From eLearning to eUniversity

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Abstract: *This paper analyses the specifics and the tendencies in building the knowledge society as well as the role of the universities in this process. Some European policies and programs dedicated to the new role of the universities in realizing the Lisbon Strategy are analysed as well. It is emphasized on the importance of integration of the 'knowledge triangle' (education, research and innovation) into a research university and on the urgent need to re-design the university activities according to the new requirements. A model of eUniversity is* defined *as a research and entrepreneurial university which integrates ICT in all university activities, including the ones related to the outside knowledge intensive organisations. The paper describes also some real experiences, emerging models and lessons learnt based on the case of Software Engineering education and research at Sofia University.*

Key words: *eLearning, eUniversity, Information Society, Knowledge Economy*

1. TOWARDS A KNOWLEDGE SOCIETY

Information Society (IS) is the successor of the industrial society. One of the main characteristics of the IS is the dominant role of the Information and Communication Technology (ICT). The recent fast developments of ICT and its deep penetration into the society caused a dramatic change in the way people live, learn and work and this process is accompanied by social, industrial, and organisational reconstructions and innovations. The economist Fritz Machlup is considered as the pioneer who developed the concept of the information society and also discovered the so called *information economics* [32]. Marchup considers university, being the center of knowledge production and teaching, as a "knowledge factory", equated to an industry [33]. Clark Kerr, former president of the University of California, Berkeley, cited Machlup's notion of the *knowledge industry* in his influential book *The Uses of the University* [30]. Kerr laid out his views that **a large modern university had to operate as a part of society, no longer as an ivory tower apart from it**.

Peter Drucker, in his book *The Age of Discontinuity*, wrote a section on Knowledge Society referring to Machlup's findings [11]. Drucker predicted that, by the late 1970s, the knowledge sector would account for one half of the GNP, and this became true. Since then the terms *information society* and *knowledge society* has been matter of interest and analysis for many researchers, politicians, technologists, educators and other stakeholders in the process of global change. Knowledge has been at the heart of economic growth and the gradual rise in levels of social well-being since time immemorial[9]. Knowledge economy is based on the activities of groups of people who produce and exchange (co-produce) new knowledge on a mass scale using ICT. The authors, David and Foray, analyse the start of the digital era as a revolution in knowledge instruments, and as being of great importance since it influences the technologies used to produce and distribute information and knowledge.

Some analysts believe that the IS has already come to an end and that the next stage in human evolution is a knowledge-based society, in which specialised institutions will no longer be happy simply to provide information but will also *plant* knowledge, through the direct involvement of information-science specialists (now known as *knowledge workers*) in the knowledge process [3]. Since the beginning of the 20th century we have seen a new characteristic of economic growth in the form of greater *intangible* capital as compared to *tangible* capital [1]. The economies of developed countries are increasingly based on knowledge and information. The problem is that access to knowledge-based economies is still very restricted and there are big disparities between different countries and different social strata.

Knowledge was recognised by the Organization for Economic Cooperation and Development (OECD) as the driver of productivity and economic growth, leading to a new focus on the role of information, technology and learning in economic performance. The term *knowledge-based economy* stems from this fuller recognition of the place of knowledge and technology in modern economies. The World Bank started the ambitious Knowledge for Development (K4D) Programme[46] pointing out that the increased importance of knowledge provides great potential for countries to strengthen their economic and social development. This could be achieved by providing more efficient ways of producing goods and services and delivering them more effectively and at lower costs to a greater number of people. The knowledge revolution also raises the danger of a growing *knowledge divide* (rather than just a *digital divide*) between the advanced countries, which are generating most of this knowledge, and developing countries, many of which are failing to tap the vast and growing stock of knowledge because of their limited awareness, poor economic incentive regimes, and weak institutions. The K4D Programme is based on the assumption that in order to capitalize on the knowledge revolution to improve their competitiveness and welfare, developing countries need to build on their strengths and carefully plan appropriate investments in human capital, effective institutions, relevant technologies, and innovative and competitive enterprises. The opportunities for rapid progress are well illustrated by countries like Finland, Korea, Ireland, Chile, etc. Finland, for instance, is a country that has successfully transformed itself into a knowledge economy in a short time [8]. The Finnish experience of the 1990s represents one of the few examples of how knowledge can become the driving force of economic growth and transformation. During that decade, the country became the most ICT specialized economy in the world and thus completed its move from the resource-driven to knowledge- and innovation-driven development. **Education is considered as the key element of a knowledge-based, innovation-driven economy**. It affects both the supply of and demand for innovation. Human capital and skilled labor complement technological advances. Finland's innovation system successfully converted R&D and educational capacity into industrial strengths in close coordination between the public and private sectors.

