fairly rapid evolution, which is required by modern change in technology tasks. It is such a fact, which should be seriously considered when reconstruction. This immobility of plans brings to the pedagogical staff known routine, and in turn to a greater extent immobility of plans rests on this routine. Fear of touching that evolved over the years, leading to what we do not have enough pulses inside, enough courage to take up resolution of problems of changing educational system and the curriculum. As for the form of educational system, whether it is a form of objective system or form of course system, in this respect, it would seem, the western schools give various examples. Can we say that this or that system is, of course, necessary for the technical school at all? It would seem that it is impossible to put the question so categorically. In Russian conditions, which system is more suitable? In this regard, accounting of the examples of the West without sufficient proof, perhaps, it will lead to the wrong soil. We are old enough to see own situation and from it to make corresponding conclusions. From this point of view, the question of educational system in terms of educational system has to be considered and we have to say that the rapid evolution that is required by our educational matter, did not fit into the framework of the course system, and only with the transition to subject system teaching got a possibility of known evolution.

What could be the tasks of necessary evolution of our engineering education? I would like to dwell on this only briefly, not to obscure with my subjective assessment a wider and comprehensive discussion. If we talk about our educational system, about what is to be considered, what is to be done, first of all, we have to speak about the elimination of the congestion in the classes, which exists actually. Then, we have to speak of a solid mastery of general scientific subjects,

strengthening of technical training, its development in new directions required by the evolution of technology problems. Then we have not only to think very seriously, but also to conduct training in the economic sector, because it is impossible to imagine an engineer who wants to become a practical figure in future, without well-known economic training. However, under these contradictory requirements we have to still talk seriously about a real reduction of some duration of the course, which allowed in a shorter time to complete it. These requirements are contradictory to each other so that it can be difficult to think of their feasibility, however, it certainly needs to be done. Life pushes in all directions; it requires a greater vitality of general scientific training, so that we can talk about more use of appropriate methods and knowledge; it requires a certain course reduction because people should always go with fresh vigor in practice. So, first of all, it is necessary to note a better mastery of what gives the school and more comprehensive development. One way is, of course, specialized technical education, carried out much more deeply than it was carried out in our schools so far. This condition is sufficiently recognized by the western technology, and this, of course, is required by our large-scale industry. Under these conditions, you can get a specialist ready in theoretical and practical direction, as he had learned to work independently in at least one special area, and then he will be able to specialize in new directions without difficulty. It is quite difficult to get specialists in this quest from persons smattering all, and in practice it is necessary constantly to make sure in it.

There is no doubt that when restructuring our educational system we have to take into account other major difficulties. Firstly, we have to reckon with our educational routine, which had enough field for its development. First of all, we need to deal with ourselves, to fight with «specialism» of teachers. Each teacher, the more he specializes, the narrower horizon he gets in the end, the less understands he another person, the greater importance gives he to its object. During revision of the program it is always difficult to make terms with specialists concerning concessions or other parts of his teaching. Programs should be considered in more general terms. After these internal constraints we have to reckon with external, primarily certain not set state of our technology, poverty and formal connectedness of schools, so that any changes in teaching require different statements that are not necessarily competent on the merits.

