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## The 50<sup>th</sup> Anniversary of VAZ: Higher Education in Togliatti as an Indicator of Innovative Development for PJSC “AVTOVAZ”

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Abstract

The Volga Automobile Factory and Togliatti State University (TSU) were simultaneously founded. The development of both institutions was conditioned by mutual interaction in a number of aspects including scientific and research ones. The university contributed to the technical, technological and innovative solutions applied at the factory. It is also TSU that provided engineering staff for the factory. The modern condition of higher education in TSU reflects the same situation in PJSC “AVTOVAZ”, that is system crises in science and production. Both institutions have the same objective and subjective problems: the lack of funding for research, the cut of engineering structures (departments) at the factory, the decrease in university science activity, staff shortage, and subjective decisions made by top managers.

**Key words:** history of development, higher education, automotive industry, PJSC “AVTOVAZ”, staff training, innovative development, social and economic situation, “WSET” department, TSU, joint projects, engineering, university science, problems in funding.

Interconnection between science and production is the key factor in any industrial branch and the entire regional economy. The failure of such relationships leads to decline both in higher education system and production. The current state of interaction between Togliatti State University (TSU) and VAZ (Togliatti) causes worries about the regional economic development. Thus, the aim of the research is to analyze the interaction of the departments that are parallel to each other in TSU and VAZ both from a historical perspective and current status.

The development of VAZ is closely connected with the development of higher education system in Togliatti, in particular Togliatti Polytechnic Institute (now Togliatti State University). These two institutions

had a parallel development and influenced each other in the spheres of education, science and innovation. The history of TSU, in its turn, is closely connected with the department “Welding and Soldering Equipment and Technology” (WSET) (now the department “Welding, Fabrication and Allied Processes”). Currently, it is one of the leading departments providing engineering training in TSU and the only department in Samara region that provides training in welding and soldering fabrication. B.E. Paton, G.A. Nikolaev, and N.N. Rykalin, the members of the Academy of Science of USSR, made a significant contribution to the WSET development. They supported scientific schools and research in developing technology for three-phase arc deposition and welding (the director was V.I. Stolbov).



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Prof. S.V. Lashko, and Prof. K.A. Vitke (GDR) promoted research activities in soldering theory and technology (scientific school of Prof. B.N. Perevezentsev). In the 70-s and 90-s of the 20<sup>th</sup> century the department laboratories and facilities were updated with the help of the local enterprises that donated modern welding equipment to the department. For example, OJSC "Volgocemash" (via the leading welder M.G. Kozulin) donated unique ESW welding equipment and Auto SAWs. PJSC "AVTOVAZ" (via the deputy chief engineer E.I. Brekkel') contributed to the ERW laboratory equipped with robot machines for resistance spot and seam welding.

Active collaboration between the department staff and VAZ, the leading automobile manufacturer in the USSR, and enterprises of the defensive industry ensured intensive development of the scientific schools. The heads of the enterprises made cooperation agreements with the department to deal with the challenges relating to new technologies and equipment development of the enterprises. These agreements involved the scientific staff members of the department. For example, from 1970 to 2008, 30 inventions and 10 international patents (including the USA, Great Britain, Japan and France) were made in the frame of 7 agreements [1]. The innovations made by ERW laboratory of the department were introduced in AvtoVAZ and in the auto plant in Ul'yanovsk. The most efficient inventions for the VAZ factory are long wearing flexible water-cooled cables for overhead spot welders, noncontact pocket device to measure current rate (the inventors are M.D. Banov (assistant professor of TSU) and A.I. Oshkin and V.A. Klenin (engineers of AVTOVAZ)).

By the end of the 20<sup>th</sup> century, production intensification, increase in load on equipment, aggressive process liquids and environments put new challenges before the socially-owned enterprises. The auto plant faced unit performance degradation and their premature failure. These problems rose to the level to be solved by the Government

of the Russian Federation. Thus, in 1980, the All-Union program "Remont" (repair) was adopted in the frame of GOSAGRPORM. In the 90-s, the Russian Ministry of Education launched a programme in renovation and surface engineering. It resulted in development of new research area at the department "Equipment and Technology for Increase in Wear Resistance and Recovery of Machinery Parts". A new department "Recovery of Machinery Parts" (RMP) was founded in TSU. V.V. Eltsov, assistant professor, who headed the new department, had graduated from WSET. The department was immediately involved in research, educational and cooperative activities with the leading enterprise of the city. For example, the department made an agreement with AVTOVAZ to develop repair technology for some expensive parts of H-type eccentric press "INNOCENTI – 400". The developed technology allowed doubling the service life of the parts.

