paradigms – humanistic and technocratic, and humanization of education within both paradigms will allow gaining a new perspective and changed worldview.

Modern education is a system with a number of functions: bringing-up, social, professional, cultural and educational, administrative, however, the only function currently accomplished is professional. Learning humanities, the students of technical universities and institutes form their personality, acquire morals, develop a flexible way of thinking, etc. Unfortunately, the disciplines based on humanist values are beyond the scope of today's education programmes. We live in the world inherited from our ancestors and the question is what our children will inherit if we train narrowly-specialized technicians incapable of predicting the effects of their actions.

REFERENCES

1. Rubantsova T.A. Gumanizatsiya sovremennogo material'nogo proizvodstva i gumanitarizatsiya inzhenernogo obrazovaniya [Humanization of Material Production and Humanitarization of Engineering Education]. Saint-Petersberg: Nestor, 1996. 109 p. (In Russ.).
2. Zlatopol'skaya A.A. Kontseptsiya «obshchei voli» Zh. Zh. Russo i revolyutsionnaya mysl' v Rossii 18 – 20 vekov [The concept of "general will" by J.-J. Rousseau and revolutionary thought in Russia over the 18th – 20th centuries]. Filosofskie nauki [Russian Studies in Philosophy], 1991, no. 9, pp. 16–29. (In Russ.).
3. Nanivskaya V.T. Anatomiya repressivnogo soznaniya [Anatomy of repressive consciousness]. Voprosy filosofii [Russian Studies in Philosophy], 1990, no. 5, p. 48. (In Russ.).
4. Irinina I. Voskresnaya shkola [Sunday school]. Sovetskie profsoyuzy [Soviet Trade Unions], 1990, no. 7–8, pp. 74–75.

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Automotive Engineer Training: Challenges and Solutions

KAMAZ PTC
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The paper proves the necessity for using a specific tool in engineer training, namely, mobile training laboratory equipped with all necessary facilities and provided with educational and methodological support. This mobile class will allow solidifying theoretical knowledge and developing the team work skills effective at each stage of product life cycle.

Key words: engineering education, competencies, mobile training laboratory, innovations, engineering personnel, requirements.

Introduction

Today, the slogan "Personnel is a key to everything" is still popular. There is an urgent need in engineers with systemic thinking and interdisciplinary competencies, and this is the issue to discuss at the Government of the RF, development institutions, different conferences and forums, and also on the pages of many journals – "Inzhenernoe obrazovanie" ("Engineering Education"), "Forsait" ("Foresight"), "Problemy upravleniya v sotsial'nykh sistemakh" ("Problems of Governance"), etc.

It is noteworthy that many efficient measures have already been implemented to improve the quality of practice-oriented education. For example, there are federal target programmes and the President's Programme for personnel training; different competitions and grants to support young scientists and engineers; business, science, and education support provided by the Government in compliance with the Resolution № 218 dated April 9, 2010, etc. To improve engineer's competencies, national educational and professional standards have also been implemented. However, the measures mentioned above are not enough to solve all business and social challenges.

Based on business experience, corporate engineer training, and interaction between KAMAZ and national education system, the key corporate engineer's competencies have been specified:

- knowledge of sciences and fundamental technical disciplines;
- ability to apply systemic engineering approach and make forecasts;
- ability to use interdisciplinary knowledge;
- creativity and ability to generate innovations;
- skill to find efficient solutions for different hand-on tasks based on the knowledge acquired at university via TRIZ technology;
- knowledge in the sphere of cutting-edge CAD – CAE– CAM – PDM – PLM systems;
- knowledge in the spheres of business process and quality management;
- project presentation skills;
- wish and skills necessary to work in a project team and to ensure efficient management at all project stages;
- knowledge about the principles of sustainable production;
- English language skills.

The above-mentioned competencies prove the idea that the engineer should not only possess fundamental and interdisciplinary knowledge, abilities, and

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skills, but also have a wish to intensively use them in practice.