2. EUROPEAN DIMENTIONS OF KNOWLEDGE SOCIETY

The Lisbon strategy and its objective to make Europe *the most competitive and dynamic knowledge-based economy in the world* led to important policy initiatives [12]. One of them aimed at refocusing the European and national budgets on research and innovation, as stated by the Barcelona European Council and reach a level of 3% of GDP [13]. The Kok's Report [15] re-confirmed that Europe's future economic development would depend on its ability to create and grow high value, innovative and research-based sectors capable of competing with the best in the world. Among the main measures for achieving the Lisbon goals, Kok's report emphasizes that Europe needs to build a *creative interaction between universities, scientists and researchers on the one hand and industry and commerce on the other, which drives technology transfer and innovation, being necessarily rooted in the close physical location of universities and companies*". In addition, increased efforts should be mobilised at national and EU level by all concerned stakeholders to promote technological initiatives based on Europe-wide public–private partnerships.

EC very clearly recognized **the role of the universities** in building Europe of Knowledge [14]. All European universities are facing very serious challenges, such as:

- **An increased demand for higher education**. Despite of the low birth rate in Europe (and particularly – in Bulgaria) increased demand for higher education is observed and it is expected to continue in the next years.
- **The internationalisation of education and research**. European universities are attracting fewer students and in particular fewer researchers from other countries than their American counterparts.
- **The need of developing effective and close cooperation between universities and industry**. Cooperation between universities and industry needs to be intensified by gearing it more effectively towards innovation, new business start-ups and, more generally, the transfer and dissemination of knowledge.
- **The proliferation of places where knowledge is produced**. The increasing tendency of the business sector to subcontract research activities to the best universities means that universities have to operate in an increasingly competitive environment.
- **The reorganisation of knowledge**. The universities should urgently adapt to the **interdisciplinary character** of most advanced research and development areas The activities of the universities tend to remain organised within the traditional disciplinary framework.
- **The emergence of new expectations**. Universities must cater for new needs in education and training which stem from the knowledge-based economy and society. These include an increasing need for scientific and technical education, horizontal skills, and opportunities for lifelong learning, which require greater permeability between the components and the levels of the education and training systems.

The EC aims at **increasing universities' excellence in research and teaching.** The European universities have to identify the areas in which different universities have attained some excellence essential for Europe and to concentrate funding on them to support academic research. The commission supports not only intra-European academic mobility, but also mobility between universities and industry, thus opening up new career opportunities for young researchers. The EC reports also that the number of young technological (*spin-off*) companies created by universities has been on the rise in Europe. Their average density nevertheless is far smaller than it is around the American campuses. A major obstacle to better application of university research results is the way intellectual property issues are handled in Europe. In addition, European universities do not have well-developed structures for managing research results.

Another important measure is to **open up universities to the outside world and increase their international attractiveness** thus preparing them to a broader international competition, especially with the American universities which attract the best talents from all over the world. It is reported that the European universities host almost as many foreign students as the American universities, in proportion they attract fewer top-level students and a smaller proportion of researchers. This means that the learning and research environment offered by the European universities is less attractive. The regions of the EU are supposed to play a very important role through the development of technology centres, science parks, and other cooperation structures between the business sector and the universities, and thus - to catalyze development of university regional development strategies and stimulate regional networking of universities.

The EC considers the universities as motors of the new, knowledge-based paradigm but clearly states that *they are not in a position to deliver their full potential contribution to* *the re-launched Lisbon Strategy* [16]. The main conclusion is that "*Europe must strengthen the three poles of its knowledge triangle: education, research and innovation. Universities are essential in all three. Investing more and better in the modernisation and quality of universities is a direct investment in the future of Europe and Europeans.*" The European University Association defines some leading principles the European universities should follow in order to meet the challenges of the Europe of Knowledge [22]:

- universities provide a unique space for basic research;
- universities play a crucial role in the training of researchers thus ensuring the continuity of the "research pipeline";
- universities are research institutions based upon the integral link between teaching and research;
- universities pursue excellence in disciplinary research, and provide environments that enable the cross-fertilisation of ideas across disciplines;
- universities are knowledge centres that create, safeguard and transmit knowledge vital for social and economic welfare, locally, regionally and globally;
- universities are engaged in knowledge transfer as full partners in the innovative process;
- universities are willing to focus and concentrate their efforts through enhanced cooperation and networking among themselves and with business, industry and other partners.