AVTOVAZ and TSU collaborated in engineering training. There was a demand for targeted training of the graduates at the plant. Besides, highly qualified specialists of AVTOVAZ participated in educational activities of the University and were involved in research projects conducted by post-graduate and doctoral students. Particularly, it was leading specialists of AVTOVAZ who were the chairmen of the State Attestation Commissions (SAC) at the departments of TSU. We should mention the names of A.K. Tikhonov, the head of Laboratory Study Administration ("WSET" department), B.N. Nikolenko, the head of Master mechanic administration ("RMP" department), and S.N. Perevezentsev, the Chief Technical Officer of dies and mold tools.

In its turn, TSU offered advanced training courses for the AVTOVAZ staff. For example, G.M. Kokotov, the chief technical officer of Assembly shop, and E.I. Brekkel', the deputy chief engineer of the same shop, defended thesis on the base of TSU laboratories "Welding Sources" and "Welding Automation" (the heads of the laboratories are assistant professors G.M. Korotkova and

R.A. Tzepenev). A.K. Tikhonov, the head of Laboratory Study Administration, A.G. Azizbekyan, the deputy manager of the Laboratory Study Administration, and M.M. Krishtal, the head of the Material Testing Laboratory, conducted their research on the base of "Material Technology" laboratory supervised by Professor A.A. Vikarchuk [2]. Their research accounted for papers published in scientific journals, patents, inventor's certificates, their coauthors being the University staff members and the factory employees [3-8]. The research done by V.Ya. Kokotov and E.I. Brekkel' resulted in manufacturing control and measuring instruments CMI-5 to control the parameters of electric resistance welders both in setup and operating modes. In its turn, using the research results of mutually conducted projects the TSU teaching staff published some manuals and text-books approved by the Ministry of Education for higher schools and vocational colleges [9-12].

In 1992 the rector of TSU V.I. Stolbov, and the chief executive officer of AVTOVAZ V.V. Kadannikov initiated a training course "Foundry Equipment and Technology" provided by the department "WSET". It met the demand of the city manufacturing enterprises, first of all, PJSC "AVTOVAZ". More than 100 graduates finished the course supervised by Prof. P.I. Vershinin, and assistant professor A.I. Kovtunov.

The interaction between PJSC "AVTOVAZ" and TSU was planned in recent history (2000 – 2016) as well. Several innovative technical and human science projects were partly implemented. In 2005, two TSU departments, "Vehicle Technical Maintenance and Repair" and "Vehicle Part Reclamation" merged into a department "Vehicle Technical Maintenance and Part Reclamation". The department staff did active research and teaching work in this field [13]. In 2011, the department merged with the department "Vehicles and Tractors" to form a new department "Vehicle Design and Maintenance", which is still a TSU structural unit. The department was headed by N.S. Solomatin, who later became a

project head manager in the Engineering Office of PJSC "AVTOVAZ".

In March 2012, an extended session of the Scientific and Technical Board (STB) took place in TSU. It was chaired by Alain Diboine, the engineering director of "AVTOVAZ". The leading specialists of "AVTOVAZ", rectors and vice-rectors of TSU and Samara University took part in the session. One of the issues under discussion was the interaction of "AVTOVAZ" with the universities and research institutes in the frame of the Innovative Development Program. It should be mentioned that TSU is one of the supportive universities involved in the Innovative Development Program of "AVTOVAZ". The topic was introduced by Amanov S.R., the vice production manager of "AVTOVAZ". The report resulted in a decision to start procedures aimed at developing priority research areas in the medium term (to 5 years) and in the long term (to 10 years). The leaders of Scientific and Technical Cooperation departments were recommended to take into account the "AVTOVAZ" strategy of the car product range development, and the provisions of the Innovative Development Program [14]. According to the Program, since 2012, TSU and "AVTOVAZ" are to conclude agreements on cooperative research work in the following fields:

- Application of modern and innovative materials and technologies in LADA vehicles.
- Techniques for tool-wear rate prediction by means of acoustic emission signals while cutting.
- Techniques to identify open porosity and surface graphitizing on inner surface of the vehicle parts by means of nondestructive testing.
- Techniques and devices for infrared nondestructive testing of electric resistance spot-welded joints.
- Increase in wear resistance of aluminum pressure die casting tooling.
- Application of acoustic emission to register crack formation during fatigue tests.

D.G. Ruzaev, the director of the research center, AVTOVAZ Engineering administration Office, provided the higher education institutions, the members of the united STB, with the information about the main focus areas in the field of new material design and processing developed by AVTOVAZ. One of the focus areas was the development of future-oriented technological processes, invention and testing of new metal and non-metal materials. For example, in the frame of the activities related to "Future-oriented technological processes" it was planned to study the following issues: [15]

1. Advanced welding technologies and processing of car parts by means of high-concentrated power sources (arc, plasma, and laser technologies).

2. Application of high-performance energy-saving technologies for joining car parts (welding, nonelastic deformation, assembly).

3. Testing of machinability of the materials and performance specifications of the tools to enhance efficiency of cutting and grinding of the parts.

