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Global Challenges of the 21st Century and Possible University's Answer

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Abstract

The new century has brought new challenges and threats that the mankind should cope with if it wants to survive. The authors emphasized among them the three most considerable, such as 1) Healthcare and quality of life – human lifespan, environment deterioration, especially in the cities, early mortality, poverty and corruption; 2) Safety – a threat of war, ecological disasters and climate change, religious and ethnic conflicts, terrorism, economic safety related to modernization of the resource based economy, corruption, globalization of the world economy, migration of population; 3) Resources and their scarcity – demand for new types of energy and energy efficient materials, pure drinking water, food problems, intensification of the housing and road construction. The world leading universities aim at solving the most urgent global challenges through R&D projects and education. One of the effective answer for the global challenges is the idea of integrative educational programs which can merge most important knowledge and skills from the ecology, technology, natural and social sciences, business and management into engineering education. Chemical engineering as one of the most effective instruments for solving global problems through providing high-tech solutions for healthcare, development of new materials, safety and the problems of energy and resource scarcity. Using benchmarking methodology the authors studied the main principles of making effective strategy of university's development in the contemporary world. The case of Kazan National Research Technological University is in the focus of their attention. Of course the attempts of redesigning of traditional university format are facing with resistance. Therefore the tools of change management are also specified.

Keywords: challenges of the 21st century, world problems, universities' strategies, chemical engineering, change management

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INTRODUCTION

In the XXI century, the mankind is facing a number of new challenges; their solution will determine the future progress and even survival. The "global agenda" today includes the following issues: corruption, poverty, environmental pollution, human rights, terrorism, armed conflicts, climate change, epidemics, unemployment, world economy globalization, religion-based conflicts, human migration. Scientists, politicians and social activists are actively discussing the so called "global challenges" on the daily agenda of the United Nations, the clubs. All the road mapping documents of the G8 and G20 member states design the future projects with a strong emphasis on the global risks and instabilities. Therefore it is important to find out the possibility of coping with "threats of progress" redesigning the strategic goal of technological universities (Ryabchenko et al. 2018). One of the most effective response to the universities is to develop the chemical engineering programs because they integrate technological, ecological, economic and managerial issues and therefore students will be well prepared to live and work in contemporary conditions.

TERMINOLOGICAL BASES

For our analyses we used benchmarking methodology and documents' studies.

The world scale problems are also reflected at the regional scale. Almost all the major challenges can be grouped into the following categories:

- ***Healthcare and quality of life –*** human lifespan, environment deterioration, especially in the cities, early mortality, poverty and corruption;

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- ***Safety –*** a threat of war, ecological disasters and climate change, religious and ethnic conflicts, terrorism, economic safety related to modernization of the resource based economy, corruption, globalization of the world economy, migration of population;
- ***Resources and their scarcity –*** demand for new types of energy and energy efficient materials, pure drinking water, food problems, intensification of the housing and road construction.

The world leading universities aim at solving the most urgent global challenges through R&D projects and education declared in their missions.

Within the research, education and project activities of the universities, chemical engineering is often considered as a decisive factor in the roadmap of the XXI century. The annual report of the Institute of Chemical Engineers (IChemE) places an emphasis on chemical engineering as one of the most effective instruments for solving global problems through providing high-tech solutions for healthcare, development of new materials, safety and the problems of energy and resource scarcity. Chemical engineering in the constantly renovating appearance will always be of particular importance for the modern civilization.

RESULTS

Our analyses and studies let us argue that the "Building Blocks" of the modern civilization based on Chemical Engineering are**:**

- **Process safety.** Modern chemical engineering processes are based on operational and industrial safety.
- **Education, knowledge and professional skills.** Chemical engineering is the major force attracting talents to engineering.
- **Research and development.** Chemical engineering faces the complex challenges of the modern science.
- **Energy.** Chemical engineering develops key energy solutions for the forthcoming decades.
- **Water.** Chemical engineering provides renewable water resources;
- **Food.** Chemical engineering can find solutions for sustainable food generation and distribution.
- **Health and welfare.** Chemical engineering has been the basic instrument for producing commodities since the early XX century.
- **Economic impact.** Chemical engineering contributes over USD 3,000 bln to the global economy, thus serving as the major economic leverage.
- **Social impact.** Chemical engineering improves the quality of life all over the world.

