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Abstract: Cyber-physical systems are structures that are controlled and monitored by computer-based algorithms consisting of physical components. The energy industry is becoming a large and complex cyber physical system with the industrial revolution. These developments in the energy sector have a positive effect on Industry 4.0. Developments in the fields of production, transmission and distribution, retail sales, trade and consumption from the elements of the energy sector are increasing day by day via sensor-based communicable autonomous systems. U.N. Industrial Revolution in its report in 2017 elaborate the relevancy between the Sustainable Development Goals no. 7 and 9 about sustainable energy and inclusive industry development that Industry 4.0 and sustainable energy transition share crucial concerns that can be interconnected to pursue a sustainable energy transition. Sustainable energy is defined to have two main components: energy efficiency and renewable energy. UNIDO’s initial hypothesis tells that a comprehensive shift in manufacturing may change the behavior in energy consumption, including energy efficiency and renewable energy usage. Circulating fluidized bed (CFB) technology is one of the important factors contributing to the above mentioned concept of sustainable energy.

Keywords: INDUSTRY 4.0, SUSTAINABILITY, RENEWABLE ENERGY, CIRCULATING FLUIDIZED BED

1. Introduction

Industry 4.0 is a collective whole of organizational concepts that involve the use of information technologies and industrial activities. It is based on the concept of cyber-physical systems, the internet of objects and the internet of services. The use of cyber-physical systems means that almost all of the people are self-coordinating and optimizing themselves, creating kendi smart factory insan systems that can produce [1]. Industry 4.0 generally consists of the following 3 structures:

- The Internet of Things: Every conceivable object is in some way accessing the Internet and communicating with other devices.
- Internet of Services: With this structure, cyber-physical systems can provide their own continuity by connecting with people and other structures.
- Cyber-Physical Systems: Organize, plan and develop the production stages independently of humans.

The biggest aim of Industry 4.0 is the production of robots that can communicate with each other, detect the environment with sensors and realize the needs by analyzing data and take over the production of these robots; to create better quality, cheaper, faster and less waste production systems. Industry 4.0 will bring together the Information Technology and Industry, and will enable more efficient business models to emerge because the intelligent factory system will be created and each data will be collected and analyzed in a good way. By integrating modern information and communication technologies, such as Cyber-Physical Systems, Cloud Computing in the manufacturing sector to increase efficiency, quality and flexibility, it will allow you to analyze the possible yield conditions and gain an advantage in the competitive environment [2].

With new generation software and hardware, which means low-cost, low-energy, low-heat, but also highly reliable hardware, unlike today’s classic hardware, with operating and software systems to run this equipment; perhaps the most important component, all the devices on earth are used to exchange information and data with each other.

Today’s economic system needs continuous change and development to maintain its continuity. The rapidly changing population growth and the difficulties experienced in the use of resources, the changing world brings with it innovations and changes. While efficiency in production continues its importance, the production of quality products is crucial. This situation leads to technological progress, robotics or approaches like Industry 4.0. With less manpower, shrinking factory areas offer advantages such as increased product variety and production, rapid introduction of new products, shortening of production times and increasing quality.

In general terms, mathematical modeling is a dynamic method that facilitates the ability to see the relationships in the nature of problems in all aspects of life, to reveal, classify, generalize and produce results in mathematical terms [3]. In order to understand the behavior of the system or to evaluate different strategies in order to operate the system with this model after the modeling of a theoretical or physical real system, simulation is a technique that evaluates the characteristics and behaviors of these systems through computer.

Circulating Fluidized Bed (CFB) systems are designed to re-rotate the unburned particles from the furnace to ensure full combustion. In this way, both low-calorie and high-calorie lignites can be burned with high efficiency. With this technology, it is possible to provide energy economy in every period according to the periodic variations between fuel alternatives.

In this study, advances in CFB biomass gasifier technology were introduced. Also, improvability of modeling and simulation studies of this systems were discussed in view of Industry 4.0.

2. Circulating Fluidized Bed Biomass Gasifiers

A rapid increase in population and industrialization brought about the need for energy. Biomass energy is one of the sources that will be used to ensure sustainable energy supply without causing environmental pollution. The fact that biomass energy is an inexhaustible resource is seen as a suitable and important energy source because it can be obtained everywhere, especially because it helps socio-economic developments for rural areas.

Specially grown plants such as corn and wheat, herbs, seaweeds, algae, animal feaces, fertilizer and industrial wastes, as well as all organic waste (fruit and vegetable residues) from houses are the sources for biomass. The use of biomass is becoming more and more important to solve the energy problem due to the limited

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Mechanical Engineering, Akdeniz University, Antalya, Turkey1
Bucak Technology Faculty, Burdur Mehmet Akif Ersoy University, Burdur, Turkey2
Bucak Emin Gülmez Vocational School of Technical Sciences, Burdur Mehmet Akif Ersoy University, Burdur, Turkey3
Department of Energy Systems Engineering, Burdur Mehmet Akif Ersoy University, Burdur, Turkey3
Department of Chemical Engineering, Pakistan Institute of Engineering and Applied Sciences, Pakistan5
School of Foreign Languages, Akdeniz University, Antalya, Turkey6

afsingungor@hotmail.com

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energy resources such as petroleum, coal, natural gas, as well as their environmental pollution. There are many methods for biomass conversion. Fig. 1 shows the biomass conversion routes [4].

Fig. 1. Scheme of biomass conversion routes [4]

CFB systems have advantages such as high modulation rate, low vapor cost, enabling fuel diversity, low emission value, high efficiency and ease of operation. Any kind of coal between 2500-6500 kcal can be used in these systems. Schematic view of a CFB system is given in Fig. 2 [5].

Fig. 2. Schematic view of CFB [5]

3. Modeling and Simulation Applications in CFB Biomass Gasifiers

Modeling and simulation has become an important tool in the fluidization system design, optimization, and scale up in the last years [6]. Mirmoshtaghi et al investigated effect of various parameters on CFB biomass gasification process. In the study, partial least square-regression and genetic algorithm were utilized to optimize input values for three various output targets. These targets were high gas quality, high carbon conversion and dry gas and low tar yield [7]. Krzywanski et al used machine learning approaches (Artificial neural networks/ANN) and genetic algorithms (GA) to sorbent enhanced hydrogen generation in bubbling fluidized bed and CFB. According to the results, experimental results and model estimations were in a good agreement [8]. Model development steps of the study is given in Fig. 3.

Fig. 3. Model development steps (a) and neural network architecture (b) [8]

In a study conducted by Zhu et al, three dimensional large scaled CFB risers were analysed. Developed material-property-dependent sub-grid drag modification were validated with simulation model [9]. Gungor, were developed two dimensional model for a CFB biomass gasifier to predict hydrodynamic, heat transfer and combustion parameters. Simulation model were utilized to calculate versatile parameters such as gas emissions, pressure drop, particule size distribution [10]. In addition there are many studies in the literature which investigated various thermochemical systems [11], stoichiometry impact on optimum conversion efficiency [12] and emission reduction techniques [13].

Computational Fluid Dynamics (CFD) are widely used in CFB studies to investigate the behaviour of the fluid and particles in the system. Nikku et al were analysed CFB with momentum exchange model with three dimensional semi-empirical model process. A novel gas-fuel momentum exchange model was developed for the analyses [14]. Yang et al investigated the ash properties of the effects of the oxyfuel combustion. Also, they conducted the uncertainty analysis of the CFD modeling to analyse ash heterogeneousness and distribution [15]. Ghadirian et al examined the most advanced relationships between the numerical modeling of all CFBs and the interface interactions between phases in the system using the CFD approach. Three-dimensional CFD model of this system were developed and analysed [16]. Schematic view of the CFB and the preliminary solid volume fraction is given in Fig. 4.

Fig. 4. Schematic view of the CFB and the preliminary solid volume fraction [16]

4. Conclusion

Modeling and simulation applications on CFB studies are basically focused on enhancing the performance of the system. This multi-perspective improvement studies are directly related with the structures of Industry 4.0. When the studies are examined, it can be
said that studies contribute directly or indirectly to the effective use of energy. The use of automatic control systems in industrial applications of these scientific studies will provide important contributions on behalf of Industry 4.0. Simulation and modeling processes allow the system to be analyzed better and to eliminate deficiencies. Implementation of automatic control technologies in the application part will both reduce the costs and contribute positively to the environment.

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References


1. Introduction

The world is entering the era of Industry 4.0, a revolution that will dramatically change the mankind. The individual technological progresses in areas like artificial intelligence, robotics, the internet of things, autonomous vehicles, additive technologies, nanotechnologies, biotechnologies, quantum computing, etc. will confluence together in shifting the society to a new level [1].

The concept that is called today Industry 4.0 has been envisioned by thinkers since the mid-twentieth century [2]. At the beginning of twenty-one century, the German government launched a project in order to define the strategy for high-tech manufacturing. It was also the moment when was imposed the term of Industry 4.0.

It would have been just a concept and strategy of national importance if industry specialists and world-renowned consultancy firms [3, 4] did not recognize the value of Industry 4.0. The impact of Industry 4.0 will affect all elements of human society: economy, employment, structure of jobs, business models, consumer expectations, product design processes, communities, individuals, personal connectivity, personal and international security, local and global governance, etc. [1]

The visionary research in the field of Industry 4.0 has identified four basic design principles [5]: a) interconnection; b) information transparency; c) decentralized decisions; d) technical assistance.

If the physical components of Industry 4.0 are developing straight-forward and at an accelerated pace, the human component manifests a certain inertia, given, on one hand, by the reluctance with which most professionals in the field accept major changes and, on the other hand, with which higher education institutions modify their curricula.

In order to overcome this, specialists in education and training are working to find ways to prepare the human resource for Industry 4.0. There are targeted the research education [6], the training of specialists to implement Industry 4.0 [7, 8], the advanced means to train specialists [9] and many others. Some universities and consortiums of universities are preparing in-depth developed curricula for the specialists needed by Industry 4.0.

2. MSIE 4.0 Project

The overall aim of MSIE 4.0 (“Curriculum Development of Master’s Degree Program in Industrial Engineering for Thailand Sustainable Smart Industry”) project is to enhance the capacity and ability of universities in Thailand (and not only) for the delivery of a high quality competence-based curriculum for Master’s degree in industrial engineering that supports sustainable smart industry (Industry 4.0), conforms to European Qualifications Framework (EQF) and is applicable to EU partner universities. The project will be specifically focused on [10]:

1. Modernization of the education of industrial engineering discipline in Thailand by the development of a curriculum for Master’s degree in industrial engineering to support sustainable smart industry;
2. Development of courses, learning and teaching tools, delivery processes and platforms for student-centred learning of the curriculum;
3. Implementation of modern ICT tools and methodologies for effective student-centred learning of the curriculum;
4. Introduction of quality assurance and of the EQF approach for the delivery of the curriculum meeting international-accepted education requirements;
5. Establishment and continuation of partnerships among partner universities.

