GLOBAL EDUCATIONAL SOFTWARE MARKET IN IT-SPHERE:

PRIORITIES FOR RUSSIAN UNIVERSITIES

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ANNOTATION

The article deals with education key trends forITandradioelectronicsectors.The comparative analysis of approaches to the organization of scientific and educational activities in 30 foreign and domestic universities, leading in the subject ratings of QS computer Science & Information Systems andEngineering-Electrical & Electronic was conducted. The trends' characteristics are following:

- close and constantly increasing integration of educational and scientific content, which is reflected in the emergence of interdisciplinary educational programs, linking of the learning process to research in breakthrough demesne of knowledge and formation of specific university ecosystems aimed at leadership in specific technologies;
- variety of educational processorganizationforms, orientation on the modularity, individuality and continuity, which are actively used in the promotion of educational services;
- general backlog of Russian universities from IT practice and expectations of the real sector.

The research methodology included analysis of the content and models for the implementation of educational products, expert opinions on the requirements for IT professionals' education. As a result, there are gaps between current sectoral trends, current situation in the education sector and requests of the real sector.A number of master's programs developed at the Institute of Radio-electronics and Information Technologies of the Ural Federal University demonstrated a mechanism of science, education and consulting integration in order to develop demanded interdisciplinary educational products.The results of the study can be used by domestic and foreign universities working in IT-segments, aimed to increase competitiveness and implement strategic research and education initiatives.

KEY WORDS: INTERDISCIPLINARITY, INFORMATION TECHNOLOGIES, RADIO-ELECTRONICS,UNIVERSITY,EDUCATIONAL SOFTWARE,MASTER'S PROGRAMME,EDUCATIONAL PROCESS,ECOSYSTEM.

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INTRODUCTION

In recent years, all technological breakthroughs in one way or another are connected with information technologies and occur, as a rule, at the intersection of IT, engineering, social and natural sciences.This trend is rapidly capturing all infrastructure industries: energy, medicine, transportation, engineering, aerospace, etc.Universal intellectualization, machine learning, neural networks, augmented reality, additive and other breakthrough information technologies quickly penetrate into the conservative branches of the economy, radically changing the industrial landscape, business models and corporate economics [Agamirzyan, I.,2015; Sukhov A., Streha A.,2012; University of the Future,2012; International Trends,2015].

The volume of the world market of information technology (for example, software) was 2.3 trillion dollars in 2016, and now the market is estimated at about $4 trillion, taking into account convergent solutions [ITIndustry,2016; Baller, S.,Dutta,S., Lanvin, B., 2016; Rangarajan Dr. K., Tiwari, S. K., 2014].

It is quite logical that the scale of such deep technological changes should correspond to the changes in universities that train highly qualified personnel for the new digital industry.

In this context, some experts highlight the development of university ecosystems, which are built around clusters that use breakthrough information technology.These ecosystems serve as market integrators, thanks to which the digital scientific and industrial environment is formed.Almost every innovation zone in the world is associated with university centers: Silicon Valley around Stanford and Berkeley, New England-MIT and Harvard; University of Paderborn, University of Bielefeld and Hammlplstadt Graduate School-in the IT cluster OwL (Germany), Cambridge in the UK; Institute of Wetzman in Israel; University of Aalto in Finland [Agamirzyan, I.,,2015; FergusonD.,FernándezR.E.,2015; GrahamR., 2014; Gaussmayer., 2012].

As a result, there are changes in the organizational models of universities while they try to integrate advanced scientific achievements into the curriculum (Figure 1).

The authors'observations on the development of IT education in Russia lead to contradictory conclusions.On the one hand, there are enough universities in Russia with a strong research infrastructure and experienced teams.However, the global IT market is dynamic and unpredictable and reliance on the latest experience in no way contributes to the transformation of scientific and educational processes in order to adapt them quickly to new market demands (employers, students, potential investors).

That is why it is advisable to analyze the experience of leading universities in the field of IT and its organization of the scientific and educational process in order to determine the readiness of universities, primarily Russian, to new challenges.

ANALYSIS PROCEDURE

The domestic universities participate in the national program of increasing the competitiveness of "5–100"and its main goal is to get into the subject ratings of QS world University Rankings and THE Times Higher Education.Therefore, the position in the QS ranking for the subject areas Computer Science and Information Systems and Engineering in Electrical and Electronic

Engineering was chosen as the first criterion for analysis while selecting a sample of international universities for analysis.

The second criterion was the geographical characteristic. Leading universities of Europe, Asia, and America were singled out to separate groups. The final, but no less important criterion, was the introduction of innovative educational models. All above mentioned allowed authors to determine the best practices for the implementation of advanced educational products. The detailed sample of foreign universities is presented in Table 1.

The following characteristics are considered:

- educational programs at the bachelor's, master's and PhD levels corresponding to the current trends in the IT industry and radio electronics;
- models of the educational process organization;
- research agenda and portfolio of research projects relevant to the areas of educational activity, the availability and capabilities of specialized research centers (laboratories);
- general indicators of the university: the number of students, the availability of programs in English, the budget of the university, the cost of the programs.