The Seventh Framework Programme (FP7) [17] tries to integrate all EU research-related initiatives in order to build the **'knowledge triangle'** - **research, education and innovation** which is a core factor in European efforts to meet the ambitious Lisbon goals. The FP7 tries to establish horizontal links with the new Competitiveness and Innovation Framework Programme (CIP), Education and Training programmes, and Structural and Cohesion Funds for regional convergence and competitiveness. It is also a key pillar for the European Research Area (ERA). European Technology Platforms (ETPs) help industrial and academic research communities in specific technology fields to co-ordinate their research and tailor it to a common *Strategic Research Agenda*, which sets out the R&D goals, time frames and action plans for technological advances that are relevant to industry and society [18]. SRA's aim is to mobilise a critical mass of national and European public and private resources. ETPs help industry and academia to better structure and co-ordinate their research in order to build links between the various elements of the innovation process. The **European Institute for Innovation and Technology** (EIT) is considered as an important step to fill the existing gap between higher education, research and innovation, together with other actions that enhance networking and synergies between excellent research and innovation communities in Europe [20]. The commission admits that Europe is good at inventing, but falls short in exploiting the results of its research work. The main reasons for that are:

- **Lack of critical mass:** The EU's higher education and research systems are too fragmented, leading to dispersed innovation efforts.
- **Not enough top-class excellence:** There are too few internationally renowned, excellent EU universities.
- **Low business involvement:** Low level of involvement of business in education and research.
- **A tendency of the education and research structures** to stifle entrepreneurial initiative and rapid response to social and economic needs.

- **Brain-drain:** Working environments fail to attract or keep the best talents in Europe.
- **Lack of funding:** Insufficient private funding for education and R&D.

The EIT is considered as one part of an integrated strategy to mobilise education, research and innovation towards the Lisbon goals.

Europe does not fully exploit its research potential, in particular in less advanced regions remote from the European core of research and industrial development. The FP7 Capacities Work Programme (Research Potential) aims at "establishing conditions that will allow research entities in these regions - whether in the public or private sector - to exploit their research potential, thus contributing to regional development while taking advantage of the knowledge and experience existing in other regions of Europe. Hence this action will help to fully realise the European Research Area (ERA) within the enlarged Union" [19]. The commission aims at stimulating the realisation of the full research potential of the enlarged European Union by unlocking and developing the research potential in the EU´s "*convergence regions*" and outermost regions, and helping to strengthen the capacities of their researchers to successfully participate in research activities at EU level and to provide support for:

- Trans-national two-way secondments of research staff in the convergence regions;
- The acquisition and development of research equipment in selected centres;
- The organisation of workshops and conferences to facilitate knowledge transfer;
- 'Evaluation facilities' for research centres in the 'Convergence regions' to obtain an international independent expert evaluation of their research quality and infrastructures.

Some barriers for implementing the Lisbon strategy that were reported in the above mentioned documents are:

- EU suffers from under-investment in human capital, especially in higher education;
- There is a chronic shortage of skilled ICT professionals in the "knowledge intensive sectors" – the demand for such specialists is expected to exceed supply by around 12% per year over the coming years;
- There is a substantial gap of 1.2 million R&D staff, including 700,000 researchers;
- There is observed a clear process of decreasing the number of math, science and technology graduates in the EU and the commission defined a policy for increasing such graduates with 15% by 2010;
- EU still produces more science graduates than the US, but it has significantly fewer researchers in the labour market;
- There is a clear process of "brain drain" – more than 85,000 EU-born science and engineering employees currently work in the US;

In order to overcome some of the above mentioned challenges and build Europe of Knowledge, EC defined a new strategy for integrating the efforts and resources from FP7, CIP, European Technology Platforms and European Institute of Technology, Risk-sharing Financial Facility, Regions of Knowledge (Europe INNOVA Initiative), Structural Funds, LLL Program, national RTD and innovation programs.