Then, it must be noted that the very task of changing the educational system is not clear for schools, at least in some schools, the well-known tendency in this direction is evident, while in others it is not. This is a major difficulty. At a time when the consciousness of schools, as a whole, will include the idea that the teaching technique need to be restructured radically, only then the case will go fast enough in life. The school has a right to expect certain external assistance. In this respect, it would seem that profile among engineers who have completed a course at the school, which sets definitely enough questions about the degree of mastery, about the extent of the use in practice of those or other knowledge, fundamentals of technical development, could provide a lot of this, what academic leaders may not have as an objective conclusion. They can guess many things, they see a lot on individual cases, but in general, systematic form they do not imagine the situation. Then, when the development and changes in the educational system will have a concrete form corresponding to the response of academics and practitioners, it would be possible to arrange a certain questionnaire among industrialists, but, we can expect the breadth of views in this environment less than among technicians-practitioners. In any case, the issue of educational system – the question is very difficult and very wide, which is not amenable to quick resolution, but one with which schools need to deal first to have a clear idea about the tasks, corresponding requirements of modern times. Then there is another issue related to educational systems, conditioning it to a large extent. It is a question of what is the end of education. We can talk, of course, about the diploma entitling or not, but it's still in life, I must admit, the issue is relatively minor, because the more graduates of the course are in the industry, rather than in government or public service, the lower value gets a diploma. There is no doubt that it is now often the personal recommendation of one or the other teacher in industrial areas, to which more importance is given than the form of the diploma with which a young engineer is on his first practice, so that in this respect the diploma disease, which our school is certainly suffering, should not be exaggerated. But that's what it would be desirable to note: Would it be correct to form our technical education so that it all comes down to one end, to one degree with that the matter would have ended? I think it is deeply wrong. Firstly, our student body is highly variegated in respect of requests that it brings with regard to abilities that he has.

Then life requires very diverse in their development and training of technicians. In Germany, a trend towards a reduction in the number of technicians with higher education is quite strong along with the desire to use secondary technicians. Is this situation correct for Russia? This question deserves serious discussion, and I think that this decision in the German way is not suitable in our country. I think that we have a quite large thirst for higher education, and it somehow has to find a satisfaction. It is clear that a technician may be not a very wide technical-minded, but with a higher education, provided that he has sufficiently learned to work, and he will cost more than the average technician in the field of small and medium industries, in terms of our municipal services, in district affairs. In all of these relatively simple industries the activity can be not very deep and not very technically independent, but some must be independent in the sense of business management. If we imagine a well-known real reduction of program and duration of the course, it may well ensure what, in practice, is required from most of our technicians and engineers, but it is not enough for those who are naturally inclined to a more independent attitude. There is no doubt that in the field of pure science, and in a more practical, the school can give enough satisfaction to these aspirations, these individuals, and I must say, in practice of I. T.S., it is well within our capabilities and in our facilities. Among the engineers graduating our course there is now much more diversity in the degree of preparedness for future activities than it was before. It is quite natural in terms of subject system operation, and I must say that those most independent, most working reach such results, which often the German school covers with a diploma «Doctor-Engineer». The development of school teaching in the sense of deepening in the scientific foundations, greater specialization in technical subjects and more inurement to independent creative work in the areas of theoretical, experimental and constructive – all this is quite achievable for us, and is very important for development of the industry, and at the same time meets certain demands of a large part of the students. Would such a second stage be associated with the first.

...Technical schools serve known certain requirements of life, and these requirements should influence in a known manner the development of the school. What forms of influence may turn out? – It is a question not easily resolvable, but I think there is a possible solution. How widely it is necessary to conduct this impact or how meticulously – it is also a significant

issue that should be discussed. With regard to the forms in which the effect can be shown, it is possible to wish for the schools themselves, and for their teachers and students greater connection with the practical techniques. The means of connection should be practical activity of teachers; from my point of view, this is an indispensable condition. Then the technical practice of students is also an essential condition that must quickly process our raw material. When a student encounters with diversity of technical environment and well-known diversity of completeness and rigor of practical technical requirements, he regards otherwise the school and its requirements. Very bright picture in this direction can be observed by students who came to the technical school from engineering practice. There are such persons now; they are units and tens, but we have to speak very differently with them on many issues than with the students, may be, very capable, but not affected by technical practice. Value of engineering practice, when students are the raw material, may be even more for Russian than German schools, which draw great attention to this side. How the school will be able to achieve a known interaction, force to start closer relations with practice, to make the practice more widely go to meet the requirements of students' works – depends, of course, on many reasons. One factor is quite a serious assessment of this issue on the part of industry, and on the other – quite a serious preparation in this direction on the part of the school. With development of special training and a greater preparedness of students to the technical environment, it is necessary to think that the industry and practical technique increasingly accommodate our schools. But we must not lose sight of what it is necessary to achieve it, and this could be one of the tasks of the interaction of academicians and practitioners.