The major contribution to the high level of new universities is made by the engineering activities, which fill the commercialization "gap" (according to Academician V. Parmon) resulting in the lack of large national companies able to carry out modernization projects and design innovative production lines. This "engineering gap" is an obstacle for the Russian engineering design companies in their strategies of entering international and even Russian markets. All items under discussion we apply to developing new strategic goals for Kazan National Research Technological University (KNRTU).

Kazan National Research Technological University is the only Russian National Research University which focuses on research and academic programs in Chemical Engineering and trains skilled professionals demanded in both the Russian and global markets. KNRTU implemented a whole set of degree programs: "Chemical Engineering of Polymer and Composite Materials", "Chemical Engineering of Energy Intensive Materials", "Chemical Engineering of Integrated Processing of Hydrocarbon Resources", "Chemical Engineering of Nanotechnologies and Nanomaterials" and "Chemical Engineering of Energy and Resource Efficiency in the Production of Advanced Materials".

Therefore, the mission of KNRTU aimed at becoming an internationally competitive institution is to solve the global challenges of the mankind in the 21st century through research, education and engineering activities based on the significant role of chemical engineering for contemporary stage of human civilization, because chemical engineering will be at the forefront of tackling many of the world's tough challenges in coming decades.

Using the benchmarking methodology we found out five world leading universities as the model for strategic planning of university's development.

The choice of the benchmarked universities is determined by the strategic focus of KNRTU on the

universities of the USA, Great Britain and Germany, which occupy the majority of positions in the TOP-100 lists of QS, Times and ARWU rankings. KNRTU has chosen QS Ranking as the basic standard. The key attention in the selection process was given to KNRTU partners, who occupy the TOP-100 positions in at least one of the world rankings or in their Chemical Engineering subject ranking.

Purdue University

The benchmark characteristic is a unique model of the interdisciplinary-oriented commercialization approach based on proven infrastructure solutions of commercialization parks and start-up parks (Discovery Park and Research Park respectively). Therefore, there is an excellent opportunity to adapt this model to the existing KNRTU innovation infrastructure. The key driving force of KNRTU transformation will be the application of Purdue University unique experience in nurturing the entrepreneurial culture in the student, faculty and administrative environment with the focus on the real challenges faced by the University business partners. This will allow earning a high level of reputation among University business partners and employers of graduates.

Imperial College London

The benchmark characteristic at Imperial College London is the transformation of the traditional discrete training process of engineers into the revolutionary continuous excellence growth sequence involving training of Bachelors, Masters and PhDs. The core concept is the adaptation of the real brainstorming practice in the world science with the "leading scientist and his research group" as the research spearhead to the education process of "mentor and his students" as the basic unit. The following algorithm: leading scientist – student group in the laboratory – research problem in the specific discipline to share – education effect is used for integration of leading scientists into the academic process, growth of publications and citations through involvement of students into creation of new knowledge. Another effect is an outstanding reputation among employers of graduates through their engagement into academic programs.

Arizona State University

At the ASU we are benchmarking their model of leading the transformation of the University into a novel dynamic world academic and research organization with the focus on continuous development. Nurturing the research and entrepreneurial environment based on students and faculty will push the envelope of modernization to ensure sustainable development of a University region and face global challenges through the creation of a knowledge-based economy and focusing on leading edge science.