3. Project’s Partnership

The project’s partners that have assumed the fulfillment of project’s objectives are [10]:

The coordinator, Asian Institute of Technology (AIT), is an international postgraduate institution established in 1959 with a mission to support the growing need for advanced engineering education in Asia. AIT has been working closely with public and private sector partners on the promotion of technological change and sustainable development in the region through advanced higher education, research, capacity building and outreach. AIT has 1700+ students from 60+ countries/territories, 75 internationally recruited Faculty from 20+ Countries, and 500+ Research and Support Staff from 30+ countries.

Chiang Mai University (CMU), founded in 1964, was the first institution of higher education in the north of Thailand, and was the first provincial university in the country. Ever since, CMU has been focusing on providing higher education emphasizing on academic excellence, preparing graduates with high moral and ethical standards under the Sufficiency Economy Philosophy, and supporting the national community with academic services. Besides, CMU has committed to preserve and nurture religious and cultural heritage, and to develop the resources of the unique natural environment of Northern Thailand. CMU has 35,532 students, 2,232 academic lecturers, and 11,440 staffs.

Czestochowa University of Technology (CUT) is the largest state university in the region with almost seven decades of scientific and educational tradition. Its mission is to assist economic and social development with innovation and reliable technical solutions and high quality engineering education. In nationwide rankings of the state institutions of higher education, CUT is among the top universities in Poland of a technological profile. Currently, CUT hires with 1000+ academic staff and offers courses to 11,000 students. Since 2010 CUT operates its own e-learning platform and practices blended learning schemes for selected courses in all its educational programs.
Khon Kaen University (KKU) was established as the major university in the North-eastern part of Thailand in 1964 and has developed itself to become one of the top universities in Thailand. Khon Kaen University has recently become one of the nine national research universities in Thailand and an educational centre in the Mekong sub-region. The university’s major mission is to prepare future global citizens to work in a continually changing world. KKU’s strategic goal is to be recognized both internationally and regionally as a leading university in research. KKU currently has more than 40,000 students.

King Mongkut’s University of Technology North Bangkok (KMUTNB) is a public university and has been established since 1959. KMUTNB has a strong closer link with German Government and German public and private organisations and later with a solid supports from French Government. KMUTNB has three campuses with nearly twenty faculties and more than ten institutes, serving 20,000+ students in undergraduate and postgraduate. KMUTNB has been received a prestigious award from Thai Government and international level e.g. winning Robot Rescue International Champion for 6 in 7 times from Thailand etc.

Prince of Songkla University was established in 1967 as the first university in southern Thailand, providing academic service to both regional communities and industries. It consists of 5 campuses with more than 2,000 faculty members instructing 30,000 students. It is one of the leading research universities in Thailand which is internationally recognized by academia and industry. Its mission is to encourage its people to create value out of their research work by producing tangible innovation, to engage in transferring knowledge and technology to the community, and more importantly to produce graduates who are knowledgeable and competent in their profession.

Thammasat University (TU), the second oldest university in Thailand, was founded in 1934. It is one of Thailand’s leading institutes for the high quality of its teaching and research, with enrolment of over 16,000 undergraduates and 5,000 graduates each year. The industrial engineering at TU is built upon a solid foundation in physical science, mathematics, engineering, humanities and social science. It offers a variety of opportunities in higher education. Its lecturers have experiences in field of safety engineering, industrial work improvement, human factors in engineering and ergonomics for over 20 years.

Founded in 1973, University of Minho (UMinho) is nowadays one of the most important and prestigious HEIs in Portugal. It is renowned for the competence of its faculty, for the level of excellence in research, the wide range of undergraduate and graduate courses offered and the remarkable degree of interaction with other institutions and the society in general. Located in the north of Portugal, UMinho covers a student population of around 20000, 40% of which are master or PhD students. The University has 1200 teaching and research staff and around 800 technical and administrative staff. UMinho education and research projects have gained strong international recognition.

University POLITEHNICA of Bucharest (UPB), established in 1818, is the oldest, biggest, and most prestigious technical university in Romania with highest international rank among all Romanian universities. The 15 faculties, 53 departments and 38 research centres, with a teaching staff consisting in almost 2000 members, are dealing with around 27000 Romanian students and more than 600 foreign students. UPB paid a special attention to bilateral cooperation agreements (more than 200) with similar universities, from more than 33 countries in Europe, Asia, and United States of America.

4. Gap Analysis for Industry 4.0

In the case of MSIE 4.0 project, the gap analysis was based on three elements: a) competences transferred to students in industrial engineering programmes, b) the needs industries were facing to develop themselves towards Industry 4.0 and c) current perception that those students had about their own competences.

Master programmes’ curricula in industrial engineering from partner countries were analysed as well as from other countries. From Romania, the analysed curricula were from two universities: POLITEHNICA University of Bucharest (“Engineering of Products’ Design and Manufacturing” and “Industrial Design and Innovative Products”) and “Gheorghe Asachi” Technical University of Iasi (“Systems Design”). There has been identified a common discipline: Production Management.

From the analysis of competences expressed explicitly or implicitly, a list of transnational professional and transversal competencies emerged [11]:

- production systems analysis and diagnosis;
- production systems design / production planning and control processes design;
- planning production and project processes;
- monitoring and controlling processes and production system performance;
- developing projects, implementing systems, applying methods and procedures;
- evaluating production systems and processes;
- describing, comparing and selecting technologies, methods and paradigms;
- articulating knowledge objects from various areas;
- communication competences;
- ability to deal with the unexpected / working in environments of uncertainty;
- teamwork competences;
- ability to solve problems;
- leadership competences;
- innovation / creativity;
- planning and organization competences;
- professional ethic;
- ability to making decisions;
- foreign languages knowledge;
- entrepreneurship.

Synthesising all the analysed aspects, the following recommendations for the design of the new master programme (particularised for Romania) were issued:

- duration: 2 years with 4 semesters;
- 120 ECTS (European credit transfer system);
- 4 – 5 disciplines per semester;
- 4 – 8 learning outcomes per discipline;
- learning outcomes should include elements associated with transversal competences;
- flexible development of disciplines for a better coverage of knowledge areas.

A particular attention was paid to the didactic approach itself. There were analysed the following teaching and learning methods: active learning, problem-based learning, project-based learning, serious games, gamification, work-based learning and case study. Regarding this topic, recommendations were made:

- use as much active learning as possible;
- project-based learning should be used to design flexible programmes and to connect with industry;
- university support for the continuous professional development of academic staff.

The analysis of industry and student needs was made based on the study “Industry 4.0 Readiness” [12] and the webtool “Industry 4.0 Self-Assessment” of PricewaterhouseCoopers [13]. Relevant Industry 4.0 areas have been selected.

The following roles of engineers in industry were considered (adapted from [14]): autonomy; improvement; control; monitoring.
and observing. The levels of competence considered were according to Bloom's taxonomy: create (5); evaluate (4); analyse (3); apply (2); understand (1).

In the design of the questionnaire for companies, the following aspects were considered:

- the level of implementation of an Industry 4.0 strategy;
- areas for implementing Industry 4.0 strategies (production technology, product development, IT, services, centralised in integrative management);
- the ratio between the adoption level and the required level of use of Industry 4.0;
- the level of skills required by Industry 4.0;
- adoption level of Industry 4.0 per domain (co-design etc.).

The student questionnaire focused on the following:

- if they had the ability to define / implement Industry 4.0 strategy;
- if they had skills in various Industry 4.0 technologies (embedded IT, sensors, mobile, RFID, real-time location, big data, cloud technology);
- if they had the skills needed by Industry 4.0;
- their perception of the need for certain transversal skills.

Excluding the questions aimed to establish the organisation’s profile, the company questionnaire had 31 closed questions. The student questionnaire had an introductory section and 25 closed questions. These questionnaires have been run in all partner countries, but here are presented just some results for Romania.

One question for companies was: “How important is the usage and analysis of data (customer data, product or machine generated data) for your business model?” The results obtained are displayed in Figure 1. Another question was “How advanced is the digitization of your production equipment (sensors, IoT connection; digital monitoring, control, optimization & automation)” and the results are presented in Figure 2.

A cross-analysis has been carried out on identified needs in the context of Industry 4.0 areas and strategies. The cross-analysis results were synthesized in a table [15]. An excerpt is shown in Table 1.

After the performance of gap analysis between engineer roles, target competence level and average current skill level, it resulted the Industry 4.0 applications on which a real competitive master curriculum should focus [16]: Quality Management; Flexible Production Planning and Scheduling for Demand Changes and Customization; Maintenance Management; Data Distribution; Logistic and supply chain management; Inventory Management; Trend analysis; Forecasting; Real Time Process Control; Data Analytics etc.

Because of space constraints and also because all the current achievements of the MSIE 4.0 project cannot be synthesised in a single paper, all the results are available (open access) on project’s site [10]. Besides results, the site contains more relevant information.
5. Discussion

The approach followed by the partnership of MSIE 4.0 project revealed several important aspects. In the case of Romania, it was noted that the implementation of Industry 4.0 in companies was at the beginning, that there were concerns in developing an implementation strategy, but also that there were companies that had ignored the need to make the technological leap.

Also in the case of Romania, the survey among students indicated that some study programmes provided an opening to Industry 4.0, but that a serious review of the curriculum was needed. The survey also indicated a differentiation of areas where the revision was needed.

The gap analysis has been successfully applied and has highlighted the applications that need to be addressed. These were relevant from the point of view of the current gap but also of the accelerated development of the associated areas.

The MSIE 4.0 project is a good example of how to design a competitive curriculum for Industry 4.0. At the time of drafting this paper, the project was in full development.

6. Conclusions

MSIE 4.0 project’s first aim was to determine the real needs for specific competences, by analysing the curricula from several universities. Also, it was organised a survey on needed competences with industrial organisations and students from industrial engineering programmes. Based on the results obtained in these activities, an analysis was performed in order to determine the gap between the required and the actual sets of competences. Moreover, there resulted the Industry 4.0 applications on which a competitive curriculum should focus.

7. Acknowledgements

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8. References


mckinsey/our-insights/the-internet-of-things-and-the-future-of-
manufacturing, accessed on 01.05.2019.

1698-4a15-8858-344351e8902f.original.pdf, accessed on 01.05.2019.


assessment.pwc.de/i40/landing/, accessed on 10.05.2018.