The sample for the comparative analysis of Russian universities included 11 universities represented in the subject ratings of QS computer Science & Information Systems and Engineering Electrical & Electronic (Table 2). The content characteristics of the master's programs were taken into account during the selection.

KEY WORLD TRENDS IN SCIENCE AND EDUCATION FOR IT SPHERES

Analysis of the best practices of foreign universities allows us to state that the research agenda plays a decisive role in the development of educational products. *A combination of research and project approaches.* The future Oxford student first of all chooses the field of research, and then a specific program.For example, the research agenda of the Department of Computer Science of Oxford University includes 10 broad areas: algorithms and complex systems, artificial intelligence and machine learning, automatic verification, computational biology and medical informatics, cyberphysical systems, structures and quantum theory, human-computer interaction systems, information systems, programming languages, security.

The design of the department's website is characterized by simple navigation and orientation towards the end user (Figure 2).

Programs have simple and specific names that cover a wide field of knowledge in order to show clear correspondence of science and education in many universities. Every student has an opportunity to define more specifically specialization in the future.

For example, at the Technical University of Munich, students can obtain a master's degree in electrical engineering and information technology, in the field of communication technology or energetics.Students can choose one of the following areas of engineering (and, correspondingly, master programs): information technology, information systems, nano-electronics, bio-engineering in the National University of Singapore. The construction of a standard bachelor's degree program in the field of computer science in Oxford is presented (Table 3) as an example of the educational processorganization.So in the first year, students study general professional disciplines, for the second year, disciplines will be added in accordance with individual interests; for the third year students starttheir own project and study only disciplines that interesting for them. The fourth year is devoted to work on the project and study of more complex subjects that are required for work on a final project containing elements of scientific research.

The university welcomes, if the selected research theme projectwill receive a logical continuation in master's project.Sampling of Cambridge programs shows that 86 out of 179 master's programs are fully research, 67 are half-research programs and only 26 applied, although even they contain some areas of in-

Fig.1. The current model of positioning of leading universities [TechTrendsReport,2017; DudmanA.,WearneS.H.,2003;UNESCO,2015;AnnettaL.A.,MinogueJ.,2016]

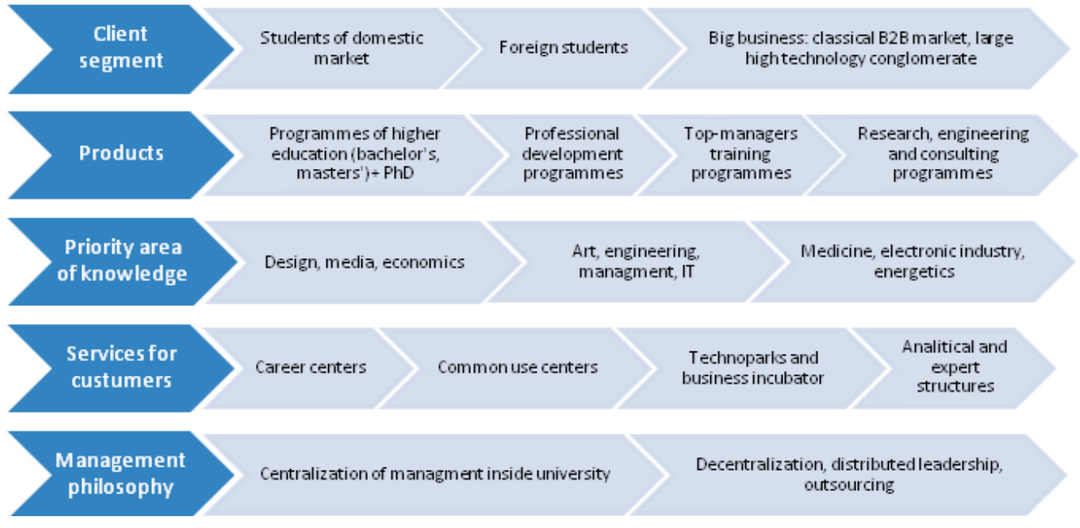


Table 1
Rating of leading foreign universities (according to:[QSWorldUniversityRankings[s.a.]])

University	Country	QS Computer Sciences &Information Systems	QS Engineering: Electrical& Electronic
Massachusetts Institute of Technology	USA	1	1
Stanford University	USA	2	2
Oxford University	Great Britain	7	11
Harvard University	USA	6	8
Cambridge University	Great Britain	5	5
Swiss Federal Institute of Technology in Zurich	Switzerland	9	10
National University of Singapore	Singapore	10	12
Hong Kong University of Science and Technology	Hong Kong	19	29
Nanyang Technological University	Singapore	20	6
Tsinghua University	China	15	7
University of Tokyo	Japan	18	13
Peking University	China	16	22
Technical University of Munich	Germany	40	41
Shanghai Jiao Tong University	China	45	37
Technion – Israel Institute of Technology	Israel	51–100	101–150

formation technology are often have some elements of research work (Figure 3).