3. THE CASE OF NEW MEMBER STATES

The New Member States (NMS) have some specific problems on their way to implementing the Lisbon strategy, such as:

- The NMS keep loosing their human capacity and great investments in education (e.g. about 1 million of Bulgarian population moved abroad during the last 15 years);
- There are many cases of "brain-waste" for NMS and, respectively, for EU: e.g. a former NMS researcher working as a plumber in the US or in the EU;
- By February 2002, 14% of the Marie Curie fellowship holders from NMS moved to the EU and only 0.5% of fellowship holders from the EU moved back to their countries;
- An open EU market for recruitment of researchers and ICT specialists is established before the complete Europe of Knowledge Ecosystem is built [EC, Era-More]. As a result - a new wave of brain-drain is expected.
- The EC keeps the tendency of building the EU RTD and innovation capacity in tiers, i.e. most of the NMS, especially the ones in SEE, would be certainly positioned in its RTD and innovation periphery.
- Some recent studies draw attention to the emergence of internal brain drain as a rising concern, namely the domestic 'drain' of intellectuals out of academia and science and into other occupations altogether [25]

Andrea, A Czech student, says "*You just can't compare our infrastructures or the investments we make in the education and scientific sectors with that of other European countries*". But the students of today might be the scientists of tomorrow…." [31]. Howard Moore, Director, ROSTE, UNESCO expresses his opinion: "*The countries of South-East Europe share some common problems to a greater or lesser extent – low investment in science, inadequate infrastructure in terms of research equipment; libraries, low industrial base and therefore very limited private sector involvement in science, and those issues lead to the chronic brain drain"* [28]. Moore points out also that "*Brain drain does indeed remain a chronic problem, although firm statistics are hard to come by. Brain drain is not just brought about by low salaries. People also need modern equipment, access to scientific literature and to be able to exchange information and experience" and "The Seventh EU Framework Programme beginning in late 2006 will grant access to scientists from Southeast Europe wishing to participate in the Union's scientific programmes. Often, however, what these scientists lack is the experience in making grant applications, which seem to get more and more complicated by the year. Equally, science managers in these countries lack experience in running international research programmes. Here, we hope in the near future to hold a training workshop on the subject for the benefit of individuals in Southeast Europe"* [35].

The above said rises the question: **"Are the NMS considered by the EC as the main suppliers of high-skilled workers and researchers for EU-15**?" Obviously not, but the efforts of the EC is not enough to impose implementation of some well known models and policies that proved they were leading to best practice results. There are several well recognized **models for turning the brain drain into brain gain and brain circulation**[6], especially ones in the area of software industry in Ireland, India, Israel and other countries [2]. Some recent studies show that "*While the brain drain has long been viewed as detrimental to poor country's growth potential, recent economic research has emphasized that alongside positive feedback effects arising from skilled migrants' participation to* *business networks, one also has to consider the effect of migration prospects on human capital building in source countries. This new literature suggests that a limited degree of skilled emigration could be beneficial for growth and. development. Empirical research shows that this is indeed the case for a limited number of large, intermediate-income developing countries. For the vast majority of poor and small developing countries, however, current skilled emigration rates are most certainly well beyond any sustainable threshold level of brain drain*" [10].

There should be clear **national and regional policies for substantial investments in building appropriate research and innovation ecosystem in NMS**, including in the countries from South-Eastern Europe. However bringing back high qualified specialists to the sending countries has been successful in a small number of countries, e.g. Ireland, and since the 1980s in some Newly Industrialized countries, namely Singapore, Taiwan, India, and China [6]. It is pointed out that since the mobility of high qualified specialists "*is highly complex and therefore successful policies must take a multidimensional approach on an individual, institutional, regional, national, supra-national and global level*".