If we talk about the situation of students, it is very difficult to struggle with many things, but, for example, the material question, seemingly, was not subject to certain regulation. That principle of recurrent benefits, that was pretty consistently put into practice by some welfare societies, seemingly, it would be correct and quite consistent to conduct it in respect to all state-owned scholarships. Return of benefits under the same favorable terms as a return of private benefits, would have given the school the funds that would have brought it to a completely different way. For example, our Welfare society for 20 years has granted about 250 thousand., has already received back 90 th., some more truly in practical life have developed a skill to a persistent, systematic work. Without such a systematic hard work, without the ability to it a little can be achieved, and this is a serious disadvantage of general education, which all need to try to overcome.

If we talk about evolution of secondary education, of course, technical school had no right to impose any specific requirements, once it comes to general education. But the well-known effects in this direction are possible, and the strengthening of real education is a natural outcome; strengthening of mathematical and graphical training in the same way is an essential element of purely general education on which we can insist; respectively, for all of modern life it would be quite reasonable. How much in this respect it is possible to influence the school, it is a problematic question; we have to reckon with this particular situation, rather disappointing. If we talk about the skills, the development of which should gain the student from the high school, it would seem – it is strange, but in fact this is the case – the biggest drawback is felt in the skill to a systematic and independent work. It is a task that is the most important educational task of secondary schools and from the poor performance of which a higher education has to suffer. Technical work requires this systematic character, responsibility, independence, and a student who comes to the technical school in this respect is still largely a raw element, even in the most basic: arithmetic. To teach a student how to count accurately – is really a serious task that falls on the higher school just because high school is very lame in this regard. In the same way, too, adequate training is required in the field of systematic work. The element that comes to higher school, is extremely diverse. You can talk a lot about the difficulties of our program, congestion of students but the fact remains that people of average ability, financially unsecured, carry our sometimes complicated, overloaded program of a more normal 5-year period, but in any case, it factor, perhaps, does not have such a decisive importance.

If we touch now the question of the direction in which changes of general academic structure are needed, then, of course, first and foremost, certainty is necessary; only within certain limits, you can really live in peace. What are these limits, whether they are large or too tight? – This should depend on the purpose of the school. Technical school performs well-known tasks of national importance, expends considerable resources of the state, performs the task not only of scientific, but also practical nature. In any case, in its educational activity, it must have a certain degree of independence. From this perspective, academic autonomy is a practical necessity, but it must be under certain specific control. And how this control can be carried out? This control should be centralized in a known manner, because it has to bring some unification that will not be achieved with perfect freedom in the field. Those forms of control that existed earlier demonstrated sufficiently their unreality and lack of credibility. Vitality in regulating technical education cannot be expected even with the best direction of bureaucratic control. It would seem that in this respect a certain uniting organization that would combine in itself representatives of higher technical schools, representatives of practical engineering, technical and industrial organizations with a certain participation of administrative entities, could provide better control over the activity of technical schools than it is available now. It would give a certain form of control, without which, apparently, cannot do, but a more one.

In what direction is it possible to act in order to make it all? It seems to me, first of all, we need more preparatory work to the school inside itself become aware of and execute its tasks. Then of course we must have a certain preparation of public opinion and the authorities, which will influence the change of the matter in this direction. The issue of such training is not necessary to put right now; the center of gravity of all the interests of the country is now in a different direction, but internal training at school and among technical practitioners should go now. My report was designed to give a well-known impetus in this direction.

Grinevetsky, V. I. Transcript of the report at the ordinary meeting of Polytechnic Society, January 17, 1915. On the reform of engineering education. Moscow, Typography-Lithography of Russian Engineering Society, 1915, 22 p. (The text in abridged version is printed on the basis of the edition, prepared by V. K. Baltyan, V. K., Molotilov, V. A., Petrakov, A. S., Bauman Moscow State Technical University).

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