Priority of interdisciplinary approach. The interdisciplinary approach is a priority for the formulation of educational programs and research agenda. This trend is particularly evident in Asian universities, where interdisciplinary programs are in separate university structures with separate management (for example, the Graduate School of Interdisciplinary Information Education at the Tokyo University, the Institute of Interdisciplinary Information Sciences at Tsinghua University).

Similar structures are created not only in the sphere of IT education. Students of the Institute of Interdisciplinary Sciences, University of Texas should choose one basic and two related sciences.There are six directions: computer science, arts and humanities, behavioral science, economics and political science, management, natural sciences and mathematics.

Students can select individual modules and creative projects within each direction.

The program "Energy management and sustainability" of the University of Lausanne was created at the intersection of energetics, IT, economics, technology, management.The university presents this program as a scientific and educational platform for training specialists to work in intelligent energy and industrial systems. The program consists of five modules: "Bioprocess engineering", "Ecosystem engineering", "Environmental modeling", "Technological features of new energy", "Technology management", also offers a wide range (more than 20) of individual courses that the student chooses, depending on his preferences in the 3rd and 4th semesters.Management programs at the intersection of management and art becomemoreandmorepopular.For example, the program "Strategic Leadership and Design" (University of Indianapolis) combines in the curriculum such modules as : "Theory of Leadership and Design-Thinking", "Cognitive Systems and Learning Organizations", "Intellectual Capital Development", "Information Management and Production Technologies", " Management Mathematics ».In Russia, ITMO University implements this model in the framework of the Master's program "Art and Science", which is a synthesis of engineering, management and art education.

The master's program "Interdisciplinary Creative Practices" of the University of Edinburgh is successfully implemented at the intersection of IT, science, media, sociology and management.

Graduates work in innovative small companies in IT sphere, software and computer support, media market (TV and film industry), design, architecture, materials science, and create their

Fig. 3. Distribution of master's programs of Cambridge University by types

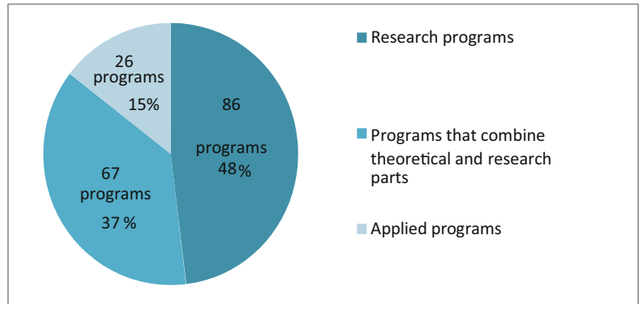


Table 2
Rating of leading Russian universities (according to:[:[QSWorldUniversityRankings[s.a.]])

University	Engineering – Electrical & Electronic	Computer Science & Information Systems
Moscow State University	–	48
Saint Petersburg State University	–	151–200
Bauman Moscow State Technical University	201–250	251–300
Moscow Institute of Physics and Technology	201–250	251–300
Peter the Great St. Petersburg Polytechnic University	201–250	401–500
National Research Nuclear University MEPhI	251–300	–
National Research Tomsk Polytechnic University	251–300	–
Novosibirsk State University	–	251–300
Saint Petersburg National Research University of Information Technologies, Mechanics and Optics	–	351–400
Higher School of Economics – National Research University	–	351–400
Novosibirsk State Technical University	351–400	–
Ural Federal University	351–400	–

own start-ups. The program pays attention to the research unit, particularly such topics as the augmented reality of the visual analytics.

Examples of such interdisciplinary structures or educational products demonstrate the opportunity to develop interesting interdisciplinary programs and researches on the basis of IT and to involve experts from various fields of knowledge.

Interdisciplinaryresearchesareaimedatbreakthroughtechnologies.Hong Kong University has a portfolio of 12 major scientific projects: ecotronics, smart eco-friendly buildings, digital world formation, functional nanostructures, photonic wireless applications, wave and material properties management, human-machine interfaces for future production, biological data analysis, knowledge-based entrepreneurship. All of them form a summons defining the long-term global leadership and sustainable development of the university. The topics of promising researches are necessarily integrated into educational content. Leading Universities of the world want to be first in the development of one or another technology, which creates new reality.

Fig.2. The user interface of the Oxford site

Table 4 shows the distribution of different universities specializations in the framework of scientific research.Universities work active and create large consortiums, and in some cases, global technology platforms. So universities play a leading role in these platforms, and in spite of their classic status of suppliers of innovative solutions [TechTrendsReport,2017;Gitelmann D., Sandler D., Kozhevnikov M., and others.,2015;TechTrends,2017;chataway-J.,ParksS.,SmithE.,2017].

Also, more universal trends that are not directly related to the integration of education and research activities will be considered.