In order to achieve the Lisbon strategy goals the European university should be transformed and ICT should play a very important role. While looking for some good models of transformation we can rely on a number well-known models, such as: *research university* [5], *entrepreneurial university*[7] and *eUniversity* (*digital university, eCampus)*[4] which in many points overlap and enrich each other. The latter model corresponds to the Marchup's vision of a university as a centre of knowledge production and teaching - *knowledge factory*. In order to fulfil its role and to be competitive (loacally and globally), the *university-enterprise* should be managed in an enterprise-like way and implement an integrated *Enterprise Resource Planning* (ERP) system. Another models which should be taken into the consideration are *Science Park* and *Knowledge Park* which could be used as instruments for establishing better links between universities and for **brain-gain**, i.e. for attracting back the talented specialists to the countries of origin[29]. They have their origin in the model of of the early fifties when the Stanford Research Park (1951) and the Cornell Business & Technology Park (1952) were established. These parks ensured that academic institutions could continue to engage in leading edge research as well as to promote technology applications as an entrepreneurial venture to support their operations. Today, the Stanford Research Park has 140 companies in electronics, software, biotechnology and other high-tech fields and employs 23,000 persons.

3. THE eLEARNING PHENOMENON

The wide penetration of Information and Communication Technologies (ICT) into society catalyze the need a global educational reform which will break the monopoly of the print and paper based educational system. The ICT based distance education is considered as "*the most significant development in education in the past quarter century*" [36]. The pattern of growth in the use of ICT in higher education can be seen through [41]:

- Increasing computing resources, including web-based technologies, encouraging supplemental instructional activities; a growth of academic resources online; and administrative services provided through networked resources;
- Organisational changes in policies and approaches;
- An increasing emphasis on quality of teaching and the importance of staff development;

- Changes in social practice, e.g. a growth in demand for life long learning opportunities, which consequently affect the need to adapt technology into instructional delivery; and an increase in average age of students.

The observed global educational reform is ICT driven, but the need of new pedagogy models is crucial. Some basic characteristics of the eLearning related pedagogy are [37]:

- Cooperative learning, as an alternative of the competitive learning [34], is widely integrated and implemented in a highly interactive (virtual) learning environment comprising computer support cooperative learning systems.
- The working on a project school activity is accepted as an alternative of the traditional classes and realized according to the project pedagogy principles[34], which is gradually shifted from the university settings to a school level now. Networked multimedia communication enables project teams working together independently of time and space.
- The teachers are given higher degree of freedom as the Internet allows them to work together across their classrooms and freely share ideas and experience. They facilitate students' inquiry, manage their learning process, and help them navigate in a shared global information space. The curriculum and the teaching and learning processes are highly individualized. Different pathways and support for learning are offered to students who can progress with a different speed. The university is open towards the world. The problems the students solve are formulated either by themselves or by the teacher and come from their everyday life. The students and the teacher cooperatively solve these problems.
- The design principles of the learning environment are based mostly on asynchronous space and time and interactive learning environments combining virtual and physical spaces. By complementing face-to-face interactions and digital communication, the physical constraints obstructing one-to-one consultation between a teacher and a student, as well as one-to-many and many-to-many type of discussions, are significantly lowered, and all sorts of new pedagogical groupings may become both feasible and effective. All students have their own responsive ICT-based learning environment allowing communication with their peers, teachers, virtual friends, network servers, digital artifacts, etc. The virtual reconstruction of university spaces makes it possible to join physically distinct spaces into virtual auditoriums, workshop rooms, reading rooms, cafes, libraries, where students from different locations can interact as if they were together face-to-face. The space, time, equipment, and all the teaching materials and information resources could be used in an extremely flexible way. The system of forming classes by age might be quitted soon and students in different age might work and study in small groups.
- The main principle in the learner centered pedagogy is that the learners do not receive ready-made knowledge but rather they discover and construct their knowledge, which does not mean to reinvent it though. The students get opportunities to obtain knowledge both in the school settings and outside school system. The students obtain new knowledge while solving real problems and transfer their knowledge to other students. They learn autonomously taking the responsibility for their learning and following their individual cognitive styles, interests, preferences. The students learn how to learn.
- The teachers are mostly facilitators, co-learners, persons ensuring the right educational resources at the right time, helping students get access to other

relevant resources. They also diagnosis the students' problems, and help them any time when needed. The formative evaluation of students' achievements and evaluation based on project outcomes is dominant. The students are also encouraged to self-evaluation of their achievements and outcomes and are enabled to present them. (ICT offers new opportunities for global student presentations.) The teachers work both individually and in small groups with the students. They might be assisted by students-mentors who would help them and other students in using software tools.