[15] Outcome 1.4 Analysis of needs of industry and students, available at https://msie4.ait.ac.th/wp-

[16] Outcome 1.5 - Gaps between the needs and graduates’ competences, available at https://msie4.ait.ac.th/wp-
MODELING OF THE NATURAL ENVIRONMENT THROUGH GEOGRAPHIC INFORMATION SYSTEMS

Assos. Prof. Milen Ivanov PhD,
NMU „Vassil Levski“ Veliko Tarnovo, Bulgaria
e-mail milen_i1970@abv.bg

Abstract: It is anticipated that the potential benefits of GIS in environmental assessment will continue to increase. Environmental studies are related to the implementation of monitoring and modeling activities that require the use of reliable databases and validated technologies. For these purposes, conventional terrestrial measurements and methods continue to apply, but geographic information systems (GIS) and remote sensing are increasingly used.

Key words: GEOINFORMATION TECHNOLOGY, GEOGRAPHIC INFORMATION SYSTEM, DIGITAL ELEVATION MODEL, LIDAR TECHNOLOGY.

1. Introduction

Environmental studies are related to the implementation of monitoring and modeling activities that require the use of reliable databases and validated technologies. For these purposes, conventional terrestrial measurements and methods continue to apply, but geographic information systems (GIS) and remote sensing are increasingly used. Their high technological and financial efficiency is the basis for their validation as sources of reliable information and quality spatial geo-data. They are therefore increasingly being used to develop a variety of environmental studies to help manage management decisions on spatial development and planning. Remote sensing and GIS technologies provide new opportunities for exploring the natural environment not only by providing modern tools, methods and data for analyzes, but also by integrating direct observation processes and quantitative measurements with spatial analysis and modeling into a unified system.

In GIS, the basic concept is one of location, of spatial distribution and relationship, and basic elements are spatial objects. By contrast, in environmental modeling the basic concept is one of system state, of mass and energy conservation, of transformation and translocation, of species and individuals’ interaction and dynamics. Populations and species, environmental media such as air, water, and soil, and environmental chemicals are the basic units. Since all the basic units, or better, actors, in environmental modeling do have a spatial distribution, and this distribution does affect the processes and dynamics of their interactions considerably, GIS has a lot to offer to environmental modeling.

The overlap and relationship is apparent, and thus the integration of these two fields of research, technologies, or sets of methods, that is, their paradigms, is an obvious and promising idea. Clearly, this could describe environmental modeling and probably GIS as a field of research, often enough a puzzle-solving activity short on theory with its own way of seeing (and displaying) things. It is exactly this way of seeing things that gets changed, or enlarged, when paradigms are merged and thus at least shifted if not revolutionized. Language, concepts, and tools of different fields can certainly enrich each other. For environmental applications in a rather loose sense, including land management, there is considerable tradition in the field, for example, in Canada under the header of land modeling in the Lands Directorate of Environment Canada [7, 10].

While many of these systems have explicit environmental components and functions, they are not usually integrated with any modeling capabilities in the sense of simulation models, that is, transport or process and fate models, models of population development, etc. The idea of this integration, however, is obvious and discussed frequently [9, 11]. Recent overview papers on environmental GIS, and more generally, information technology for environmental applications.

2. Monitoring of the natural environment

There are many different types of monitoring systems. Many of them automate the process of data collection and (pre-) processing – a task often hidden from the ordinary user. Monitoring itself may be implemented in several different ways depending on the type of system under study. When designing an environmental monitoring system, the following factors should be taken into consideration:

- the acceptable time delay is likely to range from true real-time monitoring to manual sampling with a following laboratory analysis;
- the requirement to control quality may range from showing pure raw data to a complete quality assurance/quality control (QA/QC) procedure;
- there is often a distinction between manual and fully automated data sampling systems.

Whatever method is used for the actual monitoring, the process involves the following steps:

- a communication task which takes data from a sensor (or other information source) and communicates it to a receiving monitoring system;
- pre-processing the data using steps such as calibration, checking, and formatting;
- storing the data in some sort of database;
- presenting the data in an appropriate form to users.

The reason for introducing GIS into the pure monitoring process is mostly connected to a userinterface requirement. By introducing GIS at this stage it is possible to utilise mapping functions to display objects such as measurement stations. Furthermore, it can be of great value to keep the complete system within the framework of the GIS, especially if the required data processing tasks involve spatial analysis.

3. Spatial Data Management

GIS involves raw field observations/measurements linked to a location - also known as spatial data or geographic information. These raw data can acquire added value and provide new insights when placed in a framework of reference systems in GIS (i.e. spatial, temporal and attribute reference systems providing location and units of measure, time scale/period for which the data is relevant, and qualitative characteristics or quantitative physical properties associated with a given feature or location). Consequently, such raw data can be overlaid to obtain new insights on behavioural relationships within or with other datasets, or incorporated into models to simulate, and in this way anticipate, future changes in field observations and thus support environmental assessment. However, to ensure that all relevant data are incorporated into GIS and to provide an appropriate assessment framework, a number of pre-requisites need to be fulfilled, including:

• availability and accessibility of datasets; uniformity of reference systems;
• accuracy, scale, consistency, completeness and timeliness of datasets and their attributes;
• and provision of detailed metada.


Modern GIS technologies allow the storage and visualization of huge arrays of data (satellite imagery, aerospace, GIS data) that are needed and enjoyed by professionals and the general public. Geographic information technologies provide the development of platforms providing value added public services by supporting better management decisions, greater efficiency in terms of financial resources, time, resources and more efficient communications.

An important driving force for the continued development of GIS is currently the development of Google's internet products and services. The launch of Google Earth and Google Maps changes the public perception of GIS. Google Maps and the ever-expanding online GIS services promote and make GIS and cartographic activities universally available. A variety of Google Maps applications are created in Web 2.0 that provide services not only to various professional communities but also to the general public. New resources and opportunities are emerging in relation to data collection, in relation to which Goodchild (2007) highlights the application of "new principles of voluntary participation of individuals in the creation, dissemination and free sharing of geographic information" [7].

It should be noted, however, that despite the different stages of GIS development, their essence remains unchanged, and as Dangermond (2003) emphasizes, "the true essence of GIS is the analytical part that explores at scientific level the spatial interconnections, structures and processes of geographic phenomena, cultural, biological and physical phenomena ... this is the area that opens up the best opportunities to understand the essence of our world, its development, interconnection and change" [8]. In the same sense, Poten (2012) notes that "spatial analysis and modeling functions not only distinguish GIS from other information systems but make them an effective tool for revealing and visualizing spatial relationships and interactions between objects and phenomena" [9]. It is important to add the capabilities of modern GIS to directly input geobase data of the results obtained with different forms of measurements of objects and processes of the Earth's surface. Thus, GISs currently contain not only an analytical part, but integrate the monitoring and quantitative measurements with geospatial analyzes and modeling into a unified system. All of this, together with the great capabilities of GIS for data storage and visualization, identifies them as an extremely important and necessary tool for studying the status and monitoring of landscape changes.

An environmental map is a cartographic thematic compilation which, in spatial expression and on the basis of scientific and objective assessment, presents the state of natural environment as well as the causes and results of environmental transformations (both negative and positive) taking place in the environment under the influence of various activities. It also presents the methods of protecting environmental values.

Particular elements of the thematic content of the environmental map are compiled on the basis of the collected materials and results of field mapping. The merits of environmental map contain 6 information levels. These are as follows:
1. Protection of the natural environment and its resources
2. Susceptibility of the natural environment to degradation
3. Degradation of the natural environment
4. Counteraction to natural environment degradation
5. The natural environment reclamation

An integral part of the environmental map is a commentary, which is placed on the reverse of the sheet. The commentary is produced according to a strict scheme and contains:
• characteristics of the main components of the natural environment and their selected features
• supplementary data for the individual informational levels of the map (text, tables, additional maps).
• general evaluation of the natural environment condition and degree of its degradation,
• indicators concerning environmental management and protection,
• other essential information and evaluations.

GIS is a fairly new analytical and planning tool for the visual impact of GIS produced maps in sectors concerned with agriculture, natural resources, urban and regional planning, and tourism in developing countries have been using GIS for many years. This paper is to identify and explore various environmental issues and opportunities to apply GIS in Environmental Engineering.

GIS process – GIS is fundamentally used to answer questions and make decisions. To use GIS properly, following disciplined process is used for getting the answer.

Frame the question - Start your GIS analysis by figuring out what information you need.

Select your data – Select the type of data and features that require to be worked with to help determine the method and information needed

Choose an analysis method - Decide which analysis method to use based on your original question and how the results of the analysis will be used.

Process the data - Once we have selected the analysis method, we will need to process your data in a way that makes sense for our goal.

Look at the results - The final step is to look at the results of your analysis and take action based on those results. Our results can be displayed as a digital map, printed as a paper map, combined with spreadsheet-like tables or charts etc.

GIS Features For Environmental Engineer Are:

Mapping where things are – lets you find places that have the features you're looking for, and to see where to take action.
Find a feature— we can use maps to see where or what an individual feature is.
Finding patterns—Looking at the distribution of features on the map instead of just an individual feature, we can see patterns emerge.

We can map quantities, like where the most and least are, to find places that meet their criteria and take action, or to see the relationships between places. A density map can let us to measure the number of features using a uniform aerial unit, such as acres or square miles, so you can clearly see the distribution2. We can use GIS to monitor what's happening and to take specific action by mapping what's inside a specific area.

We can use GIS to find out what's occurring within a set distance of a feature by mapping what's nearby. By mapping where and how things move over a period of time, we can gain insight into how they behave. There are five type of questions that a sophisticated GIS can answer for environmental engineering purpose:

a) Location what is at? – e.g. location of wells for study of ground water contamination study can be found out.
b) Condition where is it? – e.g., an unfrosted section of at-least 2000 square meters in size, within 100 meters of road, and with soils suitable for supporting buildings can be located.
c) Trends what has changed since? - e.g. change in vegetation on land within last 5 year can be identified. d) Patterns

Spatial Decision Support Systems: A coming of methodology, and there exists at present a lack of trained personal.

database analysis

time series are long today are safeguarding the natural environment and maintaining environmental information to the public and policy makers since it is the technical basis for the multimedia approach in environmental data framework for data validation, rather complex example implemented as a multi-user, client-server configuration. Apart from showing the basic system architecture, the figure also demonstrates how many functions may be involved in a GIS-based monitoring system. In particular, it should be noted how much of the system is actually dedicated to collecting, processing, and storing data rather than explicit spatial analysis and display operations.

Essentially GIS is only used at user workstations, whereas the major part of the system is dedicated to other tasks. This distribution is in most cases reflected in the corresponding implementation and running costs. As a rule of thumb at least 90 percent of the cost involved in setting up an environmental monitoring system is related to the measurement program, the quality control, and processing of data; only a minor part is related to the programming of GIS-based analysis and display functions.

Often the simple data analysis functions provided by standard GIS software packages are insufficient for dealing with the data monitoring requirements of environmental problems. The reasons for this are many, the most common being:

- the economic aspects of a project do not allow sufficient data to be collected to ‘feed’ the analysis tools;
- the characteristics of the data make simple extrapolation inappropriate;
- several parameters are interconnected and the required data cannot be measured directly.