Packaging of educational programs of different levels. Some universities (mainly European ones) started to combine bachelor's and master's programs (or master's and PhD). The key advantages are saving time and cost of education.At the same time, universities "cut off" applicants who want to master only one educational level: for example, in Cambridge, absolute priority is given to applicants who had previously completed their bachelor' straining. Such a relatively aggressive strategy helps to conduct a hard "screening-out" of persons who are not interested in conducting high quality scientific researches.Education for education is unprofitable for leading universities, because it does not give the university any benefits, except for short-term financial.

Increased attention to foreign students. Internationalization is not a new trend, but by attracting international students (and teachers), universities gain access

Table 3 Structure of the bachelor's degree program in Oxford, %

Year	General professional subjects	Elective courses of specialization	Advanced specialization	Project	Exam
1	100	—	—	—	5 subjects
2	50	40	—	10 (team)	5 subjeccts
3	—	75	—	25 (individual)	10 subjects + projectreport
4	—	—	63	37 (individual)	Continuous assessment of progress + project report

to new knowledges, markets, companies and create a variety of centers of excellence or platforms in order to leadsustainably in science and education.For example, in Oxford, the share of foreign students is about 30%, in Cambridge and the Swiss Federal Institute of Technology in Zurichmore than 35%, at Peking University - 22% (Figure 4).

PECULIARITIES OF RUSSIAN IT EDUCATION

The analysis of educational productsmarket in the Russian Federation shows that few interdisciplinary analog programs are offered. The number of master's programs devoted to the problems of intelligent control systems and system software engineering is increasing (up to 20%), but about half of all programs have traditional contentA selective analysis of the curricula of such programs showed that specialized subjects do not receive more than 30% of the study time.

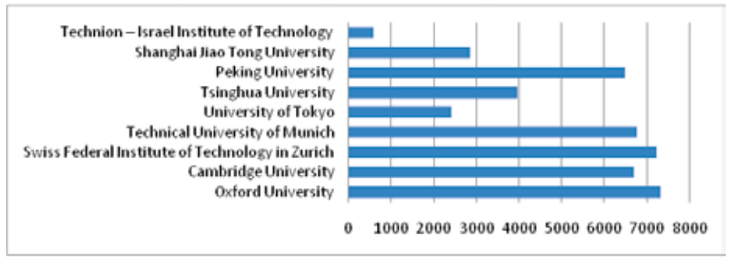
The organization of the educational process for the IT industryspecialiststraining has its own characteristics.Leading Russian universities prefer a smaller number of IT trainingareas and more programs within each direction. Quite conventional this trend can be called a specialization. Thereare three programs for one direction on average, (Fig. 5). Only five areas of training are priority for universities,, where the largest number of master's programs is concentrated.There is a gap between education and science. Specialized courses in many universities are taught without reference to specific sectoral tasks, curricula are formed with an orientation toward the interests of teaching collectives, students are weakly involved in research activities. A number of higher educational institutions have attempted to change the

Table 4
Leading world universities-leaders in breakthrough studies of information technology

University	Artificial Intelligence	Neural networks	Robotic complexes and systems	Man-machine interfaces	Recognitionsystems	Cyber security and data protection	Big Data	Self-learning systems and mechanisms	Bioelectronics and biointerfaces
Massachusetts Institute of Technology	+		+	+	+	+	+		
University of Toronto		+							
University of Berkeley		+				+			
Stanford University				+		+	+		
University of South Carolina				+			+		+
Carnegie Mellon University				+					
Worcester Polytechnic Institute			+						
Nanyang Technological University								+	
University of Tokyo			+			+		+	
Oxford University	+								
Polytechnic University (China)									
University of Edinburgh				+					
Vienna University of Technology					+				
University of Birmingham					+				
University of Michigan									+
Harvard University									+

Note: "+" is the area where the university seeks leadership.

Fig.4 Number of foreign students in leading universities



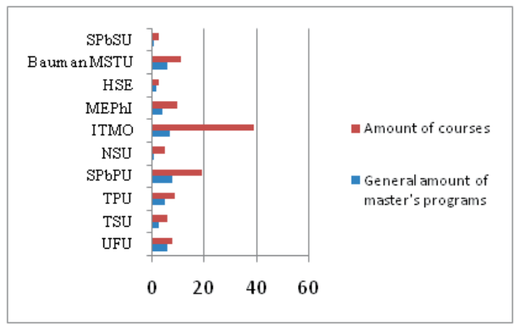
organization of the scientific and educational process in order to solve this problem. So, since 2017 MIPT and Novosibirsk State Technical University started a reception in the areas of preparation for the Master's program in competitive groups.Groups can be supervised by departments or individual scientific and educational groups, which must have research projects, scientific works, issued textbooks and other developments in line with the educational program.This experience can be considered as an attempt to approach the Western model.