However, it should be noted that most of the mutually planned research projects were not implemented, with the top staff of the alliance "Renault-Nissan-AVTOVAZ" changes and Bo Andersson being appointed as the top-manager in 2013. It is obvious that the priority tasks of the alliance do not include the development of innovative engineering in Russia, since it may create competition for the western auto manufacturers. "AVTOVAZ-Renault-Nissan" alliance may have other reasons, but thinking of nothing but the profit, the alliance should remember that the auto industry is funded much by the Russian Federation. Thus, it is economically unsound for the region and the whole Russia to have only Complete Knock Down manufacture without engineering departments, research and advanced development and staff training, which implies cooperative activities with the higher education institutions [16].

The interaction between TSU and AVTOVAZ in the areas of staff training and

R&D is not active enough. The plan of target training meant to provide 100 graduates for AVTOVAZ each year from 2010 till 2015. In fact, 100 graduates finished the course only in 2011 and 30 students in 2012 with the contract being early cancelled afterward. The EU economic sanctions against Russia must facilitate the process. To be true, the target training contract was renewed in 2017 and hopefully will be fully fulfilled.

TSU, being the basic higher education institution that provides the city with the staff, continues research, innovative and education activities in cooperation with other auto manufacturers, chemistry industry as well as with social and educational institutions. It is proved by the status of Regional Supportive University. TSU is currently carrying out four public grants with the total fund of some million rubles. The federal public grant No. 220 (90 million rubles) was awarded to a cooperative project of TSU (prof. A.A. Vikarchuk) and E.C. Aifantis, the key scientist in "Material Technology" [17]. In addition, the Ministry of Economic Development decided to establish the area of advanced development (AAD) "Togliatti" [18,19]. The city administration developed a program of activities implemented in the frame of the AAD. According to the program TSU plays an important role as the Regional Supportive University [20]. It will allow increasing the regional investment attractiveness and tax revenues, as well as launching new enterprises, which will reduce social tension. Thus, no matter what development scenario PJSC AVTOVAZ may choose, the higher education in Togliatti will serve as an indicator of innovative development of the city and the Povolzhye region.

#### Conclusion

1. TSU innovative and research developments were actively implemented in various production lines of VAZ autoplant in the 70-90-s of the 20th century. It ensured engineering development both in technological equipment and automotive manufacturing.

2. The Current interaction between PJSC AVTOVAZ and TSU in the area of staff training does not contribute to addressing the challenges in social and economic spheres of the region. However, the foundation of

AAD "Togliatti" should spur a new spiral in the interaction between PJSC AVTOVAZ and TSU in the area of staff training and research and development, but now in the frame of Supportive University.

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## Training Students to Monitor Product Quality in CAD for Car Industry

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### Abstract

Training of skilled specialists capable of designing qualitative products within the car industry could be hardly secured without the introduction of modern automated design systems into education programmes. Within the degree programme in “Mechanical Engineering”, 15.03.01 offered by Togliatti State University Siemens PLM Software NX is applied. The proposed programme is comprehensive and aimed at product quality enhancement at the stage of product design. A great attention is also paid to evaluating the quality of the products subject to pressure shaping via CAE program Autoform, Deform and LS-DYNA.

**Key words:** bachelor’s degree programme, curriculum, car industry, automated design, model design, product quality, metal pressure shaping, comprehensive education, product lifecycle management, CAD.

A modern car should be functional and meet high quality requirements. These characteristics should be considered at the stage of car design and manufacture. The experience of modern car manufactures indicates that the product quality is defined not only by its configuration, but also by the system of arrangements that constitute a part of nominative documents, standards and various programs of international communities and enterprises related to the car industry.

PLM (Product Lifecycle Management) is currently a fundamental software tool to support the development of highly-competitive products. It helps manage data at the stage of car design and manufacture. Precisely, it includes CAD, ERP, and SCADA. To operate these systems, there is a need for the specialists who possess knowledge of the up-to-date engineering technologies and have gained working experience in IT and PLM software. They are able to provide professional support to car manufacturers.

Togliatti State University offers the bachelor’s degree programme in “Mechanical Engineering”, 15.03.01 and master’s degree programme in “CAD in Mechanical Engineering”, 15.04.01 aimed at training specialists capable of fulfilling a wide range of activities related to modern car design, use of up-to-date technologies and the integrated PLM software.

Special knowledge of mechanical engineering fundamentals and CAD basis obtained by bachelor students is consolidated within the master’s degree programme. Alongside enhancement of professional skills in certain fields of mechanical engineering, future master students also get familiarized with the disciplines related to PLM software and gain relative working experience.

The curricula of cross-engineering and special engineering courses are designed so that bachelor students are explained how to use CAD system in the mechanical industry. For this purpose, computer-aided design and management tools have been introduced



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