In such cases more complex models are needed to reflect the expected environmental situation. In such circumstances, the task of environmental monitoring goes much further than can realistically be achieved within a standard GIS.

The time series data routinely collected for environmental monitoring very often have two significant analytical and display problems. First, they typically relate to points, when data based on areal units would often be more useful (a problem of spatial object type). Second, the temporal sampling incidence is often too frequent, resulting in large volumes of data. GIS offer relatively simple means of dealing with each of these problems. First, with regard to spatial resolution, a measurement point may be permanently assigned to a representative area using a simple point-to-area transform [10].

A different option is to use standard GIS gridding and contouring facilities to interpolate between the point measurements across the whole study area. Second, with regard to temporal resolution, standard database selection capabilities may be used to extract data pertaining to a time value corresponding to other data to which it must be compared.

The data flow and hardware configuration for a combined monitoring and GIS is shown in Figure 1. The illustrated system is a rather complex example implemented as a multi-user, client-server configuration. Apart from showing the basic system architecture, the figure also demonstrates how many functions may be involved in a GIS-based monitoring system. In particular, it should be noted how much of the system is actually dedicated to collecting, processing, and storing data rather than explicit spatial analysis and display operations.

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5 The role of gis in environmental monitoring

GIS, not surprisingly, has a very important role to play in environmental monitoring. GIS is ideally suited as a tool for the presentation of data derived from distributed measurement stations (e.g. field-based water quality sensors). Unfortunately, however, most GIS have some severe shortcomings when it comes to dealing with the typical data obtained from such measurements, namely time series data.

The techniques for dealing with time series data are covered more thoroughly elsewhere. In a nutshell, time series are long consecutive runs of data, such as the temperature measured every half hour at a certain point. Since most standard GIS software packages do not possess adequate tools for handling temporal data, they must be extended or auxiliary applications interfaced [8, 11].

Figure 1 Application of GIS for various environmental solutions

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GIS display and analyze aerial photos. Digital information can be overlaid on photographs to provide environmental data analysts with more familiar views of landscapes and associated data. GIS can provide a quick, comparative view of hazards (highly prone areas) and risks (areas of high risk which may occur) and areas to be safeguarded. On completion of Data analysis GIS helps in Planning and Managing the environmental hazards and risks. In order to plan and monitor the environmental problems, the assessment of hazards and risks becomes the foundation for planning decisions and for mitigation activities. GIS supports activities in environmental assessment, monitoring, and mitigation and can also be used for generating Environmental models.

Geographical information systems can be applied at all planning stages. Decision process aims to both identify and anticipate impacts on the natural environment. The interface between these two components produces several effects, which will generate specific impacts. GIS can also be explored within the whole process to improve different features, mainly related to data storage and access, to the analytical capabilities and to the communicability of the results. The development of such a system will allow a more realistic approach to the environmental descriptors and a better understanding of their interrelationships. GIS will bring to the process a new way of analyzing and manipulating spatial objects and an improved way of communicating the results of the analysis, which can be of great importance to the public participation process.

The use of GIS in the planning process, where public participation is of great importance, requires the development of applications allowing a better understanding of spatial phenomena. During the process many different variables and phenomena presenting complex interrelationships, which vary in space and time are considered. These procedures involve technical analysis that includes changing assumptions and priorities and descriptions of significant visual and audible impacts.

6. Conclusion

In summary, the capabilities of GIS in modeling of the natural environment are:

- It is possible to store large amounts of different kinds of data. The access to these rich databases allows the performance of dynamic queries based on real world representations.
- Concerning the analytical capabilities, some potential functionality can be added such as the use of interactive video and digital sound associated with zoning maps, to help planners and decision-makers to visualize and better evaluate the impact of a new infrastructure.

Other capabilities are related to the integration of spatial simulations associated with real images and to stereoscopic aerial photographs in order to get an improved visualization of the phenomena and their evaluation in real time.

The results of modeling correspond to compressed information to synthesize in a small number of descriptors the complex and diversified universe that has been analysed. In a GIS, the improvements in the communicability of the results are associated with the use of images, which represent information in a compact way, of easier comprehension.

The development of GIS for modeling requires the analysis of this process in order to identify the tasks that will be beneficial. To better understand the study area it may be necessary to view it from several different perspectives: aerial views, static and dynamic ground views. The aerial view corresponds to a combined flight through aerial photographs or satellite digital photographs, giving a perspective of the study area. This representation can be associated with the corresponding route of the flight over a map, allowing the interrelationship between the two spatial representations to be established.

7. Literature

1. Vulchinov V., Geoinformatics, UACEG, Sofia, 2003
3. Tepeliev Y. et al., Geographic Information Systems, Sofia, 2003
Abstract: The development of microelectronics forms new channels of confidential information leakage. The transmission of acoustic information by digitally modulating the light output of LEDs has now become physically realizable. Theoretical calculations showed a high potential sensitivity of MEMS microphones. The combined use of digital MEMS microphones and LED room lighting controllers allows you to transmit a digital data stream of 40 800 Bits / s over 100 meters with minimal signal-to-noise ratios. Conducted research reveals a new information leakage channel and describes its characteristics, which will make it possible to develop administrative and technical countermeasures.

Keywords: ACOUSTIC LEAK CHANNEL, LED, MODULATION OF THE VISIBLE LIGHT, DSP, MEMS.

1. Introduction

Visible light produced by LEDs has great potential as a medium of transmission of acoustic information by means of modulation of visible light. The very nature of visible light reveals a number of important properties such as a huge unregulated frequency band, the absence of radio interference, the possibility of using high frequencies of carrier waves, a small attenuation of visible light with distance, so on a clear day the attenuation of the optical signal in the atmosphere is only a few decibels per kilometer. The main problem in ensuring the transmission of information through the optical channel is a strong background illumination and noise of the photodetector.

2. Identification of information leakage channel

2.1. Determination of the leakage channel of acoustic information

The acoustic channel of information leakage by means of the modulation of visible light (AKUMS) is understood as the acquisition of acoustic information using the equipment that receives the modulated optical signal in the visible range. The modulation of visible light is generated by a microcontroller that controls a non-coherent LED visible light source. It is possible to use various types of modulation, such as analog amplitude modulation of light intensity, and digital modulation types in terms of the duration and intensity of transmitted light pulses.

The technological transition in the creation of lighting in rooms from incandescent lamps to high-tech low-inertia LED illuminators containing controllers creates the prerequisites for the formation of a new information leakage channel.

2.2. AKUMS structure

The generalized leakage channel of acoustic information through the modulation of visible light has the form shown in Fig.1. The considered AKUMS channel consists of a transmitter of a signal in the visible range, located in the room, or a special technical means (CTS) and a reconnaissance receiver remote at a distance R from the transmitter in an optical medium.

Acoustic confidential information is transmitted through a microphone to a digital signal processing unit (DSP). The output signal is a digital data stream with different coding. The digital signal is modulated by the LED controller according to the intensity and duration of the light pulses. Visible modulated light from the LED propagates in the optical medium both directly in the forward direction to the receiver, and by means of scattered re-radiation. The receiving part of the AKUMS equipment consists of an optical system of lenses and a photodetector. Photodiode as an embodiment of the photodetector under the influence of the incident light flux with varying intensity generates an electrical photocurrent of digital data. The encoder and digital-to-analog converter of the DSP unit generates from the received digital coded sequence a reconstructed acoustic signal with confidential information.

3. Acoustic Information Leak Channel Characteristics

The main characteristics of the JTS significantly affect the possibility of unauthorized information: the signal-to-noise ratio at the transmitter microphone, the parameters of the digital processing of the acoustic signal (the amount of information), the type of digital modulation, the solid angle and the luminous flux of the radiating power.

The main characteristics of the optical environment have a significant impact on the ability to transmit information: the distance between the CTS and the intelligence receiver, the light power of the illumination, the scattering, absorption and reflection coefficients, the optical density of the propagation medium, the noise power.

The main characteristics of the reconnaissance receiver affecting the possibility of obtaining information at a distance R: angular and numerical apertures, as well as the values of the relative aperture, f-number, geometric aperture of the optical system; sensitivity, geometric size, spectral and frequency response of the photodetector.

3.1. The sensitivity of the digital transmitter microphone

The threshold for hearing a person is 2x10⁻⁵ N / m² or 20 μPa for a 1 kHz sine wave. This is the minimum sound level or a very quiet sound that a person can still hear. Уровень звукового давления в децибелах $L_{ZV}$ определяется по формуле

$$L_{ZV} = 20\log(P/P_0),$$

where $P_0 = 2\cdot10^{-5} \text{ Pa}$. Not loud speech man ranges from 45 to 55 dB.
Microphones have diverse parameters, but to analyze the leakage channel, consider the sensitivity of the \( L_m \) microphone. \( L_m \) shows the magnitude of the induced potential difference when exposed to a sound pressure of 1 Pa. \( L_m \) is the ratio of the voltage \( E \) developed at the nominal load resistance at a sound pressure of 1 Pa to the voltage corresponding to 1 mW of power, expressed in decibels.

\[
L_m = 20\log(e/E_{1000})
\]

As it is known with increasing distance, the sound pressure level drops and the 6dB rule is valid for free space without scattering and absorption. According to which the pressure level decreases by 6 dB each time the distance is doubled. In reality, the environment is affected by the propagation medium, medium temperature, etc. For practical calculations use the following relationship:

\[
L_p = L_w - 10\log(r) - 11, \text{ dB}
\]

Where \( L_p \) is the sound pressure level at the source, \( L_w \) is the sound pressure level at distance \( r \) from the source (distance \( r \) is measured in meters).

Taking into account the considered dependencies, the voltage induced on the microphone with regard to the distance is determined by the expression:

\[
U = \frac{2}{10^{0.025(L_m-5m-11)-5}}
\]

Clause 5.3.2 outlines the requirements for microphone amplifiers when measuring the parameters of microphones. So the microphone amplifier should have the following parameters: “the voltage of its own noise and background, brought to the input, should not exceed 5 \( \mu \)V”. We assume that the voltage value of 5 \( \mu \)V determines the lower threshold recorded. In accordance with this threshold, we find the dependence of the potential difference created by the microphone on the distance for microphones with different sensitivity values.

For the formation of a leak channel, other parameters of the microphone are not very informative, since the greatest threat is the leakage of confidential negotiations carried out in a quiet voice. From the graph it is clear that the sensitivity of the microphone is the defining characteristic of the source of information. Maximum sensitivity is determined by the largest negative number. Classic analog microphones provide sensitivity from -40 to -65 dB. MEMS digital microphones are characterized by high sensitivity from -18 to -35 dB. Microphones with \( L_m = 22 \) dB are quite common. The dependences presented in Fig. 2 show the good theoretical results of MEMS microphones in free space along the axis. And identifies the potential threat of an acoustic leakage channel.