In 2013, the University of Innagolis was established in the Republic of Tatarstan in order to train modern staff for the IT industry. The university has 13 research laboratories and 3 research centers (Table 5), which conduct research and provide a platform for the practice of students entering the training, implement consulting and educational business projects for existing customers. This university uses an original educational model. For example, the programs "Managing software development" and "Developing safe systems and networks" spend first year for theoretical and practical studies, and during second year students participate in the industrial project of the IT company. So such applicants are subject to stringent selection criteria: rigid criteria for selection : at least 1.5 years of work experience, good knowledge of English, knowledge of the basic programming languages, protocols and architecture of computer networks, experience in writing technical documentation.The cost of master's program is in 5-10 times higher than the average market (1400 thousand rubles per year), but the candidates who have been selected receive a grant that covers the costs of training.

For comparison: the year of study at the MSU is 300,000, in MIPT-250,000, at the Tomsk State University- 170,000, at St. Petersburg State Polytechnic University-150,000, at the Novosibirsk State University-100,000. The special attention is paid to a limited set of master's programs, graduates of which receive a double diploma.In the represented universities the most remarkable examples are the programs:

- Verification and testing of hardware and software modules of telecommunication systems (Tomsk State University + National Taiwan University);
- Intellectual systems (St. Petersburg State Polytechnic University + City University London + University of Hanover);computer networks and telecommunications(Tomsk Polytechnic University + Technical University of Munich).

Fig. 5. Cut-out on the leading Russian universities: coverage in the areas of IT-preparation and master's programs



WHICH SPECIALISTS ARE IN NEED FOR IT-INDUSTRIES?

According to the Ministry of Communications and Mass Media of the Russian Federation, in order to solve problems in the field of technological innovation and import substitution, at least 350 thousand qualified specialists will be required by 2020 in the field of information technology. It is also expedient to consider expert opinions on related issues within the framework of this work.

- What are the main trends of the personnel market for the IT industry?
- What are the current requirements of employers for IT professionals? Do graduates of Russian universities meet these requirements?
- Are there any changes in Russian universities in order to ensure better compliance with the demands of IT companies for staff?

Let's start with the trends of the IT market specialties. According to experts from Yandex, at present they are following: the demand for specialists in the field of data science is continuously growing in all developed countries ;

- According to the Glassdoor rating, in 2016 the position of an expert in analytical data is the best work in America. The evaluation was conducted on the basis of three key factors: the number of vacancies, wages and the rating of career opportunities.Also in the top 10 of the best vacancies were: a specialist in software architecture development, a specialist in mobile applications and a software engineer;
- In Russia, concurrently with the growing demand, the prospective professions are still in demand for traditional IT specialties: developer Java, PHP, c / c ++, c #, 1C, Python. The popularity of Swift and Unity3D is growing. At the same time, fewer experts on Objectivec are required. In general, the directions of IT-preparation remain one of the most popular among university entrants in Russia.One of the main reasons is the wages of IT specialization graduates: according to the latest Superjob rating, IT graduates receive the most competitive salary in the labor market [Rating, 2017]. The universities in the rating are presented in Table 6. In comparison with most foreign universities, these figures look very modest (Fig. 6), however, for the Russian Federation the proportions between the cost of higher education and annual salary of a graduate are approximately the same.
- According to the data presented in Table 6 and Figure 6, several comments should be made. Comparison of the graduates average salary is not fully objective and correct: firstly, because of its averaging and aggregation, and secondly, because of the significant socio-economic conditions difference between regions.

Table 5
Scientific infrastructure of Innopolis University

	Исследовательские центры
Cyberphysical systems: program aspects related to the development and operation of KFS **Cognitive robotic systems:** verbal and non-verbal interactions between humans and robots, symbolic justifications, large man-machine cognitive systems **Cloud systems and services visualization:** development of a new generation of cloud storage and data management technologies with an integrated security system and guaranteed access and fault tolerance **Intellectual robotic systems:** developments in the field of unmanned ground robots and aircraft. The interaction of autonomous homogeneous and heterogeneous groups of robots **Software engineering:** developing an environment for creating high-reliability programs-automatic testing of code reliability and automatic replacement of parts of code with reliable analogs **Intelligent transport systems:** analysis of transport data. Modeling traffic using adaptive control algorithms. Long-term planning of transport infrastructure development **Development of industrial software** **Architecture and software development modules** **large data and information systems:** methods for managing large data sets and computer-controlled data analysis (datamining, web-mining, machine-learning) **Artificial intelligence in the development of games:** attracting users of computer games to interact with artificial intelligence through the game space (video, desktop, mathematical and educational games) **Machine learning:** Research in areas: machine learning algorithms, in-depth training, image processing and computer vision, context-oriented analysis **computer analysis of medical images:** automatic recognition of X-ray images, automatic diagnosis of various forms and localization of the cancer and tuberculosis **Electronic educational systems**	**Information Security.** Science-intensive projects and prospective research in the field of practical cyber securityIIOT / IOT systems and Internet / Intranet networks. **Modeling and analysis of large data in finance and economics.** Research and business education in the field of computer analysis and mathematical modeling of financial and economic processes. **Automation of business processes.** Recommendations (including consulting) on improving the company's non-processes through improved application software

Despite the really high demand for the IT industry as a medium for career development, more than half of the working specialists in some and related industries (for example, in radio electronics) are representatives of the older age group (over 45 years).