Massachusetts Institute of Technology

MIT is the model of an open education system integrating joint academic programs with an extensive network of world top universities and an open access to the educational resources. Integration into the network of the academic and research elite represented by the faculty from all the world top universities ensures the unprecedented level of joint intellectual activities of students and faculty. The outcomes are the world changing discoveries and the guaranteed contributions to all the characteristic indicators forming world rankings (such as an academic and an industrial reputation, citations and attraction of foreign scientists).

Technical University Munich

The benchmark characteristic at TUM is the internationalization of the University by joining the world education and engineering alliances and implementing an entrepreneurial University concept based on commercialization of fundamental research through start-ups in the European and international markets.

At present, KNRTU is not included into the world rankings of top universities; however, we have applied for the 2014 QS ranking and claim the position in the Top-500 - 600 list. The two ranking gaps are evidently seen: the gaps between the positions of KNRTU and the benchmarked universities in the general and subject world rankings. The guiding lines to follow are the strategic advantages of the benchmarked universities in the chemical engineering context as they occupy high positions in the respective subject rankings. The benchmarked universities carry the beaconing function through inspiring the process of concentrating the efforts set by all the strategic initiatives to follow their reference strengths.

We want to underline that the success of university's development is closely connected with following the new trends in world higher education. Our analyses let us put forward the very three of them.

Improvement and Expansion of Distance Learning Opportunities

One of the most important characteristics of a world class University is the use of distance learning opportunities to disseminate the knowledge around the world. One of the options is the creation of the audio visual courses which make the University popular among the professionals and among the knowledge consumers. The cultural mission of the University, as well as the commercial potential of the on-line educational products, can also expand. In this respect, we have selected MIT as the future vision of the University which provides a number of open courseware (OCW) disseminated through the popular internet resources. The MIT web-site gives a reference to the Consortium of the world leading universities which provide a free access to on-line courseware.

MIT gives an access to teaching and learning materials of the course (plan, texts, tasks) and video materials (lectures, movies, and case studies). The commercial constituent of the project is as follows: when you open a file with the recommended texts, you get an opportunity to buy a textbook at amazon.com.

Through OCW, the educators improve courses and curricula, making their schools more effective; students find additional cutting edge resources to help them succeed; and independent learners can tackle some of our world's most difficult challenges (including cancer eradication, climate change, and sustainable development).

The experience of KNRTU in this field is represented by working in the virtual educational space. Video modules have been developed for 10 Master's degree programs, we have all the necessary equipment for producing audio visual content, we know the technology of virtual experiments and laboratory works. The goal of our eventual development is to enter the Consortium of open courseware producers.

Nurturing Entrepreneurship to Solve Global Challenges

KNRTU is characterized by a high percentage of revenue from entrepreneurial activities. In order to nurture entrepreneurship at the University we have formed a chain which integrates the results of intellectual activities in all forms and commercialization which is an important condition for a successful competition in the world engineering market.

The University vision is aimed at a complex target market development under the marketing strategy. The research market will integrate the elements and subsystems of the university innovative infrastructure with that of the benchmarked foreign universities resulting in joint research and technology transfer for the Russian economy and economy of the developing countries, strategic partners of Russia. The best international students will be attracted by the opportunities for an innovative growth and the use of their creativity potential in the rapidly developing high additional value sectors of economy. The graduates will find better jobs due to their practical skills obtained in the innovative university infrastructure.

Improving International Visibility and Recognition of the University

The international academic reputation and reputation among the employers is possible only in case of improving the University visibility. This characteristic can be achieved through the systematic development of partnerships with the world leading centers and key partners (including universities, corporations, engineering companies, education and research centers) due to the new infrastructural solutions in the international activities of the University and academic mobility, as well as the development of a world image of KNRTU and creation of a multicultural multilingual environment.

A number of activities aimed at the development and reinforcement of the KNRTU positions in the world market of research, education and engineering will be implemented. The benchmarked University in this case is the Technical University Munich.