3.2. Digital processing options in the acoustic leak channel

The parameters of digital processing of an acoustic signal determine the amount of information for transmitting a streaming audio signal from a room for processing confidential information. Consider the minimum requirements for converting voice information. In international and domestic standards, the bandwidth is specified from \( f_{min} = 300 \) Hz to \( f_{max} = 3400 \) Hz of the standard telephone channel, which determines the maximum frequency of the transmitted acoustic signal via AKUMS. The upper frequency determines the required number of samples of a discrete signal. Another voice parameter is dynamic range. The dynamic range of the ADC is determined by the expression:

\[
DR_a = 20\log\left(\frac{f_{max}}{f_{min}}\right)
\]

where \( A_{min}, A_{max} \) is the minimum and maximum value of the harmonic signal, \( A_{max} = Q \cdot 2^{(Q-1)}, A_{min} = Q/2 \). Q is the quantization step, q is the number of digits. The number of digits and dynamic range can be represented as

\[
DR_a = 20\log\left(\frac{2^{Q(q-1)}}{Q/2}\right) = 6.02q
\]

The dynamic range of the voice (main tone) is 25 - 35 dB, chorus 30-45 dB, etc. Thus, for a speech path with a dynamic range of 35 dB, \( q = 6 \) is required.

Calculate the capacity of the speech path with the upper frequency of 3400 Hz and a dynamic range of 35 dB for the presentation, which requires a six-digit code 3400 \( \times 2 \times 6 = 40800 \) bps or 5.1 Kb / s. The considered values correspond to the minimum requirements for a digital speech path, an increase in the frequency and dynamic range will inevitably lead to an increase in the amount of information.

The digitized speech signal is converted to a digital modulation type by controlling the LED controller. Light incoherent sweat from the LED is a sequence of pulses of different amplitudes and durations propagated in an optical medium. In the process of propagation, the information luminous flux fades and dissipates. Let us find an estimate of the limiting values of the transmission distance of messages.

In [7], the authors note the feasibility of a data transfer rate of 11 Mbit / s in a laboratory experiment at a distance of 3 meters. When using bright LEDs, a blue filter and binary amplitude modulation, a data rate of 280 Mb / s was obtained at a distance of 23 cm. The experiments did not use optical lens systems and were studied with the aim of obtaining the highest data rate. Based on the results of the experiments described and on the relation between bandwidth and signal-to-noise ratio, we describe the bandwidth of the information leakage channel as a function of distance:

\[
q
\]

Fig. 3. Influence of signal-to-noise ratio and transmission range for transmission of 40800 bit/s streaming information
4. Conclusion

The development of microelectronics forms new channels of confidential information leakage. The transmission of acoustic information by digitally modulating the light output of LEDs has now become physically realizable. Theoretical calculations showed a high potential sensitivity of MEMS microphones. The combined use of digital MEMS microphones and LED room lighting controllers allows you to transmit a digital data stream of 40,800 Bits/s over 100 meters with minimal signal-to-noise ratios. Conducted research reveals a new information leakage channel and describes its characteristics, which will make it possible to develop administrative and technical countermeasures.

5. Literature

MULTI-CRITERIA OPTIMIZATION OF TRACKED VEHICLE TRANSMISSIONS

Oleksandr Ustynenko\textsuperscript{1,1}, Oleksiy Bondarenko\textsuperscript{1}, Illia Klochkov\textsuperscript{1}, Volodymyr Serykov\textsuperscript{1}

\textsuperscript{1} National Technical University “Kharkiv Polytechnic Institute”, Department of Theory and Computer-Aided Design of Mechanisms and Machines, 61002 Kharkiv, Ukraine

Abstract. The article is devoted to the problem of computer modeling of rational design of tracked vehicle transmissions with multiple criteria. The problems of finding optimal geometric parameters that satisfy several quality criteria. All the complexity of the layout and the relationship of the parameters make difficult their choice, which is simplified when using approaches of mathematical optimization. Using the famous pseudo-random method LPT-search with the author’s modification made it possible to avoid problems associated with the discreteness and the number of parameters. The main optimization criteria for transmission are minimum center distance, minimum length, minimum mass, and maximum uptime probability. To solve this problem, the problem was formulated and design parameters with constraints were specified, criteria were recorded and a transformation from multicriteria to a single criterion was proposed. The approach is based on analysis of test points that obtained using LPT-search, and further processing of the information received. The approach of transformation from many criteria to one is proposed by introducing the scale of importance by the designer and assigning the importance of each of the criteria, finding the desired solution for each trial point of relative offset, which is proposed to be used as a unifying criterion. Basic schemes and flowcharts of the algorithm elements are provided. The implementation of the computer model was carried out in the Delphi 7 environment.

1 The actuality of the task

Wide application in transport engineering has mechanical transmission, which are used to change the torque and rotation speed of driving wheels of tracked vehicles. Their most widespread representatives are cylindrical gearboxes and additional drives. This can be performed both in deployed and in coaxial layouts [1].

The complexity of designing this type of drive is the distribution of gear rations between the stages, and, consequently, the selection of appropriate design parameters. Also, during the design, it is necessary to ensure the equal strength of gearings.

Usually, when designing technical systems, an engineer is confronted with a dilemma, since a wide range of product requirements leads to several quality criteria [2]. Most tasks of optimal design of stepped drives are also multicriteria. From the position of the gearbox design, the following most significant weight and gabarit characteristics are usually used: center distance (coaxial gears) or total center distance; length; mass of the gearbox [3]; integral value, which includes all the calculated safety coefficients of bending and contact stresses.

Simultaneous achievement of the best characteristics is always controversial, complex and subjective process; therefore, it is expedient to use approaches of multi-criteria mathematical optimization at designing.

To solve this problem a pseudo-random search is proposed. It is based on the study of the space of parameters, where the points of the LPT-sequence [4] are used as test points in the unit multidimensional cube. Also, all the criteria are combined into one.

With such an approach to solving the problem, the following questions are:
- formulation of objective functions according to the criteria;
- development of the approach and algorithm for combining the criteria, that make it possible to reduce the problem to one-criteria;
- computer realization of the proposed algorithm;
- presentation and interpretation of the results.

Thus, the realization of this approach to the rational design of a transmission under several criteria, with their merging into one, and numerical solutions of the problem is actual.

2 Design parameters and design criteria

In order to solve the problem of optimal design, the following design parameters of the gear drive were adopted as variables planning [3, 5]:
- \( m_\mu \) – the corresponding modules of gears pairs \((\mu = 1, 2)\);
- \( z_\mu \) – the corresponding number of teeth; \( k \) – the number of wheel in the mesh \((k = 1 \text{ – driving wheel}, k = 2 \text{ – driven wheel})\);
- \( \beta_\mu \) – the helix angle of the teeth.

Let’s consider proposed quality criteria for a distribution gearbox.

The objective function of the criterion of minimum center distance for a coaxial arrangement is presented as [3, 5]:

\[
F_a = a_{w1} = a_{w2} = 0.5 \cdot m_1 \cdot (z_{1,1} + z_{1,2}) \cdot \frac{1}{\cos \beta_1} = 0.5 \cdot m_2 \cdot (z_{2,1} + z_{2,2}) \cdot \frac{1}{\cos \beta_2} . \quad F_a \rightarrow \min. \tag{1}
\]

Objective function in the case when the criterion of optimality is the minimum length of the drive represented as the sum of the width of the toothed wheels, without other geometric indicators (sizes of gaps, bearings, synchronizers, etc.). This sum of width exactly characterizes the specified criterion, that is:

\[
F_L = \sum_{i=1}^{k} b_{ui} , \quad F_L \rightarrow \min. \tag{2}
\]

Objective function in the case when the criterion of optimality is the minimum mass of the gear drive. The main mass of the gearbox consists of masses of the following elements: gears, shafts, bearings and crankcase. But for solving the presented problem, it is proposed to evaluate only the masses of the gears. Let’s write the objective function in the form:

\[
F_M = \sum_{j=1}^{n} M_j , \quad F_M \rightarrow \min. \tag{3}
\]

The objective function in the case when the criterion of optimality is the probability of failure-free operation \((P)\). It is proposed [6] to represent in the form of product the probabilities of failure-free operation of drive by contact and bending:

\[
F_p = p(K_{nat1}) \cdot p(K_{nF11}) \cdot p(K_{nF12}) \times p(K_{nat2}) \cdot p(K_{nF21}) \cdot p(K_{nF22}) \rightarrow \max. \tag{4}
\]

3 Limitations and functional relationships between constructive parameters

1) The center distances of meshes for the coaxial arrangement should be equal, that is:

\[
da_1 = a_2. \tag{5}
\]

2) The teeth of the wheels must have the necessary contact durability:

\[
\sigma_{H\mu} \leq \sigma_{HP\mu} . \tag{6}
\]
3) The teeth of the wheels must have the required bending strength:

\[ \sigma_{F_{\mu},k} \leq \sigma_{F_{P_{\mu},k}}. \] (7)

4) The teeth module is the main parameter of the gearing. They are standardized. We accept the following row for calculations:

\[ m_{\mu} = 1, \ldots, 8 \text{ mm}. \] (8)

5) The number of teeth must accept integers (must be natural – N), and also limited to the upper and lower values for manufacturing reasons:

\[ z_{\mu,k} \in N; \quad z_{\min} \leq z_{\mu,k} \leq z_{\max}. \] (9)

6) From the requirement of the overall relationship, the gear ratio must not exceed a certain value \( u_{\max} \):

\[ u_{\mu} = \frac{\max(z_{\mu,1},z_{\mu,2})}{\min(z_{\mu,1},z_{\mu,2})} \leq u_{\max}. \] (10)

7) The helix angle of the teeth must be in the range from \( \beta_{\min} \) to \( \beta_{\max} \):

\[ \beta_{\min} \leq \beta_{\mu} \leq \beta_{\max}. \] (11)

8) The face width factor is also limited to extreme values:

\[ \psi_{bd,\min} \leq \psi_{bd,\mu} \leq \psi_{bd,\max}. \] (12)

9) The condition for the absence of sharpening tooth tip pointing:

\[ \sigma_{sy} \geq 0.4 \cdot m_{\mu}. \] (13)

4 Approach and sequence of problem solving

As is known from [3], the LP-SEARCH method is based on LP-uniformly-distributed sequences and allows operating a large number of parameters (up to 51) and uniformly-distributed test points (up to 250).

The approach is based on the research positions all possible space of parameters \( W \) by the points of the LP-uniformly-distributed \( A_{\mu} \) sequence. This space of parameters is determined by the technical and technological requirements for the type of drive.

