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THE 'THIRD PLATFORM' AND NEW EDUCATION REQUIREMENTS

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Abstract

This article discusses some of current trends in the IT higher education. Current development of the computer industry as well as respective new challenges to higher education are analyzed. The article deals with the changes implemented in the IT curricula, as well as education technology changes. The reasons of strengthening links between education and industry are explained.

Keywords: *information infrastructures, third platform, IT education.*

1. THE THIRD PLATFORM — PRIMARY AREA OF GROWTH OF THE COMPUTER INDUSTRY IN THE NEXT FEW YEARS

Thanks to the worldwide analytical companies, primarily to IDC, the history of the computer industry is commonly developed into stages [1]. Each stage corresponds to the so-called "platform" that combines technologies that have grown at the respective stage. The entire history of the "computer age" can be allocated to only three such platforms (Figure 1). The heyday of the first platform chronologically relates to the period before 1985. The first platform is characterized by mainframes used as primary computing means and terminals used as primary means providing for the user's operations. By the end of this period there were millions of users and thousands of applications for the first platform in the world.

In the next 20 years, until 2005, primary development vector gradually shifted to the second platform. It is based on the use of client-server architecture and widely spread variety of networks, both local and long-distance, including the Internet. The second platform is also characterized by the spreading of personal computers. The second platform was used by hundreds of millions of users, dozens of thousands of applications were created to be used on it.

Around 2005, new IT infrastructure trends became obvious which later were noted, analyzed and formalized by IDC analysts in the form of a third platform concept. This formalization was first made in 2007. In general, the third platform is characterized by rapid development of four technology areas: social networks, big data analytics, fast mobile access, including access to enterprise infrastructure and cloud computing and services. The number of users worldwide reached billions; the number of applications — millions. Development of four above said areas results in a sort of synergy: mutual complement and mutual penetration of these areas bring qualitatively new results. New technologies are being developed on the basis of the third platform that are fundamentally impossible for the second platform.

It should be understood that the proposed periodization is conditional in many respects. The chronological framework is very blurred. Different platforms successfully co-exist, interact

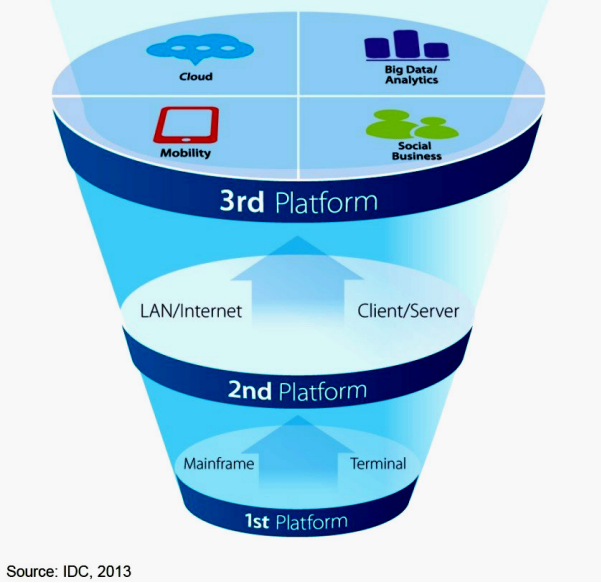

Figure 1

with each other. For example, now, in 2016, there are also successfully operated corporate infrastructures, built on the principles of the first platform. Third platform elements originated much earlier than 2005. For example, a key concept of the third platform — virtualization has been known probably since the 60's of the last century.

So, where are we now? Most IT infrastructures for both corporate as well as for private use are still built on the basis of the second platform. At the same time it is clear that most of the newly created solutions are based on the third platform. The total volume of such solutions is growing rapidly from year to year, while the amount of second-platform solutions is either not growing or is growing very slowly. These trends are naturally reflected in all processes occurring in the industry. Investments in products and solutions specific to the second platform are hardly growing, although still prevail in absolute terms. Investments into the third platform, on the contrary, are growing very fast (Figure 2).