The change process needs the change management. We understand that change management means leading the people, the structure of their interaction, and the processes in the organization and the culture in the period of transformations, caused by the external and internal factors, implementation of the new organization strategy aimed at achieving new goals. The strategy of KNRTU is based on the principles and ideas of Kotter (1996), Kanter (1999), Kanter, Stein and Jick (1992). These principles are applied in leading the change as the best world practices.

Finding the balance between making people change and creating an interest to changes is an important issue. The academic environment is very conservative and critical in evaluating the actions of the University management team.

Considering the practical experience of the world leading universities, KNRTU will establish an *Office for*

the Change Management and a Public Advisory Council for the Change Management which will consist of the leading University staff and representatives of the foreign partner universities.

The Mission of the Office for the Change Management is to promote organizational and cultural changes of the University in order to obtain the vision characteristics of a world class University and to enhance the efficiency of research, education, and projects of the University. The changes are formed and managed as projects.

Both the Office and the Council will aim at transforming the organizational culture of the University. The programs of organizational and cultural changes will be developed and will include values and rationales, such as knowledge, planning, information and institutionalization. They are represented by the following steps:

- providing rationale and advocacy for the necessity of change, determining a general vision and their promotion: analysis of the threats, risks, challenges and possible chances;
- providing support for the proposed changes: involvement of the key and interested groups and people in search for optimum solutions;
- continuous monitoring of the changes and discussing the results with the University staff through communication platforms (special forums at the University web-site);
- reinforcing a new way of actions: matching a new behavior and success, creating a salary distribution system promoting a new behavior.

*Methods to overcome the resistance to changes***.** In order to overcome the resistance, the following methods will be used during the transformations:

1) education and consulting (individual talks, reports in front of a group and discussions); 2) participation and engagement (the possible opponents should be engaged in planning and implementation of the transformations); 3) assistance and support (additional professional development of the University faculty); 4) negotiations and agreements (opinions are exchanged and a compromise is reached in order to approve transformations); 5) cooptation (the person who may resist the transformations is given the leading role in making a decision about introducing innovations and their implementation).

DISCUSSION AND CONCLUSION

The challenges of the 21st century has been being discusses since the second half of the 20th century. Very detailed analyses is given in World Bank (1999) report. Any way the most considerable challenges of the coming age are resources scarcity, quality of life and healthcare, problems of safety. All these challenges are reflected in so called alarmist as well as in sustainable development discourses. Academic community tries to rethink the roles and strategy of higher education (Barnett 2012, Morley 2012, 2013, Ramsey and Wesley 2015, Sadovnichy 2008, UNESCO 2009). The role of chemical engineering is revealed in IChemE publications 2016.

We stand for the point of technological and educational answer for the challenges and threats of the 21st century and think that integrative educational programs like chemical engineering could help to build up better future.

The new century has brought new challenges and threats, which concern three main groups of problems that we want to point out first of all: 1) Healthcare and quality of life; 2) Safety; 3) Resources and their scarcity**.** All these challenges are closely connected with ecological issues that the mankind should solve. Discourse that deals with "saving the Earth" takes the shape of 1) green technologies design and 2) spreading the ecological ("green") culture. Both are rather influential. Universities as scientific, technological and cultural institutions could play the decisive role in finding system answer to global problems. Elaborating and developing special educational programs in the sphere of chemical engineering is the example of such kind of university's answer. Such programs are based on integration of engineering sciences as well as social and economic ones. The university should do not only R&D projects in the field of "green technologies" (new materials, new machinery, new energy) but should do their best in providing students with humanitarian, economic, managerial knowledge and skills which could help them to work effectively and ecologically reasonable. Therefore, the strategic goals of KNRTU are aimed at solving the global challenges of the mankind in the 21st century through research, education and engineering activities based on the significant role of chemical engineering for contemporary stage of human civilization, because chemical engineering will be at the forefront of tackling many of the world's tough challenges in coming decades.

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