Then the points are checked in a certain sequence, which allows to timely manner clear the "inappropriate" points and thus reduce the time of computer solution. From the points that have passed the test, a set is created that satisfies the design conditions \( Q, Q \in W \).

The linear curtailment of criteria for solving multicriterial optimization problems is used quite often. But linear curtailment has a significant drawback – the value of the resulting function has no physical content.

The authors were proposed to depart from linear curtailment [7] and to combine the criteria in the sequence discussed below.

The designer is invited to introduce a scale of importance that will be applied to all criteria. In this scale, the importance \( \alpha \) can vary from 0 to \( \alpha_{\max} \) at step 1, the value \( \alpha_{\max} \) is also chosen by the designer on its own: \( \alpha = 0, 1, 2, \ldots, \alpha_{\max} \); thus, the designer can independently choose the level of discreteness for the scale of importance. The value \( \alpha = 0 \) corresponds to the absolute priority of the criterion, the value \( \alpha = \alpha_{\max} \) corresponds to the relative unimportance of the criterion. For each of the criteria \( (F_u, F_L, F_M, F_P) \), the designer independently assigns the relevant values of importances \( (\alpha_u, \alpha_L, \alpha_M, \alpha_P) \). Importance's can be assigned to values within the accepted scale. The situation of equality of the importance's values for any criteria is possible. That allows implementing hierarchical, binary or any other connections and correlation between the criteria.

After that, the generation of test points of LP-uniformly-distributed sequences of the whole possible space of parameters is carried out. Test points are checked for constraints and functional dependencies (5–13), the selected points form a set of solutions \( Q \).

For all points of a set \( Q \), the values of all criteria are calculated separately for the corresponding objective functions (1–4). After, the maximum \( (F_{u_{\max}}, F_{L_{\max}}, F_{M_{\max}}, F_{P_{\max}}) \) and the minimum \( (F_{u_{\min}}, F_{L_{\min}}, F_{M_{\min}}, F_{P_{\min}}) \) value for each criterion are determined.

The following is proposed to calculate the criterion step [7]:

\[ R_u = \frac{F_{u_{\max}} - F_{u_{\min}}}{(\alpha_{\max} + 1)}, \quad u = u, L, M, P. \] (14)

The next step is to determine of required solution offset of the relative to the current solutions for each of the criteria [4], for each (s) the point of the set \( Q \):

\[
\begin{align*}
E_{u,s} &= \left[ F_{u_{\min}} + \alpha_{u,s} \cdot R_u - F_{u,s} \right] - F_{u,s}; \\
E_{L,s} &= \left[ F_{L_{\min}} + \alpha_{L,s} \cdot R_L - F_{L,s} \right] - F_{L,s}; \\
E_{M,s} &= \left[ F_{M_{\min}} + \alpha_{M,s} \cdot R_M - F_{M,s} \right] - F_{M,s}; \\
E_{P,s} &= \left[ F_{P_{\min}} - \alpha \cdot R_P - F_{P,s} \right] - F_{P,s}.
\end{align*}
\] (15)

Then combine the criteria for the required solution offset relative to the actual as arithmetic mean square-weighted:

\[ E_s = \sqrt{\frac{\sum_u [E_{u,s}^2 \cdot \alpha_u]}{\sum_u \alpha_u}}, \quad E_s \to \min. \] (16)

Thus, the designer has the possibility to solve multicriteria tasks, turning them into one-criterion, and the introduced criterion has a physical content – the relative approximation of the test point to the desired solution.

5 Software implementations of the optimization algorithm

In view of the presented algorithm [6], the optimal rational design of the gearbox, which combines the given approach, the mathematical model of the problem (objective functions and limits of the variables planning) and rational logical sequences of operations, developed an integrated program complex. Its implementation was carried out in the software Delphi 7, because the program language of this package enables to describe the algorithm qualitatively and rationally, it is quite easy to use.

The received program has a block-procedural structure, therefore it can be easily modified at the request of the designer, which enables to carry out optimally rational design of other types of transmission with fixed parallel shafts.

Also, one of the advantages of Delphi 7 is the ability to create a visual shell program as a standard window. This allows the user to easily enter the necessary input data and easy view the data received.
A graphical representation of the calculation results

The authors proposed to present calculations results in graphical form for a more visual representation.

The calculations results are presented in the form of closed polygonal graph. The graph is based on the axes, the number of which corresponds to the number of criteria.

Axes are locating in the plane of the sheet radially and uniformly. On each axis marked equal segments.

The beginning and end of the segments correspond to the limits of the existence of the criteria solution of within the task.

Figure 1 shows a graphical representation of the solution to the problem of optimally rational design of a distribution gearbox.

Two graphs are shown, with and without a unifying criterion.

Fig. 1. Polygonal graphs solution.

7 Conclusions

1. The relevance of the task is considered. The necessity to develop an approach to the design of transmission with rational design parameters with several criteria, with their transformation in one is described.

2. Objective functions of the most significant criteria and limits of the variables planning are recorded. The given objective functions allow the designer to choose one or several quality criteria. The structure of the objective functions is logical and concise, and they can be supplemented of necessary refinement applications.

3. A new approach to solving multicriteria problems of a transmission rational design, the essence of which is to combine the criteria into one, is proposed. The approach is based on the analysis of test points obtained using LPr-search, and further processing of the received information.

4. It is proposed to replace many criteria to one by introducing a scale of importance to the designer and assigning the importance of each criterion. For each test point required solution desired is calculate, which is proposed to be used as a unifying the criteria.

5. A numerical experiments were conducted. Its target is testing the proposed method for unifying the criteria and obtaining adequate output data. The universality and convenience of the proposed software system made it possible to quickly change the concept of a numerical experiment (one-criteria or multi-criteria design) and to comfort vary input parameters.

References


CREATING A 3D MODEL OF DENTAL SPLINT FOR BRUXISM

Tihomir Dovramadjiev1,*, Diana Pavlova2 and Alexandrina Bankova1
1Technical University of Varna, Department of Industrial Design, 9010 str. „Studentska“ N1, Varna, Bulgaria
2Medical University of Varna, Department of Dental Material Science and Propaedeutics of Prosthetic Dental Medicine, 9002 „Tsar Osvoboditel Blvd” 150, Varna, Bulgaria

Abstract. The present study examines the possibilities of applying modern technologies in the field of dental science and specifically in the treatment of bruxism. Based on an optimized methodology, a prototype, and digital and real dental splint models have been developed using biocompatible material and specialized equipment including a 3D scanner and a 3D printer. The details of the production of the models are precisely designed, taking into consideration the medical and technical requirements.

1 Introduction

Bruxism is a specific condition, which is characterized with excessive teeth grinding or jaw clenching. When a person is affected, he or she unconsciously grinds the teeth during the day or in their sleep. These unconscious jaw movements may lead to enamel scratching and painful teeth sensitivity, jaw pain, headaches, etc. Bruxism causes teeth cracking, develops deep dental caries, and damages teeth bridges, fillings and crowns.[1 - 6]. Fig. 1 shows effects of Bruxism against Healthy Teeth respectively in Visible View[7] and Section View[8].

![Fig. 1. Effects of Bruxism and Healthy Teeth: (a) Visible View [7], (b) Section View [8].](image)

The actual destructive process caused by Bruxism is shown in Fig. 2, where the serious problem that this condition represents can be seen.

![Fig. 2. Effects of Bruxism – real pictures [8].](image)

Regarding the musculoskeletal movements caused by bruxism, treatment may be applied by splinters or by other similar mouthguards. they are designed to keep the teeth separated in order to prevent them from destruction. The application of different technological methods and techniques has been presented in the works of various scientific teams and specialists working in the field of dentistry specifically regarding Bruxism [9 - 18].

2 Materials and methods

The construction of the specific splinter (for Bruxism) involves the conventional development of a three-dimensional real jaw pattern (by model) and a technological pathway constructing a 3D print model. The method sequence is shown in Fig.3.

![Fig. 3. Method for making a bruxism splinter.](image)

2.1 Physical model of gypsum

A silicone imprint is taken from the patient's mouth and a physical model of gypsum is cast. In Fig. 4 is a development model shown.

![Fig. 4. Physical model of gypsum: (a) Top view of upper and lower jaw, (b) Front view.](image)

2.2 3D scan of the physical model

The physical model is scanned with a 3Shape D750 Series Laboratory Scanner (Fig. 5). Technically the scanner provides scanning of a gypsum model. Operates with 2 x 1.3Mp cameras, blue LED lighting. The scanning time of a single structure is 25 seconds, and a 3-membered tooth bridge - 55 seconds. Accuracy for crown and bridge scanning is 10 μm and formplant Bars - 12 μm. The scanner is equipped with computer control and Dental SystemTM Premium dental software, which allows drawing and links to .stl files. The software can generate single caps, anatomic crowns, dental bridge constructions, gingival mask, inlays, onlays, veneers, temporary dental structures, virtual diagnostic models, telescopic crowns, individual spoon prints, mouthprotectors [19].


2.3 3D computer processing of the resulting digital splinter model

The creation of the 3D model is accomplished by the presence of data obtained by scanning the imprint of the upper and lower jaw. A STL file from the Applianse Designer 3Shape program is received (Fig. 6).

The scanned pattern is processed with Applianse Designer 3Shape. A virtual articulator is used to fix the jaw while maintaining the trajectory of movement of the lower jaw part relative to the upper jaw part [20]. The STL file format is saved (Fig. 7).

Unblocking of the retention areas for normal splinter mounting is shown in Fig. 8.

Defining the boundary of the bruxism splinter vestibularly and lingually is shown in Fig. 9.

Three-dimensional software has good interactivity and the ability to visualize the work pattern from different views. An example is given in Fig.10.

The virtual conclusion of upper and lower jaw and the attached bruxism splinter are shown in Fig. 11.

Specific geometric elements on the splinter are bent to prevent its fast abrasion. The thickness can be 1-2 or 3 mm. It is predetermined by the dentist according to the physiological characteristics of the patient (Fig. 12).
2.4 3D specialized computer modelling of the splinter

The netfabb Professional for RapidShape program [21] activates the received model (from the STL file). A platform is placed, the model is positioned and the retaining pins are added to help the construction stability during printing. An optimal position and direction is selected. The final design of the model is forwarded to the 3D printer for printing (Fig. 13).

Once the digital model has been finalized, it is moved to 3D printing.

2.5 3D printing of the splinter and finalizing the model

3D prototyping has a number of benefits, the capabilities of which are enhanced by technological advances regarding the geometry accuracy [22]. 3D printer (Rapid Shape Series D30, [23]) is an open-ended system and is often used in conjunction with the 3Shape lab 3D scanner as well as in this specific case. Besides the current development of a bruxism splinter this type of 3D printer can print models, individual dental spoons, surgical guides, temporary dental bridges and crowns, casting models, gingival masks, dentures, mouthprotectors. The kit also includes an additional polymerization device after printing. The principle of the 3D printer is a layer construction of the model through photopolymerization of photopolymers [19]. Professional RapidShape 3D printers (Fig.16) work with various types of liquid resin specializing in industrial and other applications; for example for Orthodontic material, NextDent Ortho is used [24].