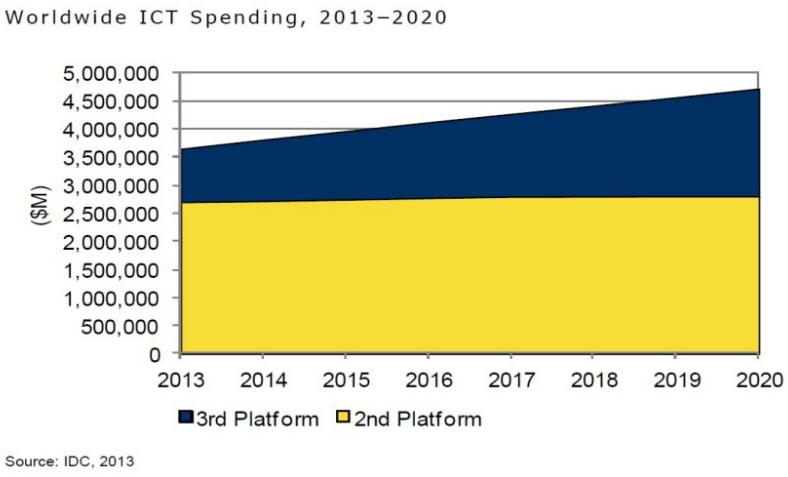

Figure 2

Gradual transition to the new paradigm could not help but affect the requirements to specialists engaged into IT infrastructure development, implementation and maintaining, as well as into development of applications that are to be operated therein.

2. CURRENT STATE OF IT EDUCATION

Education system of any country is well-known for its conservative nature. This has both pros and cons. Conservatism allows to keep higher education safe from unreasonable experiments, maintaining continuity in education standards. Thanks to conservatism the effect of negative social factors is also reduced. For example, the effects of occasional economic crisis and political turbulences in various countries are smoothed out due to the high inertia of the education system.

Let's note the fundamental difference between education sectors in terms of their need for changes. For example, if changes in the teaching of classical sections of mathematics from year to year are insignificant, and, if any, are hardly related to the content of education, but most likely to the introduction of some new forms and approaches. At the same time, IT education is changing very rapidly. Subjects that were relevant 10 years ago, often lose their relevance. New subjects come instead, about which no one has ever heard of 10 years ago. This picture, by the way, brings along lots of organizational difficulties which universities sometimes cannot adequately cope with. Often a single faculty gathers specialties requiring completely different approaches to change management during the education process, which creates special demands to the management of educational institutions, regulatory framework and methodological support.

Let us study what an IT master's degree curriculum in Russia is composed of. If we look at the graduates mainly employed with companies connected with information technology, we can see that the range of specialties is wide enough, though experts prevail who graduated in one of the following specialties:

1. COMPUTER AND INFORMATION SCIENCE:
   (a) Mathematical support and administration of information systems,
   (b) Fundamental Informatics and information technologies.
2. COMPUTER SCIENCE AND ENGINEERING:
   (a) Computer science and engineering,
   (b) Information systems and technology,
   (c) Applied Informatics,
   (d) Software Engineering,
   (e) Information systems and technologies,
   (f) Computer systems and networks.

In any case, these are the main specialties for training of IT engineers. In this case we consider professionals associated with the development of information systems as well as with their operation in the broadest sense of these professional activities. The curriculum for these degrees is composed in accordance with the education standards set forth in the documents of the Ministry of Education and Science of the Russian Federation. The following programs to get master degree in IT are being used in West universities and in the USA:

1. Computational and Mathematical Engineering.
2. Computer, Communication and Information Sciences.
3. Electrical Engineering and Computer Science.

