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## **AC 2012-4749: CHALLENGES OF CREATING A NEW ENGINEERING EDUCATION MODEL IN RUSSIA**

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# **Challenges of Creating a New Engineering and Graduate Education Model in Russia:**

## **Part 1: Formation of a New Degree Structure**

### **Abstract**

The engineering education model in the Russian Federation has its roots in the Soviet system of higher education where students would study for 5, or even 6, years according to a very strict pre-determined curriculum which earned them a diploma of engineer in a narrow area of specialization, e.g. polymer engineering or petroleum engineering. Today, after signing the Bologna agreement which is aimed at standardizing the rigor of the bachelor and masters degrees in Europe, the Russian Federation is transforming its system to meet the requirements of the declaration. Universities are developing four year bachelor curricula and two year masters curricula. This implies a restructuring of the sequence and content of courses which will form a new generation of engineers having a solid foundation in engineering principles plus the soft skills needed to meet the challenges of this global world. This paper concentrates on the development of a new engineering education model in Russia and the challenges that universities face in this process. Areas where the best practices of the U.S. engineering education system could benefit and shorten the process are suggested in the future.

### **Background**

In 2004 Russia agreed to the Bologna Declaration on the European Space for higher education, more commonly known as the Bologna Agreement<sup>1</sup>, which required significant new challenges to the Russian engineering education system. Prior to 2004, the Soviet system (and subsequently the Russian system until 2004) of University education was one-level. The Russian study plans were for 5 or 6 years at the end of which the graduate received a diploma of higher education and qualification as a specialist. The diploma could say: "Mr. X studied according to the specialty of Technology of Processing Plastics and obtained the qualification of Chemical Engineer." This degree encompassed the material that the American system would include in a combined bachelor and masters degree program. In particular, the Russian system did not have an intermediate degree such as a bachelor degree and had only one type of degree, that of specialist. These specialists were qualified in chemical engineering generally and had training in particular specialties such as in plastics, or synthetic rubber, or cosmetics, or high molecular weight compounds, or organic compounds of nitrogen, or treatment of fur and leather.

There was a huge list of over 200 specialties approved by the Russian Ministry of Education. Each specialty had its own federally defined educational standards centrally approved by the Russian Ministry of Education and all universities were required to follow these standards. Seventy per cent (70%) of the curricula for all disciplines taught in Russia were predetermined, and had to be absolutely the same. The remaining 30% of the curricula could be developed by the universities themselves though in many cases they were the same as well. The common thinking was that a graduate of this type of program was a well trained specialist, and was immediately ready to work and contribute to the work of an industrial enterprise.

## **New Engineering Degree Structure**

Since Russia entered the Bologna process in 2004, all Russian universities had to transition to a two stage degree system resulting in dramatic changes. From 2004 to 2010, universities could attract students both for the specialist degree program (5-6 years) and for a bachelor degree program (4 years). Moreover a masters degree program was introduced for which enrollment was allowed by graduates from either the specialist degree or the bachelor degree. In 2010, the transition was complete permanently eliminating the specialist degree leaving only the bachelor and masters degrees (referred to as the “two-level system”)

As in the previous one degree system, federally defined educational standards were set. However only 30% of the curriculum was compulsory and 70% of the curriculum was left to each university to determine. The bachelor curriculum is shorter by one year and requires a broader engineering foundation. Engineering professionals are being educated for wider opportunities without specialization in any specific application of the discipline, for example, general chemical engineer.

## **Comparison to Typical American Engineering Curricula**

Figure 1 displays the various curricula being considered in this paper: the three Russian degrees (specialist, bachelor and masters) from Kazan National Research Technological University (KNRTU) and three typical examples of American curricula for comparison. The authors realize that there exists considerable variation among American curricula but hope that the general structure of the curricula selected is sufficiently representative to facilitate comparisons and useful observations. Several observations are quickly apparent:

- 1) Regardless of degree, the number of instruction contact hours for a degree program in Russia is considerably higher than comparable degrees in the American system. American bachelor degrees are in the 120-130 credit hours range compared to ~220 contact hours in the Russian system. The authors realize that contact hours are different than credit hours. The hours included in Figure 1 are also a mixture of lecture and laboratory for both Russian and American systems. It has been assumed that the relative mixture of lecture/lab is approximately the same in both programs and the distinction between contact and credit is not a factor for this high level comparison.
- 2) A masters program in a typical American system is approximately 30 hours with a significant portion of the program covered by a thesis if required. The Russian system also requires a thesis with almost twice the number of course hours (66 vs. 30).
- 3) In both the older specialist degree and the new bachelor degree, the Russian system requires a project in industry (the equivalent of a short COOP in the American system), plus the equivalent of a significant senior capstone project. The result is an emphasis on practical experience in the initial degrees that is not always present in American programs.
- 4) A typical requirement in the Russian system is a foreign language proficiency which is not universally required in the American system.
- 5) One of the reasons for a larger number of course hours in the Russian system is a more extensive focus on a foundation in mathematics and science (80-90 vs. 30-50).