The preferences analysis of the master's degree graduates in IT specialties in the areas of professional development is presented in Fig. 7. Approximately two-thirds of the respondents would prefer the engineering direction of IT-processes, and one third-managerial. These are the conclusions of the survey conducted in 2015. Almost 2,000 students and IT specialties graduates studying in the Russian universities took part in this survey [Zhilyaev A., Oleinik A., 2015].

Taking into account the requests of domestic employers, 4 most promising profiles of the magistracy are singled out:

- data science: methods of extracting knowledge from data, mathematical methods of modeling and forecasting, modern software systems and programming methods for data analysis;
- system and software engineering: industrial production, software, creation of information and communication technologies, systems for various purposes;
- mathematical methods of optimization and stochastics: modern applied mathematics and mathematical modeling, stochastic analysis and discrete mathematics, optimization methods with emphasis on convex optimization methods in high-dimensional problems;
- data analysis in biology and medicine: interdisciplinary education for the analysis of specific medical and biological data through the latest information systems and software packages.

As our analysis of Russian universities has shown, the first two profiles are reflected in one form or another in the master's degree programs. Unfortunately, very few are proposed in other areas. The content of most leading universities master's programs also does not fully correspond to the new types of professional activity of IT specialists, which will be in demand for the next 3-5 years.Experts of the Russian Association of Electronic Communications made a perspective portrait of the professions of the future IT industry.So,HR-directors mention among the new professions in the IT sphere, Internet and digital technologies that will appear in the next 3-5 years, new specialties related to BigData: generation and storage to analysis, modeling and visualization; professions related to artificial intelligence systems (including the processing of natural languages).

The emergence of both "serving" specialties (operators, engineers), yet "creative" (direct development, creation of devices) is expecting in the field of mobile technologies and robotics.

[Fuchsw.,2012;FloresN.H.,PaivaA.c.R.,LetraP.,2016;Mohd-YusofKh.,HelmiS.A.,PhangF.A.Etal.,2015].

We can identify the following key areas that will be particularly in demand in the IT industry according to the outlook for next 3-5 years:

- computer linguistics and artificial intelligence;
- robotics and robot software;
- 3D-design and printing;
- augmented and virtual reality;
- cloudtechnologies;
- IT in education and consulting
- "smart cities";
- bioinformatics and IT in medicine;
- data science;
- Internetofthings.

Today only 13% of graduates can say that they have enough knowledge for their work [Zhilyaev A., Oleynik A., 2015].Only half of all graduates are satisfied by process of studying at the university, which is associated with a significant disparity between theoretical and practical occupations (not in favor of the latter), as well as a lack of interaction in the process of studying with IT enterprises.

This conclusion is closely correlated with the requirements of leading IT companies (Google, Yandex, Microsoft, Sberbank MTS, Beeline, Megafon, Rostelecom, Lukoil) toyoung staff:

- High motivation to work;
- Ability to self-study, independence, enthusiasm, focus on personal growth, active life position;
- knowledge of English is obligatory;
- sociability, diligence, responsibility in solving problems with high uncertainty.

Among these requirements, there is essentially no demand for specialized skills. As a rule, large employers consider universities as a tool for transferring knowledge, but not as a platform for professional development and begin to create their own universities for programmers (this approach is now implemented by Mail. RuGroup).Another mechanism is the creation of basic departments in universities by the forces of industry leaders, while the educational process is reoriented to involve students and course participants in projects that are performed on examples of real companies.

The survey of the head of the enterprise in the field of information technology, telecommunications and radio electronics, generalization of expert opinions, open sources, shows that fundamental problem of the gap between training in the sphere of IT and employing employers is the absolute loss of life-cycle products for modern technologies.

On average, designing and launching an educational program in Russian universities takes a year, bachelor's degree study is four years, master's degree two more.IT sector can survive a few mini-revolutions during 7 years, in response to which the university does not respond by promptly updating the content and teaching methods.Unfortunately, the curricula approved on the first year actually do not have operational flexibility, therefore, it is necessary to revise the models of the educational process for training both IT specialists and personnel for other dynamic sectors of the economy.

Perhaps the situation could be changed by the organization of the continuous training of IT specialists, starting even with the high school classes (Fig. 8);increase the number of programs created on the basis of their own educational standards, pilot implementation of adaptive programs, when in the control points (for example, the completion of the academic year) the customer, teachers and students jointly determine the results and trajectories of training, a set of relevant training courses and practices of the next stage.