Currently, educational standards in many countries are based on the competence approach. They specify the competence to be acquired by students as a result of the training under the curriculum, as well as basic courses recommended for the implementation of the curriculum. For example, for master's degree curriculum in Information systems development and management, courses in project management, software quality control, additional chapters of mathematical logic, history and methodology of computer science are recommended, in short, courses which have been taught for more than ten years already. The variable part of the master's program is usually determined by the university itself. Modern educational standards give universities greater freedom in determining the specific courses to be included in the curriculum. Analysis of available specific curricula shows that many of higher education institutions during master's degree training paid a lot of attention to such courses as network technology, modern operating systems, design and development of information systems. We may note that in fact the curricula implement the requirements to a professional performing works within the second platform. The competence specific to the third platform are not usually covered to full extend. We mention such ones as design of information systems for use in a virtualized environment, development and operation of cloud applications, cloud infrastructures management, etc. We should note that in some cases fundamentally new courses reflecting the competence inherent in a third platform are not to be necessarily included into the curricula. It is enough to modify the existing courses to include new sections. Thus, a course on operating systems can be supplemented with sections that reveal the specifics of mobile operating systems or operating systems used in the cloud.

3. NEW DEMAND OF THE INDUSTRY AND EDUCATION

Let us try to identify the technologies inherent in third platform, which to some extent should be familiar to IT graduates of a modern university. Since the third platform is primarily characterized by four areas named above, i.e. social networks, big data analytics, mobile platforms and cloud computing, we'll try to understand the meaning of each of these areas for the modern IT education, and which technologies should be covered by the higher education curriculum. It should be said that when the third platform is concerned, some other areas in addition to the four named above are given new development, which are not addressed in this article. For example, information security becomes more important, which is associated with the need to transfer big data volumes and spreading of distributed development.

3.1. Big Data Analytics

Fortunately, standard curricula for IT training include mathematical basis, without which it is difficult to train a professional in the field of big data analytics. This mathematical basis is most extensively present in the curricula for training of computer professionals at mathematical faculties, to a lesser extent in the polytechnic faculties and universities. First of all, we have in mind the probability theory and mathematical statistics courses, as well as in-depth mathematical knowledge. In addition, the curricula should, in our opinion, include training in the application of the known methods to solving practical problems. This in turn involves understanding of the specific nature of big data, their life cycle from the collection and preparation to model building and obtaining analysis results. Also, the curricula should include theoretical and practical study of one or several tools and software environments used for big data analytics, for example, R programming language, the MapReduce technology, as well as any practical imple-

mentation thereof, such as Apache Hadoop, or Greenplum Software implementation. Separately, we note some of the technologies and tools which are not directly related to the analytics, but which are often used together with analytic applications, such as the initial data preparation, their efficient storage and visualization of the analysis results.

3.2. Cloud Computing

Learning the basic aspects of cloud infrastructures and their fundamental difference from the classic one should be ensured. Before we delve into the technological aspects of building clouds we should dwell on the concept of virtualization of various resources. It is important to understand how providing of processing power, disk space, network resources is replaced with providing of services. The need to provide broadband access to the cloud, availability of a cloud management system that provides for self-service, flexibility of cloud infrastructure and even the business aspects of the cloud use - all this should be covered by the respective course prior to going deeper into the technological aspects of cloud computing.

Three basic models of cloud services are IaaS, PaaS, SaaS, as well as the classification of clouds in the degree of publicity (private, public, hybrid) should be considered in detail.

Turning to the technological aspects of cloud infrastructure, we should note that software stack, which ensures cloud operation should be studied comprehensively, with examples of software implementing virtual level, control level, service organization level, as well as additional features that ensure security, continuity of operations, etc. Special consideration should be given to the physical level of cloud building.

For a deeper understanding of the subject the three main components of cloud resources need to be considered in detail — processor power, memory, and network resources, unless this is studied outside the scope of cloud computing courses. Besides, the concept of virtualization applied to each of the three types of resources is a key one.

The concept of software defined resources should be studied in detail due to its importance for building solutions within the framework of the third platform. Techniques and approaches to automatic resource management should also be covered.