The final 3D print model of the bruxism splinter is shown in Fig. 17.

The following students worked too on creating the bruxism splinter: Pavlina Andonova, Momchil Minchev, Alexandra Boeva and Velizara Maneva from the Technical University - Varna specialty “Industrial Design”, practising their technical skills at the Medical University - Varna, based on the project “Student Practices” - Phase 1, BG05M20P001-2.002-0001 of the Ministry of Education and funded by Operational Program “Science and Education for Smart Growth 2014-2020”, European Social Fund of the European Union. [25].
3 Conclusion

Using the modern technological means and the correct methodology of work, a model of the bruxism splinter is created. The process of designing has been optimized by applying the right approach to both the model itself and the stages of gathering information on the subject and systematizing the parameters, the geometric features and other data typical for the physiological condition of bruxism. With advanced technology, modern 3D scanners and 3D printers have greatly improved their technical features, making it easy to develop the tested models. They are distinguished by the correct geometric shape and accuracy. It also saves time, resulting in optimization of the workflow and cost reduction.

References

AUTOMATED SOFTWARE TESTING FRAMEWORK "STASSY"

Denislav Letterov PhD student, Svetoslav Enkov assoc. professor
Faculty of Mathematics and Informatics, Plovdiv University “Paisii Hilendarski”, Bulgaria
denislav.letterov@uni-plovdiv.bg, enkov@uni-plovdiv.bg

Abstract: Over the last two decades, software testing has expanded in terms of both the tools used to perform different types of activities and mind-set of the people using those tools. Automated testing involves use of strategies and instruments that perform testing activities of a software product and where the interference of a person is mainly related to the research of the results of these activities. Automated testing processes are popular because of the benefits that make them an indispensable tool in everyday work for testing activities. The main advantage of automation is the abstraction of rehearsal processes within the tested system. In this way, a complete separation of the human operations from the system is achieved, only the functionality that needs to be programmed. This article presents the development of an automation-based testing framework "Stassy" - System Stable Testing, which supports and helps to implement easily new tests related to Web platforms. The implementation includes the following structure: Object repository, Functional libraries, Global variables and Constants, Data Provider, Test scripts, Configuration files, Recovery scenarios, Loggers, Clean-up scripts and Reporting mechanism. With the advantages of Page Object Pattern and using of the following technologies: Java programming language, JUnit and TestNG extended libraries. The created scripts represent automated acceptance, functional and non-functional tests in which Page Object is used to separate those tests into individual fragments and subsequently call them in a different order according to the automation requirements and business logic. We will track the overall preparation and creation of "Stassy" automated framework and explain the benefits of such approach.

Keywords: AUTOMATION, FRAMEWORK, TESTING, QUALITY, ASSURANCE

1. Introduction

Nowadays software testing technologies provide a lot of testing efforts and solutions, but mainly they are concentrated to present the idea of general answer to the issue, and they are not specified with the current requirements of one particular application. So, of these conclusions we have to say that there is a need for providing an adaptive solution for proposing a set of testing efforts oriented to the current needs for applications of this nature. For example, there are a lot open source specialized tools for automation purpose, but separately they are insufficient to fulfill the whole software development life cycle. In this context, the automated software framework provides flexible solutions for the needs of the software industry.

The initial setup on various projects took a lot of time. At the end of the day, we all go again through similar issues. We resolved this by creating a framework to use it as a template for every new project, offering us the leverage to avoid all of the known problems. When automated tests are created, the first thing we do is to interact with the browser. This can include navigating to a page, clicking a button, or filling in a login form and many different actions. After that, we need to verify and report the actual versus the expected result. While we have many different tests at our disposal, how and when we use them is dependent on the scenario. In some cases, we’ll execute several tests in a specified order. In others, only execute specific tests. In order to achieve all of this, testers usually need to implement different frameworks or libraries along with the Selenium Web driver. [1]

2. Problem area

As we said most projects have common user actions that need to be accomplished in an automated flow. These interactions are developed and implemented in the framework itself and the testers can use them right away without wasting time to write or re-write them again from the start. Another advantage is that we can easily read data from files, for this purpose a Data Provider stub has been created. For example, we can have a list with username and account details credentials which we want to use when we execute tests. With advantages of the framework, there is no need to waste time developing this functionality since it is already done generally. Along with all positives, this development is integrated and extended from Selenium internal frames [2]. This gives us the flexibility to easily choose which tests we want to execute: whole test suite / scenario, or only smoke, sanity tests and etc. also other perspectives or set of tests. It supports data-driven behavior testing and flexible configuration setup.

Main areas of automation needs in an example Web application divided by business logic:

- Main Pages/Re-Direction/Links Testing;
- Categories, Details and Search option Testing;
- Content Detail and Management Testing;
- Payments Testing if is applicable;
- Analytics, Reviews, Ratings and User Profile interaction Testing;
- Promotions/Deals/Ads Testing;
- Social Media Integration and SEO Testing;
- Browser/Device Compatibility Testing;
- Integration Testing;
- Globalization Testing.

Problems that can occur are different, more from less, here are the most common cases that can happen while we are developing our software product:

1. Frequently Changing Requirements

Considering the latest technologies emerging these days, our web applications need to be upgraded. This calls for a change. This change can be related to any new version, integration with the third party tools or maybe sometimes, there are new functionalities that we want to implement in our web application.

2. Increasing Complexity of Testing Web Elements

Latest web functionalities that we implement in our web applications can include various web elements. Those elements can be embedded frames and other products as well. Sometimes, large enterprise websites contain complex flowcharts, diagrams, maps, etc. These make the website’s UI test automation complex.

3. Handling Multiple Errors

Error handling has been an issue with user interface (UI) automation testing. Whenever there are complex UI test scenarios with tight deadlines, most time is utilized in creating test scripts. Thus, testers choose manual testing over automation for UI testing. Error handling becomes extremely difficult when you manually revoke the error messages and automate the same.

4. Maintaining Automated Scripts

Web developers often make changes to UI rather to the logic of the features and functionalities. With this, the UI test scripts fail each time there are new changes to the UI. Hence, maintenance of the UI scripts has been a challenge for long. [3]
3. Framework Architecture

The Framework can support and help the flow of making data-managed scripts more compact and less susceptible to failure. Utilities can also facilitate gradual and manageable conversion of existing scripts. We have functions for each common step under a common library and we call it in the test scripts when it is necessary, it also contains data file that is provided from external storage, such as SQL, CSV or other external resource files or any data carrier from which we can retrieve the necessary records to test the software.

Custom exception package

This package contains user-defined exception class that expands the primary class that is used for processing when an exception occurs during the execution. It is used to provide a simple message for quality assurance (QA) specialists about the logging of errors at the time of interruption. Generally, this helps to understand the failure and the debugging can be more effectively. [4]

Utilities package

In this package, there are a couple of read-only files which contain information about the characteristics and cases of the test steps, such as: Properties file with static variables referencing to the paths and other environmental details logic, different Database location and connection approach. These details can be application URL, Database root path, credentials access, and also third-party URL’s of a given set of tools which are responsible for full handling of the application. The Property class provides data levels that cannot be accessed through the property evaluation methods and are strongly encapsulated in the utilities package. [7]
Reporting mechanism functionality

Reporting mechanisms are the most important part of any testing purpose. This action provides valuable information to the user, who can calculate the current status of the Web application and also the accuracy and the reasons for failures after test execution. On the other perspective, there is a need to identify any measure to eradicate errors in case of loss. TestNG implies generating a different report type from test execution. This includes HTML and XML reports. TestNG may also allow its users to write their own Reporter class with individual custom methods. In this situation we developed our own way for handling report’s stage and we have the freedom to perform generation of it as the way we want. [2] [4]

Library compressed logic

In the Library package folder, we have stored all the jar files that are required by the project needs. These jar files are used by Java classes. They are presented in ZIP archive format and are used to sum up multiple files in one basic file. JAR’s are used as common backup tools, and the main motivation for development is that Java applets and their components (.class files, images, sounds and packages) can be downloaded via browser with an HTTP protocol copy instead of opening a new connection each time. In our project we have used Selenium and TestNG custom compact JAR’s to access the functionality of these tools. [2] [4]

**Figure 5 Architecture of the Framework**

4. Benefits

Using automation framework provide several of benefits such like code re-usage, higher portability, easy maintainability, reduced script maintenance, low cost and many more features. In this developed Framework, mainly the BaseClass will be executed on first place which calls customized XML suite file, the main purpose of it is to arrange and prioritize the order of test case/specs execution. When the first test case is executed it will load the predefined functions which are retrieved from a pool of reusable methods package. They are developed to be used in many places, which include: clicking elements, buttons, entering text to box values, select values from drop down boxes, focusing and retrieving elements and content with JavaScript and many more actions from Web perspective. These functions are called in the customized package class, which is the reusable functionalities like login page, register page, home page and etc. can be used for reusable purpose. They take the values from ObjectRepository.class and Properties file. ObjectPatternRepository has the variables of all web elements and Properties file has details of which values are needed to populate different kind of forms, application URL addresses, Credentials data and etc. If an error occurs in the execution flow we track and capture this issue in CustomException class. We extended Exception.class and used it to handle the exception which occurs from this execution and provides a meaningful message on every error.

In test suite QA specialist needs to login to Web platform, test internal functionality of the software product and run smoke tests related to the main activities of the application. To avoid repetition, there are main functionalities developed in the utility tool file. Each action is indicated and implemented in a step of actions.

In the very end, one spec of tests looks in the following way. Those tests represent empty login functionality with negative behavior.

```java
[Test]
public void Empty_Username_Validation()
{
    Pages.Login.LoginAs(string.Empty).WithPassword(TestData.UserPasswordHosted).Login();
    Pages.Login.GetEmptyFieldError();
}

[Test]
public void EmptyPassword()
{
    Pages.Login.LoginAs(TestData.User).WithPassword(string.Empty).Login();
    Assert.AreEqual(TestData.PasswordEmptyMessage, Pages.Login.GetEmptyFieldError());
}
```

The annotation for “Test” is taken from the configuration in which group of methods will be executed.

Each method in the class represents an assembly of all inherited and abstract classes. This presents a more convenient way for framing and integrates elements with operation in the spec class for arranging and structuring tests.