Table 6 The best universities in Russia in terms of salaries of graduates 2011-2016

rank	University	Salary, RUB.*	Average grade USE
1	Moscow Institute of Physics and Technology	136 000	93,5
2	National Research Nuclear University MEPhI	110 000	90,0
2	Bauman Moscow State Technical University	110 000	88,1
3	ITMO University (Saint Petersburg)	98 000	88,6
4	Lomonosov Moscow State University	95 000	86,9
5	Novosibirsk StateNational Research University	90 000	81,1
6	Moscow Power Engineering Institute (National Research University)	87 000	74,9
7	Higher School of Economics - National Research University	85 000	78,0
7	Saint Petersburg State University of Aerospace Instrumentation	85 000	90,4
8	Perm State National Research University	83 000	78,0
8	Moscow Aviation Institute (National Research University)	83 000	75,0
8	National Research University "Moscow Institute of Electronic Technology"	83 000	79,0
8	National University of Science and Technology "MISiS"	83 000	80,8
9	Lobachevsky State University of Nizhny Novgorod - National Research University	82 000	70,8
9	Ural Federal University		76,2
10	Kazan (Volga region) Federal University	81 000	80,0

*Salary, which can be claimed specialist who graduated from the university rating participantin Moscow.

EXPERIENCE OF THE URAL FEDERAL UNIVERSITY

The abovementioned global and domestic IT trends in the development of IT education are reflected in several new educational products of the Institute of Radioelectronics and Information Technologies of the Ural Federal University (Ural Federal University), designed on the basis of the analysis carried out by the authors.In particular, due to this study has been developed master's programs "leadership in engineering, management, IT business, "Intellectual Robotics", "Intelligent Information Systems and Technologies for Functional Diagnostics and Neurorehabilitation", "Adaptive Data Analysis", "Large Data Analytics and Video Analysis Methods".

The concept of programs assumes that they will become points of growth in both the scientific sphere and in education, generating a variety of additional products for different groups of customers. For example, the program "leadership in engineering, management, IT business" was prepared as a joint project of the Institute and the Higher School of Economics and Management of the UFU. The program is aimed at training specialists in demand in the most promising and dynamically developing sectors of the economy: artificial intelligence and machine learning, bioengineering, IT consulting, cybersecurity, additive technologies. The project was developed in accordance with the UFU standard of training for energetics and high-tech industries - with the federal standard of higher education in the direction of "Management", which makes it possible to organize more flexible of the educational process in comparison with the federal standard of higher education.

The program is implemented as a set of modules, grouped as follows:

- unified modules, mandatory for the direction of training;
- specialized modules that are mandatory for the training profile;
- variable modules - selected when forming an individual learning plan.

Each module is a logically completed by content, methodical provision of an independent educational unit, focused on the formation of a group of interrelated competencies that determine the specific results of training.The program organically combines managerial and engineering disciplines, the mastering of which allows specialists to navigate quickly in IT innovations, to create their own technology start-ups, and to work successfully in large IT companies (Table 7).

The program "Intelligent Information Systems and Technologies for Functional Diagnostics and Neurorehabilitation" combines IT, medicine and neuroscience and was implemented jointly with the Ural State Medical

Academy, the Interuniversity Scientific Center for Bioengineering, the corporation Triton Electronics, the New University of Lisbon (Portugal) and the University of Wisconsin (USA) take part in the development of the research infrastructure of the program. There is a classical engineering module "Digital processing of signals and images", and several interdisciplinary modules ("Devices and Information Technologies for Medicine", "Sections of science on the brain and the autonomic nervous system", "Mathematical modeling and analysis of data in medicine and biology ") and two design and research modules (" Methods of modeling and research in engineering "," Professional Communications ").

Master's program "Analytics of BigData and methods of video analysis" provides the study of modern mathematical methods and software for solving problems associated with the problems of Big Data. It focuses on the research and practical

Fig. 6. Comparison of universities in terms of the cost of training and the average starting salary of graduates after graduation [10TopEuropeanUniversities(2017); CollegeROIReport(2017);CompareSalariesbyUniversity([s.a.])]