From a practical point of view it is important to consider, as well as to give students an opportunity to practice the use of an environment for third platform applications development and deployment, for example, Spring Framework and Cloud Foundry.

3.3. Social Networks

Analysis of the world experience in teaching subjects related to social networks shows that three main aspects are examined: how an individual user uses social networks, how social networks are structured from the technological point of view and how they can be used at the corporate level. The first of these aspects is mainly devoted to the classification of social networks, the goals that a user can achieve using a particular network, as well as ethical and legal aspects of their use. The technology of social networks implementation is important for a narrow circle of professionals engaged in the development and maintenance of the networks. Within the third platform the use of networks and their content for achieving a variety of business purposes is the most interesting part. It seems that this third area should be the most widely represented one in modern IT education. It should be noted that this area often requires knowledge of the disciplines that are not traditional for IT education, such as for example sociology and marketing.

Let's note some specific tasks that can be addressed through social networking: marketing campaigns, creation of professional communities, analysis of public opinion on specific issues, and in some cases the impact on public opinion, organization of team cooperation, crowd sourcing, etc. It seems that the most interesting aspects related to social networks are those associated with other characteristic of the third platform, parties, namely, analysis of big data collected through social networks, provision of cloud services through social networks, role of mobile platforms in distributing and use of social networks.

3.4. Mobile Platforms

Rapidly growing popularity of mobile platforms and increasing number of applications results in the demand for developers with appropriate skills, so modern IT education cannot do without a course or courses on mobile platforms development. Such training should cover the following aspects: development environment, architecture of mobile applications, cross-platform development, specific user interface features associated with the mobile platforms resource constraints. In fact, virtually every engineering aspect of the software development, whether it is quality control or performance optimization, has its own peculiarities due to transition to the mobile platform, which requires training.

The required amount of knowledge is not limited to application development. It is necessary to study the interaction of applications with server hardware and cloud applications, access from mobile applications to corporate infrastructure, issues of information security during use of mobile platforms, the specifics of networking.

3.5. Education Technologies

Apart from the fact that the transition to the third platform creates new requirements to IT education, it also provides new technological and methodological possibilities for increasing the effectiveness of the education process. The popularity increases, new educational technologies become widely used. We mention some of them.

- Teachers during lectures use presentations that facilitates the perception of the material. Testing using online forms is often used to conduct tests and examinations.
- Many universities use different educational process support systems. These systems ensure central storage and access to educational information, and solves learning monitoring and results analysis tasks. Such systems provide remote interaction between professors and students, enable universities to organize independent work of students, and students to quickly and efficiently acquire knowledge and to check whether it is correct and well-learned. These systems are usually web-based, allowing teachers and students to access it via a standard web browser.
- Distance education is becoming increasingly popular since recently. To this end, training courses are being designed for mass interactive participation using e-learning technology and open access through the Internet. Traditional learning materials are video recordings of lectures, recommended literature and homework. These courses can be designed for students of different levels of training - it can be courses for both beginners and experienced professionals. Good or bad, but we can say that the role of lectures gradually decreases. Online lectures become available recorded by the best specialists of the best universities. The lectures can be listened by students at any convenient time and at their own pace which allows to learn the material well. The center of gravity shifts from the classroom towards laboratory works and practical exercises.

- We should note that the level of computer literacy of applicants, yesterday schoolboys, has immeasurably increased in the last ten years, which allows to easily use new technologies from the first day in the university.

3.6. Equipment and material support

The changes in teaching process under consideration related to the need to train professionals to work in the framework of the third platform also have an impact on the requirements to providing higher education institutions with the necessary equipment, software and access to the services of cloud service providers.