This idea is shared by many education experts. For example, the classification described in paper [1, p. 36] includes five categories, each of them comprising four competencies. The categories are as follows: professional knowledge, team work, management skills, personal performance and communicative skills. It is noteworthy that professional knowledge, team work, and management skills are among the priorities.

Articles [2, p. 15] emphasized the necessity to boost the development of engineer's competencies since it is necessary for the national knowledge-based economy. The engineering education should be improved through education programme modification with due regard to business demand for elite engineering education. The authors of paper [3, p. 18-19] point out the need for additional corporate engineering education after graduation from university, which is efficiently implemented at our enterprise, as well as goal-oriented training. It is also important to keep in mind "breakthrough" competencies, which will be in need in future.

In paper [5, p. 13] the authors put emphasize on the personnel competencies, which are the same as those specified by KAMAZ. The information on modern notions and trends in the sphere of "elite" education are described in paper [6, pp. 15-17]. Practice-oriented engineering education and its perspective are considered in article [4, p. 49] and other works.

In the present paper the authors explain how to involve engineering students in scientific work, how to improve their professionalism, and what to do to develop team work skills.

Current challenges: business perspective

Automotive industry plays an important part in securing economic stability and boosting national development, ensuring social progress, political and economic independence, and improving defense capacity. In terms of statistics, one person working in automotive industry is supplied with materials and utilities by 5–6 people, therefore, automotive industry development is a national strategic objective and the level of its development is the criterion to estimate the economic strength of the country.

Modern automobiles have to meet a number of restrictive specifications on their efficiency, reliability, comfort, level of active and passive safety, and environmental impact. To develop innovative products, the automotive sector needs innovative personnel and technologies, including educational ones.

Today, the major challenges of automotive industry development and staff training are as follows:

- lack of national utility base;
- a number of competencies which remain undeveloped: knowledge of systemic engineering, mechatronics, electronic systems, algorithms for management and programming;
- inefficient facilities and resources of universities and their laboratories;
- inadequate system of professional training and current demand for the staff possessing interdisciplinary competencies meeting international standards.

In the Republic of Tatarstan, there are many small and medium-sized enterprises which supply materials and utilities for KAMAZ. In general, the enterprises employees graduate from Naberezhnye Chelny Institute (NCI), Kazan Federal University (KFU). Some professionals of enterprises-suppliers cooperate with research department staff of KAMAZ. However, this cooperation fails to be on a regular basis and research in design and engineering is unsystematic.

Another challenge is the staff of enterprises-suppliers, who are not experienced enough in conducting scientific research to provide world-class outcomes. There is no IT unification in CAD – CAE– CAM – PLM systems. Many enterprises lack professionals possessing interdisciplinary competences in need.

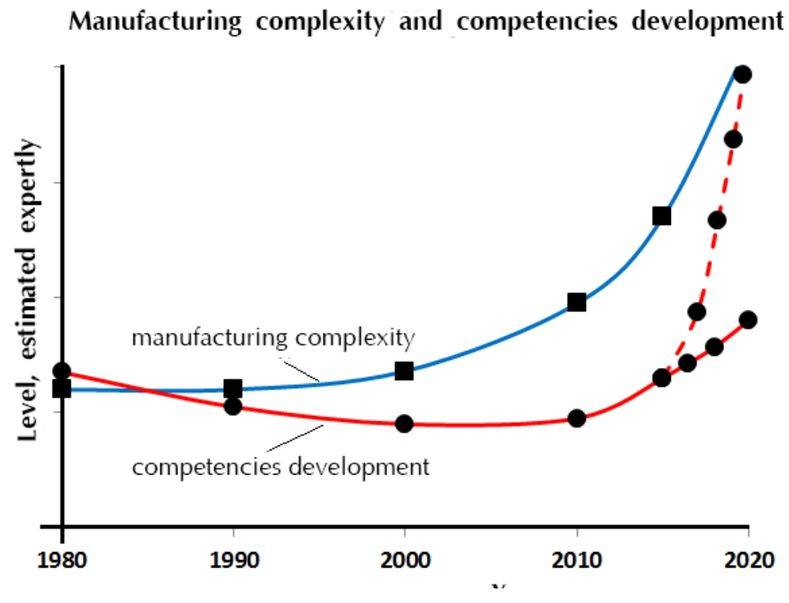
Moreover, to train highly-qualified engineers for automotive industry, higher education institutions need modern laboratory and research equipment. For instance, there should be engine test rigs to assess their quality in compliance with EURO-5 requirements; however, it is only at KAMAZ where the automatized transmission and vehicle test rigs are used.