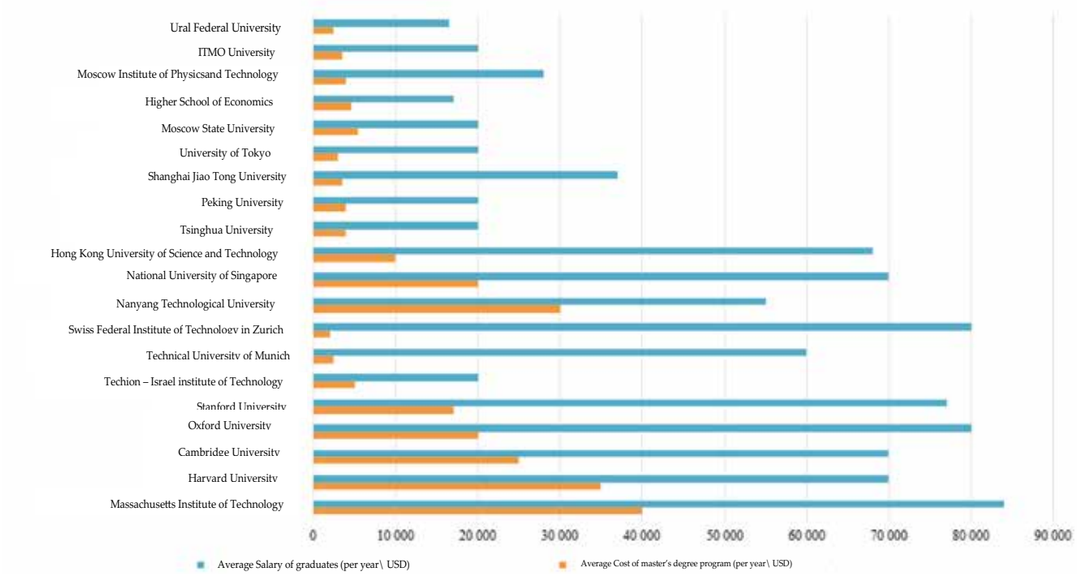
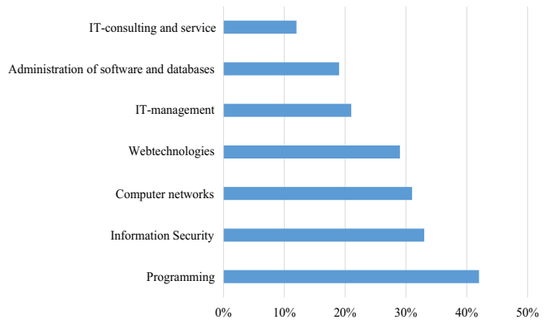


Fig. 7. The most demanded by students of IT-specialties types of professional activity



implementation of DataMining and BigData concepts in key industrial sectors such as metallurgy (optimization of production processes), rail transport (innovative methods of modeling and optimization of technological processes of transportation), etc. These projects are done with the help of mathematical methods, which include in-depth data research, graph optimization algorithms, video analytics, including digital image processing, which serves as a rationale for choosing one of the newest Data Discovery-Teradata Aster platforms.

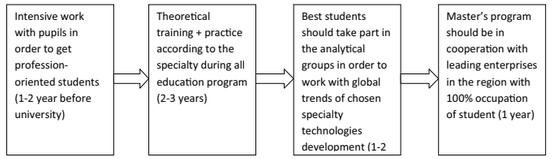
CONCLUSION

Summarizing master's programs analysis results and educational models of leading universities, the expert opinions of IT companies chiefs, we made recommendations that may have practical value for Russian universities in the design of branded educational products that support the implementation of the leadership.

Creation and promotion of new interdisciplinary educational programs. Universities of the Russian Federation have a shortage of training programs, demanded in the most promising and dynamically developing branches of economy: artificial intelligence and machine learning, bioengineering, IT-consulting, cyber security, additive technologies.

The global trend-program is a the master's program at the intersection intersection of biology, IT and neuroscience. Moreover, There is a demand for programs at the intersection of engineering, Art management. It is expedient to prefer short-term

Fig. 8. Stages of continuous training of specialists for the IT industry



programs (pilot projects) for the preparation of students both engineering and humanitarian specialties.

The focused programs for training specialists for specific professions and functions are more familiar for our country. Nevertheless, in the next five years, demand for interdisciplinary Professionals in the IT sphere will grow. According to the dynamics, this growth can be quite unexpected and rapid.

In addition, it is necessary to strengthen interaction between institutes (departments), departments, laboratories, scientific and educational centers inside and outside the university, and also to enter into network partnerships with a knowledge-intensive business. This will help to update the research agenda, to create educational products that are of interest for the market, primarily commercial ones. Radical increase of the scientific component in the magistracy.

In order to enter the TOP-100 QS ratings, it is necessary to intensify scientific and publishing activities. One of the tools is the involvement of undergraduates in research projects. Presumably, this will increase the number of publications by 20-30%.

An additional point is that the combination of training on the basis of Project-based and Research-based models will contribute to the formation of a unique brand of programs. There is no necessity to make all master's degree programs research ones, it is necessary to identify priority products, in the first place, promising for promotion in the global market.

Developed programs. The acting in the Institute of Radioelectronics and Information Technologies, Ural Federal University "leadership in engineering, management, IT business", "Intellectual robotics", "Intellectual information systems and technologies for functional diagnostics and neuro-rehabilitation" are designed taking into account world trends in IT education, are interdisciplinary and have the potential not only to become points of growth of the university, but also to form a scientific and educational ecosystem that integrates academic and corporate partners, support promising scientific developments in the field of IT and related technologies.

Table 7
Modular structure of the master's program "Leadership in Engineering, Management, IT-business" (fragment)

Module	key discipline
Proactive management	Leadership strategies. Corporate early warning systems. Innovative leadership
Information Assets Management	Management of IT resources of the knowledge-based business. Organization of the enterprise information system
System engineering for technological modernization	Fundamentals of system engineering for engineers and managers. Engineering creativity
Information-analytical systems in business	Smart multiagent systems. Business-modeling

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