If we talk about building a platform for practical works as part of the educational process, a university will have to decide whether it should build its own, albeit small, private cloud to be used for building appropriate infrastructure, or to use the services of commercial providers. Each university will decide it independently, considering its specific features, necessary resources and financial means. The first option requires a large one-time capital investment, and operating costs will be high, given that building and maintenance of IT infrastructures is not a core activity of an educational institution. The second option is easier from an organizational point of view and requires no capital investment. At the same time, operating costs can be quite high for a university. For example, according to some estimates, the deployment of the popular cloud platform Cloud Foundry on Amazon Web Services will cost about $ 8,000 a year. If we talk about the platform for big data analytics, the deployment of minimally reasonable infrastructure in the cloud for a popular distributed computing environment Hadoop also requires significant operating costs. It should be noted that if a university already has a data processing center used for any other purposes, increasing its capacity for teaching the basics of the third platform technology does not seem a big problem.

Fortunately, the situation is much better with the software. It is known that free software can be often operated on the platform solutions that are used within the paradigm of the third platform. Cloud Foundry and Hadoop mentioned above, as well as the popular OpenStack (establishment of cloud infrastructure), KVM (virtualization) and many other software products are distributed freely. Commercial software that performs the same functions, in most cases, can be obtained free of charge when used only for educational purposes.

3.7. Cooperation with Industry

A close cooperation between universities and potential employers has become another trend of IT modern education. We note some factors that have become the reason for this. These factors can be divided into two groups: those that encourage higher education institutions to move towards the industry, and those that, on the contrary, encourage employers to move toward universities. Both groups include enough factors that explain close and fruitful cooperation that we observe everywhere.

Many universities somehow realize that they cannot fully keep up with IT technology development, and in order to maintain the competitiveness of the education they need to engage industry experience, whether by engaging professionals and managers engaged in the production of software as lecturers, or by participating in joint research projects, inviting industrial companies to conduct practice and prepare diploma and course works, and so on. Universities are also interested in good employment for their graduates. This increases the prestige of the university and attracts applicants. In some cases, universities can obtain access to unique hard-

ware and software, expert advice on new technologies only thanks to cooperation with existing companies. Sometimes such cooperation ensures additional funding for universities.

The fact that many universities introduce a full-time position of a manager of the relationship with the industry is a confirmation of the increasing interest of universities in contacts with the industry. This position is usually occupied by a professional having experience in the industry who is able to represent the interests of all departments of the university on the one hand, and has a clear idea of how modern enterprise operates, on the other hand.

For companies engaged in software development and maintenance, as well as other IT activities, collaboration with universities is vital to gain access to human resources. Due to current situation on the labor market in some countries it is not an easy task to equip a company with qualified personnel at a reasonable price. As a result, some IT companies develop their own undergraduate programs, allowing to hire the best graduates of the best universities before they are given the diplomas. Companies are also often interested in collaboration with universities in the field of research and development. Some companies inform future users about their products and solutions through university programs, which will have a positive impact on the demand for the company's products in the future.

Summing up we can say that at the present stage broad mutually beneficial cooperation between the companies and higher education institutions in the field of IT has become a reality, which, on the one hand, affects the structure of the learning process (although it does not change it radically), and, on the other hand, helps to satisfy requirements to education in terms of compliance with the current level of technology development. This is another modern trend of IT education development.

References

1. Gens, F. "The 3rd Platform: Enabling Digital Transformation" [Online], available at: http://www.tcs.com/SiteCollectionDocuments/White-Papers/3rd-Platform-Enabling-Digital-Transformation.pdf [Accessed 30 Feb. 2016].

«ТРЕТЬЯ ПЛАТФОРМА» И НОВЫЕ ТРЕБОВАНИЯ К ОБРАЗОВАНИЮ

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Аннотация

В статье рассматриваются некоторые современные тенденции в высшем образовании в области ИТ. Приводится анализ современного состояния развития компьютерной индустрии, и анализируются новые задачи, стоящие в этой связи перед высшей школой. Рассмотрены как изменения, реализуемые в учебных программах ИТ специальностей, так и изменения в технологии образования. Раскрываются причины усиления связи образования и промышленности.

Ключевые слова: *информационные инфраструктуры, третья платформа, ИТ образование.*

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