	Breakdown of New and Old Russian Curricula			Breakdown of Typical American Curricula		
	<i>Chemical/Petroleum Engineering (equivalent credit hours)</i>			<i>Electrical and Chemical Engineering (equivalent credit hours)</i>		
Degree Type	Original Specialist	New Bachelor	New Masters	Bachelor	Bachelor	Masters
Duration	5 yrs	4 yrs	2 yrs	4yr Electrical	4yr Chemical	
Social Sciences- (General Education)	49	40	10	30	31	
Mathematics/ Sciences	95	79	5	32	47	
General Engineering (core)	56	98	17	26	43	9
Specialized --Electrical Chemical Engineering	31	0	34	35	6	21
<b>Total Equivalent Credit hrs</b>	231	217	66	123	127	30
COOP	6 wks	4 wks	na	na	na	
Capstone Projects/ Thesis	15 wks	12 wks	18 wks	30 wks 6 credits	na	6

Table 1 A combined bachelor and masters degree contained more materials than the specialist degree but take one year longer. the Russian bachelor degree requires 75% more contact hours than a comparable American curriculum<sup>2</sup>

- 6) The Russian system requires more general engineering course hours than a typical American system. This situation is true even in the specialist degree but is over twice as many in the bachelor degree (98 vs. 25-40).

Overall the Russian system seems to 1) require many more course hours from faculty and students, 2) include a broader foundation in math and science and 3) incorporates practical experience through intervals of practical experience in industry with an integrative capstone project.

### Present Issues within Russia

It is not surprising that the substantial changes in the Russian system described above have created issues: some of perception and others of substance.

- 1) University education used to last for 5 years, now it is 4 years. New study plans are not just a compressed version of the old plans. They represent a change in the content of the education provided. There are new goals for a university education. Previously programs produced specialists with a narrow expertise, now degree programs produce a universal specialist who can work in any position which requires engineering background.
- 2) In the past, universities had graduating departments which taught disciplines related to narrow specializations. Now the faculty of these departments has to change the courses that they teach and are asked to produce graduates with a broad range of competences.

- 3) Faculty members have to issue students a grade according to a 100 grade system in contrast to a 5-grade system. New requirements for teaching and learning materials are being imposed.
- 4) There are no legal regulations necessary to accommodate academic mobility: There is no process for giving credits for courses taken at other universities. There are no guarantees or regulations governing the sending of faculty and students to work in foreign countries.
- 5) Employers do not yet know the capabilities of graduates with the bachelor degree and how to capitalize on the breadth of the educational base. They don't know how to use graduates with a bachelor degree in their industrial enterprise. Specifically in Tatarstan, the major industries and plants focus on plants or organic synthesis, automobile tires production, cosmetic industry and light industry. Employers and educators don't trust the general education and consider them to be undereducated specialists. This is a actual quote from a senior academic administrator: "A (graduate with a) bachelor (degree) can be compared to a house with a good foundation, but without a roof." The issue is further complicated by the fact that the same industrial position at an industrial enterprise can be filled by a specialist, a bachelor, or a masters degree without distinction in capabilities.
- 6) The introduction of a masters degree program presents even more problems. First, both bachelor and specialists are eligible to enroll in these programs. There are no exact standards or prerequisites for the masters degree programs and our universities have to develop specific requirement and study plans. The present approach is to develop two types of programs – a masters degrees for those who plan to continue scientific research, and a masters degree for those who plan to work in industry. There are no strict regulations and prerequisites (except medical education) for entering a masters degree program. For example, a specialist or bachelor in economics can enroll in a chemical engineering masters degree program. Similarly a bachelors or specialists degree graduate in engineering education can enroll in a masters of law program.
- 7) In the near term, the number of potential masters students has increased dramatically and is expected to continue increasing for national research universities. At KNRTU the normal enrollment used to be 150 state-funded masters degree students. In 2011-12 state funding is expected for 800 masters degree students without regard for faculty load and instructional infrastructure.

## **Future Work**

One approach to future evolution of the Russian engineering education system is to examine worldwide best practices in this field of engineering education and to study the international experience base in engineering education. The U.S. experience of training future engineers, both bachelor and masters, could be especially interesting and the authors seek to adapt/adopt practices that can solve many of the present problems. Areas that might be fruitful are: 1) the development of prerequisites for the technical programs to avoid unprepared students from entering degree programs and 2) the development of an accreditation system to establish a norm of education across Russia in the various disciplines.

## Conclusions

The Bologna Declaration has resulted in a major restructuring of the Russian educational system. The impacts include 1) a shift away from a deep specialization knowledge in the five year specialist degree and toward a broader but shallower general engineering base in the bachelor degree, 2) an uncertainty from employers about the capabilities of the new type of bachelor degree, 3) a reduction of the centrally controlled curricula which has lead to large variations in the curriculum content from one university to another and 4) a realization for the need of an accreditation processes to replace the former centrally dictated curriculum uniformity. The authors look forward to future work exploring best practices in the American engineering educational system that could shorten the process of resolving these issues.

## Bibliography

1. Full text of the Bologna Agreement- <http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf>
2. Credit hour requirements were taken from curricula at KNRTU in Russia and from the published website curricula of Western Carolina University and North Carolina State University.