As a result, the educational process in general and conducted tests and experiments in particular are hindered due to the lack of facilities at higher education institutions. However, work with cutting-edge vehicles and their components allows involving today's students in scientific research.

E-learning courses designed in 3D and presenting video on different components and assembly units fail to make students comprehend a vehicle as a system. Furthermore, the products and utilities become more and more enhanced, which makes them impossible to be produced at the current level of competencies development (see Fig. 1). However, it should be noted that at the end of the 80s of the 20th century, the level of competencies development corresponded to that of manufacturing complexity.

It should be noted that the levels are estimated expertly, in relative units, to emphasize the differences between them and it is obvious that there is an urgent need to reduce the gap between the two levels. The scenario of increasing the level of competencies development marked by solid line is inadequate since it is too time-consuming but there is another option to be successfully used even under the circumstances when the enterprises lack qualified personnel and financial resources.

Fig. 1. Manufacturing complexity and competencies development



Solutions for the challenges

One of the ways to improve professional competencies is to organize mobile training and research laboratories (TRL) at NCI KFU. Even today there is a solid base for laboratory establishment:

- engineering school at KAMAZ Scientific and Technical Center (STC);
- educational resources and methodological support to train a new generation of engineers and to found a scientific school;
- the infrastructure of Engineering Centre of NCI KFU.

Educational activities consolidated under the auspices of a staff education centre established by KAMAZ and NCI KFU in cooperation, equipped with all necessary facilities and TRL, provided with necessary methodological support will allow ensuring the high quality of education.

As for TRL, it is supposed to fulfill the following functions:

1. Educational facility – TRL is a special vehicle for students and engineers to conduct on-road practical tests to estimate parameters and properties of vehicles and their components.

2. During extracurricular time, TRL is a mobile complex for the university and KAMAZ personnel to conduct research on design and checkout algorithms for assist and development systems (engine, transmission, breaks, suspension), robot vision, etc.

3. During winter time, TRL is an instrument to promote engineering education, a tool of occupational guidance for prospective students, especially for those living in remote areas of the Republic of Tatarstan and other regions of the RF.

The concept of TRL and educational activities.

Let us enumerate the education and research fields where TRL can be efficiently used:

- Testing robot vision, engine control, driving machine, and mobile units.
- Scientific research and checking out algorithms for electronic component control and vehicle control systems.
- Testing undercarriage, vehicle cabin, hydraulic, pneumatic, and mechatronic components of energy-saving and autonomous vehicles.

The above-described TRL is represented in Fig. 2.

Vehicle chassis can be equipped with radar, lidar, video camera, odometer, speedometer, accelerometer, decelerometer, fuel flowmeter, resistive strain sensor, noise and vibration sensor, etc. There can also be climate control system with the options of air heating or cooling inside the van, screen, projector, system of collecting, analysing, processing and transmitting data from digital and analog sensors (up to 100 channels), various lockers and drawers, fridge, special gages, devices and equipment.

When testing, TRL moves in the immediate proximity of tested objects (one or two vehicles, Fig. 3) equipped with the systems of signal detection and transmission. The data are transmitted from tested vehicles to the TRL computer center via local area network or Internet.

Engineers or students in the TRL process and analyze data obtained on-line when the vehicles are moving. Therefore, there is an opportunity to adjust the tested vehicle's systems from the mobile lab directly.

TRL will include the following components:

1. Studying room "on wheels" placed on KAMAZ chassis. The number of studying seats is no less than 16.

2. Measuring and recording equipment.

3. A set of educational resources and methodological support materials for conducting laboratory activities.

Target audience and educational process.