One of the main conclusions related to the ongoing educational reform is that it is based on designing and using different virtual learning environments which do not put clear boundary between physical and virtual worlds. A key factor for success is to integrate them, not to separate them, and to apply relevant instructional design strategy based on a current learning theory. A tool for implementing such learning environment is an integrated information system which provides services and supports all university activities. Most of the eLearning undertakings are demand, fashion and market driven, but they rarely lay on adequite learning theories.

Some recent analysis shows that "*eLearning is no longer something separate from mainstream learning. eLearning is taking root in departments, usually but not always with (at least tacit) support from central units, as part of an evolution. The process is steady and irreversible but currently the purpose and usage of eLearning are locally determined. The sometimes difficult task for an higher education institution is to operate as a whole, integrating activities into its Learning and Teaching and related frameworks, modifying both if necessary*"[42]. A number of tensions within existing thinking in university educational activities are observed, such as: between the benefits for an individual academic and those for the university, between developing more materials and deploying existing material more effectively, and between fundamental educational research and descriptions of monitored development and usage. A most supported model for deploying eLearning is to 'embed' it into all other university activities. This could represent a view that the universities may soon no longer need financial encouragement to engage with eLearning, but rather will need support with structures and models, and with finding appropriate standards and procedures. It is also emphasised that "*the uptake of IT in academia has been research led and it is now very hard to be research active without exploiting computing and networking technology*". The international research virtual communities are currently the norm but people do not do claim to do eResearch – they merely rely on ICT in doing research. Integrating ICT into administration (eAdministration) is also in process although there exist some opposition from some of the senior faculties who do not like extending the channels for communication with peers, students and other stakeholders and use online university administrative services. The same holds for using Library (eLibrary), campus and global resources, etc. The further eLearning adoption needs however, building a culture and developing a complete system for quality assurance procedures. The global competition in the education market requires also new strategies and business models which are more known in the business world. A good example for such needs is the failure of the $113 million UK eUniversity project [24].

4. THE eUNIVERSITY MODEL

The ninth annual EDUCAUSE Current Issues Campus Computing Survey [21] results highlighted the most critical challenges that the campus information technology leaders are facing in 2008, namely: security and Enterprise Resource Planning (ERP) systems along with change management and eLearning. For 2008 the committee introduced the following issues and subtopics:

- ***E-Learning/Distributed Teaching and Learning:*** Developing infrastructure to support learning technologies; Supporting distance learning and virtual campuses; Using active, collaborative, and immersive learning environments; Aligning technology use with student expectations and institutional mission; Integrating emerging tools (podcasts, immersive environments, mobile computing); Realigning policies, organizational structures, and procedures; Supporting information and technology fluency/literacy; Integrating library, learning, and support resources; Promoting the effective use of technology in instruction; Supporting faculty development; Conducting assessment and evaluation of e-learning programs, instruction, and student learning; Developing and managing e-portfolios;
- ***Support Services/Service Delivery Models:*** Providing 24 × 7 help desk; Establishing service level agreements (SLAs) with internal clients; Centralizing versus distributing support; Developing standards for support services; Developing "smarter" support models (knowledge bases, self-help tools); Managing customer relationships; Individualizing/personalizing support; Testing (functional, load, integrity) applications with automated scripts prior to "going live"; Monitoring services end-to-end to assess end-user experiences; Handling incidents/alerts efficiently and effectively when problems occur; Establishing/negotiating SLAs and organizational level agreements (OLAs);
- ***Communications/Public Relations for IT (new for 2008):*** Developing a communications plan for IT; Sending regular, targeted communications to faculty, staff, and students; Communicating with the millennium student; Communicating the value of IT, internally and externally; Dealing with the press/media; Maintaining internal IT communications; Explaining the return on technology investments to leadership and stakeholders; Evaluating and implementing IT Infrastructure Library (ITIL) practices and standards.

An emerging issue was recognised, namely c*yberinfrastructure* - hardware and software systems, distributed computing, data, communications technology and tools for collaborating of the research communities.

There exist some European higher education projects aiming at integrating the ICT into all university activities. For example Technical University in Munich is developing a Digital University project [4]. The university realigns its ICT strategically in co-operation with the Leibniz Supercomputing Centre. This realignment is accomplished under guidance of the Chief Information Officer (CIO) in accordance with the overall university strategy by means of closely interconnected projects in the areas of organisation, campus management, eLearning and ICT infrastructure. They found a basis of success in standardisation of the organisational and technical solutions as well as the university-wide integration of all groups involved.