- Students of NCI KFU and other higher education institutions of the RF of the relevant professional domain.

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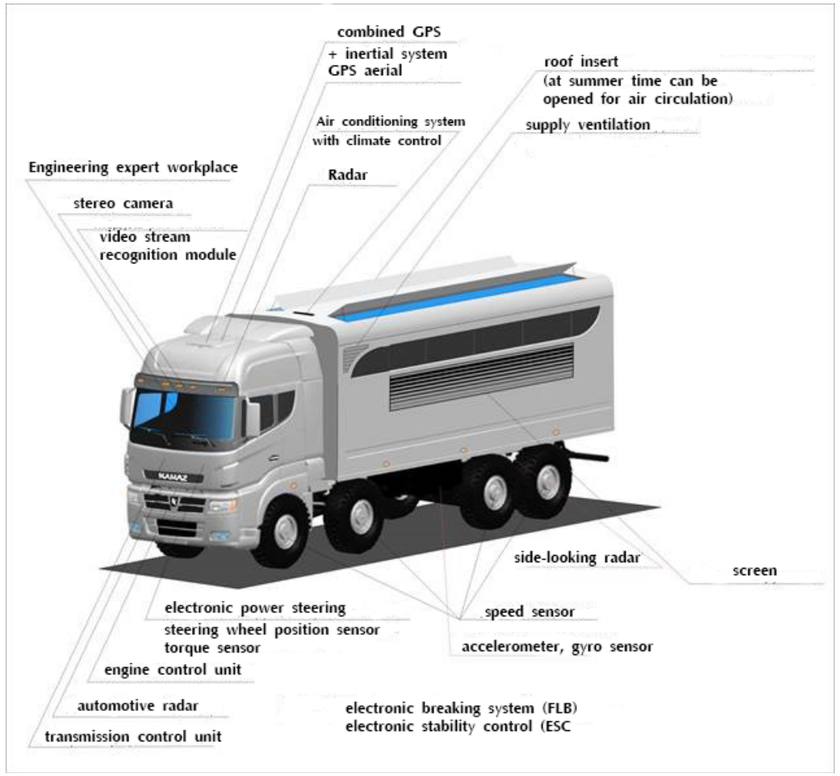
Fig. 2. TRL: general view



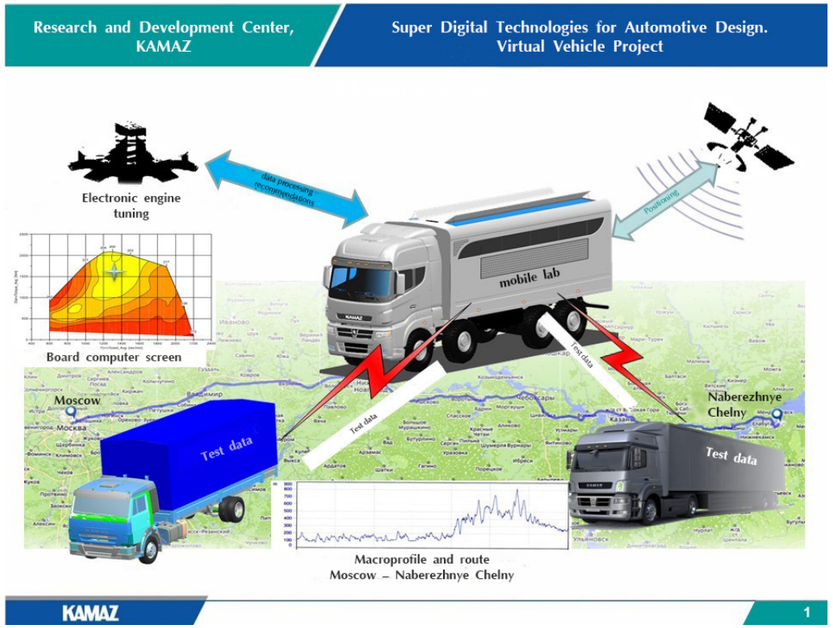
- Engineers of the enterprises, which are key members of Kamsky innovative cluster "Innokam", taking continuing professional development courses.
- Engineers of enterprises, which are suppliers for KAMAZ, taking continuing professional development courses.
- Teachers of the RF higher education institutions of automotive profile in the framework of continuous professional development.
- School graduates – prospective students and engineers.

TRL will be designed and implemented by the engineers of KAMAZ, who will develop project documentation for the lab design, set the equipment, purchase and fit the van, develop methodological support materials, ensure proper maintenance, etc.

At the test site, the instructor gives a class to explain the methodology of the prospective work. Then the students (engineers) under the instructor's supervision conduct tests on vehicle mass, tire pressure, vehicle assemblies, systems and aggregators, check traffic striping for driving test maneuvers, etc. While testing, students observe the process outside the lab.

After testing students or engineers with the instructor process the data obtained in

Fig. 3. Testing and data transmission



the study room. They work individually, each having an individual data file, and prepare test protocols or report on study deliverables.

Expected outcomes and conclusion

- Practice-oriented approach will ensure professional qualification required.
- A new scientific school for automotive industry will be founded (about 30–40 professionals with the degree of candidate of technical sciences, 4 – 6 with doctor's degree.
- The number of student and engineers educated within five years will be more than 250.

To sum up, TRL can make a great contribution to training "engineering elite" for national automotive industry, which is a key driver of economic growth. To be implemented, the project needs to be supported by the government. The lab costs 70 million rubles. KAMAZ investment is vehicle chassis, providing methodological support, ensuring proper use and maintenance of the equipment and lab.

REFERENCES

1. Shmatko N.A. Kompetentsii inzhenernykh kadrov: opyt sravnitel'nogo issledovaniya v Rossii i stranakh ES [Competences of engineers. Evidence from a comparative study for Russia and EU countries]. Forsait [Foresight], 2012, vol. 6, no. 4, pp. 32–47. (In Russ., abstr. in Engl.).
2. Gokhberg L.M., Kuznetsova T.E. Strategiya – 2020: novye kontury innovatsionnoi politiki [Strategy 2020: new outlines of Russian innovation policy]. Forsait [Foresight], 2011, vol. 5, no. 4, pp. 8–30. (In Russ., abstr. in Engl.).
3. Kondrat'ev V.V., Kudryavtsev Yu.M., Kazakova U.A., Kuznetsova M.N. Inzhenernoe obrazovanie v strane i mire: vyzovy i resheniya (itogi mezhdunarodnogo simpoziuma i mezhdunarodnoi nauchnoi shkoly) [Engineering education in the country and the world: calls and decisions (results of the international symposium and international scientific school)]. Kazanskaya nauka [Kazan Science], 2013, no. 10, pp. 13–22. (In Russ., abstr. in Engl.).
4. Kondratyev V.V., Kudryavtsev Yu.M., Kazakova U.A., Kuznetsova M.N. Global'nye vyzovy v inzhenernom obrazovanii. Inzhenernoe obrazovanie dlya novoi industrializatsii (itogi mezhdunarodnogo simpoziuma i mezhdunarodnoi nauchnoi shkoly) [Global challenges in the engineering education. The engineering education for new industrialization (Resume of the International Symposium and the International School)]. Mir obrazovaniya — obrazovanie v mire [World of Education – Education in the World], 2013, no. 4, pp. 46–52. (In Russ., abstr. in Engl.).
5. Pokholkov Yu.P., Rozhkova S.V., Tolkacheva K.K. Uroven' podgotovki inzhenerov Rossii. Otsenka, problemy i puti ikh resheniya [Level of engineers schooling in Russia. Estimation of problems and ways of solving them]. Problemy upravleniya v sotsial'nykh sistemakh [Problems of Governance], 2012, vol. 4, no. 7, pp. 6–15. (In Russ., abstr. in Engl.).
6. Sydnyaev N.I. Contemporary Discussions on the Concept of Elite Engineering Education. Engineering Education, 2015, no. 17, pp. 14–20.