In 2004 University of Edinburgh started a "*change project which would include the implementation of a new student system, as well as fundamentally reviewing the way processes were carried out to identify shared solutions*" (http://www.projects.ed.ac.uk/euclid/). The primary objective of the project is to develop a "*streamlined, modern approach to interacting with enquirers, applicants and students which reflects our international standing and the calibre of our teaching and research*". This will involve:

- Using online technology to communicate with speed and facilitate global access

- Reducing paperwork so that the focus is on core University activities - teaching, research and supporting students and the university
- Developing integrated, efficient processes to be used across the university
- Sharing a single student system that provides accurate student information to everyone who needs it

For example, Sofia University has started such project in February, 2002[43]. The main goal of the project was to develop a general institutional and technological framework for ensuring better quality of education by integration and optimization of the existing and attracting additional resources. The project has three main components:

- Development of an institutional framework for quality assurance, including a framework for integration of the European Credit Transfer System (ECTS) in the university.
- Development of a prototype of an integrated information system with an embedded framework for quality assurance and a platform for e-learning and team-work;
- Development of a university multi-media resource centre for foreign language study based on the European Language Portfolio.

The first two components were successfully developed and a process of wide implementation of the prototype of the integrated information system is under way now. One of the main problems identified during the process of development was the lack of clear description of the university processes. The implementation of the pilot information system in the educational activities catalyzed the need of a more formal description and modeling of these processes in order to develop a complete "*Digital Campus Environment*" [44].

In order to build a contemporary model of a university one should consider also the model of the Research University[5]. The model of Research University could be considered as among the most successful models for building research and educational capacity in universities. While most of European universities try to integrate education, research and innovation at a MSc and PhD level, many of the American research universities target the BSc level as well. The research universities could be both student-centered and research-centered through a synergistic system in which faculty and students are learners and researchers, whose interactions make for a healthy and flourishing intellectual atmosphere. The research universities typically integrate information technology in all university activities. Because such universities create technological innovations, their students should have the best opportunities to learn state-of-the-art practices — and learn to ask questions that stretch the uses of the technology. The concept of integrated education at a research university requires restructuring both the pedagogical and the management aspects of the university based on an effective use of information technology.

Another model is provided by the framework of "Entrepreneurial University" defined by Clark [7]. The main characteristic of such university is that it "*understands the commercial value of knowledge*". Clark identifies five elements that constitute the irreducible minimum of entrepreneurial actions for an entrepreneurial university. The degree of implementation of each of these actions provides some good indicators for successful transformation of a university towards the framework of an entrepreneurial university. These actions are:

- strengthening the steering core;
- expanding the developmental periphery;

- diversifying the funding base;
- stimulating the academic heartland;
- integrating the entrepreneurial culture.

The United Kingdom Science Park Association defines a *Science Park* as "*a cluster of knowledge-based businesses, where support and advice are supplied to assist in the growth of the companies. In most instances, science parks are associated with a centre of technology such as a university or research institute* "[45]. The Features of the Knowledge Park model [29] include a focus on:

- the design and development of knowledge-based enterprise;
- technology transfer;
- capacity building and services for the onsite companies;
- linkages with higher education and research institutions;

We can define *eUniversity as a research and entrepreneurial university which integrates ICT in all university activities, including the ones related to the outside knowledge intensive organisations*. Building a synergetic eUniversity model incorporating the characteristics of the above mentioned models could be a direction of research for many scholars.

5. IMPLEMENTATION OF THE eUNIVERSITY MODEL IN BULGARIA

Like all other NMS Bulgaria is experiencing a dramatic change in all areas of its society. These changes reflect very seriously on the research capacity of the country and, in particular to Sofia University (SU). The Faculty of Mathematics and Informatics (FMI) has experienced some serious problems closely related to the general socio-economic and the research environment in Bulgaria:

- **Emigration and migration to industry of highly skilled professionals**. Bulgarian students are among the largest SEE student populations in many European countries, and between 1990 and 1992 around 40,000 Bulgarian scientists emigrated to the U.K., Germany, France and Ireland with the intention of settling permanently [25]. In addition, around 50,000 Bulgarian citizens leave the country annually
- **Insufficient research funding.** In addition to the lack of enough state funding for university research and scientific equipment the loss of many experienced researchers decreases the chances and capacity for contractual research.
- **Lack of sufficiently stimulating research environment**. The R&D legislation is still obsolete. The research infrastructure is far from the requirements for advanced research, especially in the science and technology areas;
- **Lack of youth staff.** As a result from economical situation in Bulgaria and the small budget for the universities, young people are not motivated to continue their education as PhD students, researchers or teaching assistants at the universities.
- **Lack of stable and multiple bridges between research, development, education and training**. Such bridges are a powerful mean for building a large community of researchers and improving quality of education.
- **Lack of traditions in university-industry-government cooperation.** Both universities and industry in Bulgaria could hardly build a strong cooperation in a short period of time although the government considers the ICT sector as an upper

priority sector and a driver for development of Bulgarian industry and Knowledge Economy. There is no one Science or Knowledge Park which corresponds to the best world practice.

- **Fragmented nature of research activities and the dispersal and not effective use of limited resources**. The individual partnerships of researchers seldom grow to institutional ones or a long-term collaboration. In addition, there is still dispersed project management expertise.
- **Very few Bulgarian universities and research institutions have implemented a real ERP system**.

Development of the Bulgarian eUniversity (BeU) and eLearning industry could be considered as one of the strategic direction of the New Economy. This industry could be considered a 'meta-industry' since it could positively influence all other industry sectors. It could become Bulgaria's most important asset on its way to the Information Society and Knowledge Economy [38]. However this industry, as any other for that matter, needs investments. Foreign direct investments have radically changed the food and beverages sector, cement industry, non-ferrous metallurgy, wholesale trade and banking in Bulgaria. It could be expected that such investments would radically change the 'knowledge sector' of the industry which should be built around the real knowledge producers – universities and research institutions. By attracting direct investments in universities and other academic institutions, coordinated by the government and supported by international organizations, we might expect a radical change in building sustainable "university-industry-government" partnerships. This might happen to be the only chance for Bulgaria to leap forward into the 'knowledge economy'.

The project for establishment of the Bulgarian Virtual University - BVU[26,27], which started in 2002, could be used as a very good platform for cooperation and development of the BeU. The main difference is that the BeU is both 'real' and 'virtual', and it is an association of other e-universities and other e-organisations. In addition, each Bulgarian university should take the risk to transform towards an eUniversity, i.e. towards integrating ICT in all university activities and strengthening its research and innovation capacity. In turn, the institutes of the Bulgarian Academy of Sciences, who are also members of BVU, could also strive to become eUniversities, i.e. to go 'digital and become more open for education and innovation. Many other Bulgarian and foreign knowledge intensive stakeholders could join the BeU and help building a sustainable Bulgarian knowledge triangle as part of the European one. This means also that a number of Science or Knowledge Parks should be developed in Bulgaria as well.

6. CONCLUSIONS AND FUTURE WORK

An early stage implementation of an eUniversity model in the frames of Sofia University is described in [38, 39, 40]. The further work will be strongly supported by the EC project SISTER: *Strengthening the IST Research Capacity of Sofia University* under the FP7 Capacities Work Programme (Research Potential). The **main goal** of SISTER project is to develop FMI as a Leading Centre in SEE in research, innovation and training in the area of ICT and more specifically in Software and Services, and Intelligent Content and Semantics. An **overall goal** of the project is to foster the integration of Faculty of Mathematics and Informatics (FMI) in the ICT ERA and to contribute to competitiveness and growth of the SEE region and Europe as a whole.

In order to achieve the main goal the following **project objectives** are defined:

- to elaborate and further develop a strategic R&D and innovation framework for future development of FMI;
- to strengthen the research capacity of FMI by enhancing the human resources capabilities of FMI and research integration with EU partners;
- to strengthen the capacity of FMI for business exploitation of academic results and cooperation with industry;
- to improve the research environment of FMI;
- to build a strong long-term collaboration of FMI with leading research organisations and enterprises in EU and in SEE countries;
- to make FMI a well-known research and innovation centre in SEE.

In addition, recently a **Technology Transfer Office** was established at Sofia University and a project for development a large **Sofia University Science Park** started in 2007. All above mentioned establishments and activities are going to be open at a national, regional and European level

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