**Figure 6 Activity Diagram flow of a Login Functionality**

This UML Activity diagram displays the main flow for one test spec, which presents login functionality behavior of the application and also the test which accompanying it. In this test we catch not only the positive cases but also the negative demeanor to handle end to end testing functionality on the Login approach.
In Figure 7 is listed comparison from the traditional basic Selenium Web Driver approach versus our custom created framework called “Stassy”. We can see overall time duration on tests execution against Google Web application (the whole package apps) environment. With our framework we managed to save approximately one hour and a half, which is very important in one testing argument. This is because of the custom developed packages, classes and methods.

5. Conclusion

In this paper we have proposed the “Stassy” - System Stable Testing framework approach to test Web applications configured and extended on Selenium Web Driver basis. The proposed automation framework reduces the required time to write and run test cases and increases pass percentage rate of them by covering all the main steps in applications of this kind. It also reduces vulnerable workload of testers. With the usage of this framework, specialists can implement it over any application oriented to Web platforms by configuring the classes and main methods by their needs. With the custom developed packages such as: Controller, Asserter, Logger and Data provider stubs, we easily can generate customized actions, test reports, errors handling and also analyze the failures using screenshots of failed test cases and manage to trace the issue precisely. QA specialists can maintain all the data from centralized stored place. This framework is useful for dynamically changing Web applications, which implement new features very often. Developments of such kind are the future of software quality assurance automation process, recent years trends have shown that solutions of this nature are needed for complete application security and comprehensiveness. Automation test scripts are easy to handle and are understandable. In this way automation framework helps the companies to test Web applications more accurately and efficiently.

6. References


For contacts:
UNIVERSITY OF PLOVDIV PAISII HILENDARSKI, 24 TZAR ASEN, 4000 PLOVDIV
Denislav Lefterov, PhD student, Faculty of Mathematics and Informatics
E-mail: denislav.lefterov@uni-plovdiv.bg

Figure 7
SUPER INKJET TECHNOLOGY MACHINE DEVELOPMENT FOR ADDITIVE 3D MANUFACTURING

PhD. Oleg Bochov 1, PhD. Petr Afanasev 1, Marcel Grooten, Henk van Broekhuyzen, Viktor Startsev 1, Ivan Mandrik 1, Veronika Nikonova 1, Artem Smirnov 1

1 Center of Microdiagnostics, Saint-Petersburg State Electrotechnical University, prof Popova 5, 197376 St-Petersburg, Russia
E-mail: tech@contractmanufacturing.ru, petr80@inbox.ru

Abstract: The novel approach of fully digital and maskless manufacturing of electronic devices requires new technology set for electronic device manufacturing. These demands can be achieved by designing of technology equipment that can support such concept at technology level as well as on hardware and software levels.

One of the promising technology is the Electrodynamic coating that can perfume nanomaterials deposition to create structures for printed 3D electronics devices.

KEYWORDS: ADDITIVE TECHNOLOGY, INKJET, PRINTED ELECTRONICS, ELECTROSPINNING, MACHINE DEVELOPMENT

1. Introduction

Electrospinning technology is known for decades and commonly used for producing filters and non-wovens for the textile industry. By electrospinning wires of several nanometres thick are produced. A typical electrospinning setup is configured by a syringe pump, high voltage supply, needle and collector.

![Fig. 1. Electrospinning Setup](image1)

Traditionally a rather chaotic random deposition of fibres is deployed on a relative far field spinning distance of about 300mm and under 20K to 30K electrostatic voltage. By this electrostatic repulsion a polymer solution or melted polymer fibre is stretched and streaming out of a so called ‘Tailor cone’ at the spinning tip or needle. The solvent evaporates out of the solution during flight In case of a melt the fibre solidifies during flight. This is followed by whipping. The whipping process causes the fibre to be elongated further and is creating chaotically deposition on the collector. The whipping process is caused by the relocation of the charge to the surface of the fibre, which causes the flow to go from ohmic to convective characteristic (Reneker & Yarin, 2008). The whipping process creates a drastic decrease in fibre diameter and an increase in fibre length.

![Fig. 2. Taylor cone](image2)

![Fig. 3. Distribution of charges in the wire](image3)

Recently application research on electrospinning is focused on nanotechnology in electronics. By near field electrospinning at about 10 to 20 mm distance, controlled deposition of fibres creates new possibilities such as patterning and masking for lithographic process or direct deposition of functional materials

2. Materials & Applications

For materials all kinds of polymers are applicable as underneath table shows.

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
<th>Min Dia [nm]</th>
<th>Max dia [μm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVDF</td>
<td>PolyVinylidene DiFluoride</td>
<td>300</td>
<td>1,40</td>
</tr>
<tr>
<td>PEO</td>
<td>PolyEthylene Oxide</td>
<td>400</td>
<td>1,30</td>
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<td>Nylon6.6</td>
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<tr>
<td>PU</td>
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<td>PLLGA</td>
<td>PolyLactic-co-Glycolic Acid</td>
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<td>PES</td>
<td>PolyEthyleneSulfone</td>
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<tr>
<td>CA</td>
<td>Cellulase Acetate</td>
<td>400</td>
<td>5,10</td>
</tr>
</tbody>
</table>

Note: Quality and performance of materials may differ by their manufactureres.

Fibrillation or mass production sometimes be difficult
3. Electrospinning process

There are many parameters that affect the creation of nanowires with the electrospinning process. The parameters can be distinguished into three groups: materials, process and environmental conditions.

Recent research presents electrospinning of coaxial nanofiber material. Production of silver nanowires is feasible being conductive after photonic curing or thermal sintering. These new, unique, proprietary silver nanoparticle (AgNP) inks and electrospinning deposition technology has been developed by The Dow Chemical Company. The inks have tunable properties, especially a significantly improved balance of low viscosity and silver load versus other inks in the market. The inks can be sintered to high conductivity using typical photonic or thermal sintering methods. The process in combination with the inks enables deposition of narrow lines and is also suitable for transparent conductive films on large substrates (≥ 50 inch) keeping excellent transmission, resistivity and haze.

**Fig. 4.** Ag nanowire. Left – general view; right – not sintered

**Fig. 5.** Ag nanowire. Left – termaly sintered; right – photonic sintered

AgNP Bulk resistivity comparison:

\[ \rho_{\text{thin film}}/\rho_{\text{bulk}} = 2 \]

With conductive silver nanowires all kinds of applications in electronics become feasible: OLED / OPV Electrodes, Transparent Conductive Films for ITO replacement, Transistors on flexible substrates and for instance transparent heating functionality. As fibres below 3 to 5 microns are not visible by naked eye, manufacturing transparent conductive layers and films are enabled.

**Fig. 6.** Metal Mesh AgNP

Creating metal mesh by electrospinning is an attractive technology because of high conductivity at low cost.

**Fig. 7.** Technology comparison

Metal mesh can be created in direct write mode by coaxial polymer/silver-nanoparticle Ink or by using a subtractive method via masking and lithography. Recent research is showing the capability of this technology creating great resistivity and transparency.

**Fig. 8.** Layer properties

Besides Touch Screens research and development can be performed and explored in fields like Batteries, Memory, Bio chips, MEMS technology and Micro Electronics. By controlled ‘direct write’ electrospinning deposition also functional components like transistors and flexible substrates for micro-electronics are possible applications. Underneath pictures show some research examples from recent research.

**Fig. 9.** Research examples (part 1)
4. Nano-Wire printing platform DM50-ENP

For enabling such a direct write mode a multifunctional and versatile printer platform is introduced. The DM50-ENP features a direct write mode for near field electrospinning technology.

This printing platform is based on the PiXDRO LP50 Inkjet Printer by Meyer Burger of which over the last decade more than 200 units are sold worldwide.

5. General Specification

Substrates max size 327 x 227 mm (A4)
System accuracy X-Y axis Repeatability ± 5μm 3σ
Y-axis direct drive velocity max 500 mm/sec
X-axis stepper motor driven velocity max 200 mm/sec
Z-axis stepper motor driven repeatability ± 5μm 3σ
Rotate substrate table on Z-axis stroke -1°/1°

9. References

ANALYSIS OF THE SMART GRID CONCEPT FOR DC POWER SUPPLY SYSTEMS

АНАЛИЗ КОНЦЕПЦИИ «SMART GRID» ДЛЯ СИСТЕМ ТЯГОВОГО ЭЛЕКТРОСНАБЖЕНИЯ ПОСТОЯННОГО ТОКА

PhD (Technical), Associate Professor, Nerubatskyi V.1, PhD (Technical), Associate Professor, Plakhtii O.2, Dr.Sc. (Technical), Associate Professor, Ananieva O.3, PhD (Technical), Associate Professor, Zinchenko O.3
Faculty of Mechanics and Energy1,2, Faculty of Information-control systems and technologies 3 – Ukrainian State University of Railway Transport, Ukraine
NVP9@i.ua, a.plakhtii1989@gmail.com

Abstract: The Smart Grid network system is a concept of a fully integrated, self-regulating and renewable power system with a network topology and includes all generating sources, main and distribution networks and all types of electrical energy consumers controlled by a single network of information and control devices and systems in real of time. The article proposes the introduction of the Smart Grid concept into the traction power supply systems, an analysis of the necessary steps to upgrade the traction substations, and the boundaries of the energy-saving effect from its implementation.

KEYWORDS: SMART GRID, INNOVATIVE DEVELOPMENT, POWER SUPPLY SYSTEM, TRACTION SUBSTATION, ELECTRIC POWER INDUSTRY.

1. Introduction

The fourth industrial revolution (Industrie 4.0) is the transition to fully automated digital production, driven by intelligent systems in real time in constant interaction with the external environment, which goes beyond the boundaries of one enterprise, with the prospect of joining into the global industrial network Internet of Things.

Industry 4.0 describes the current trend of automation and data exchange development, which includes cyber-physics systems, the Internet of Things, and cloud computing. It is a new level of organization of production and management of the chain of value creation throughout the life cycle of products.

Despite the active introduction of various types of information technology, electronics and industrial robotics in production processes, the automation of industry, which began at the end of the XX century, was predominantly local in nature, when each enterprise or subdivision within a single enterprise used its own (proprietary) control system (or a combination of them) that were incompatible with other systems [1, 2].

The development of the Internet, information technology, stable communication channels, cloud technologies and digital platforms, as well as information “explosion” broke out from various data channels, provided the emergence of open information systems and global industrial networks that go beyond the boundaries of an individual enterprise and interacting with each other [3, 4]. Such systems and networks have the effect of transforming the impact on all sectors of the modern economy and business beyond the information technology sector itself, and translate industrial automation into a new fourth stage of industrialization.

2. Components of the Smart Grid network

The term «Smart Grid» has become known since 2003, when it appeared in the article «Reliability demands drive automation investments» by Michael T. Burr [5]. In this paper, several functional and technological definitions of the smart network are listed, as well as some advantages. A common element for most definitions is the application of digital data processing and communication to the electrical network, which makes data flow and information management the key technologies of smart networks. Various opportunities for the wide integration of digital technologies, as well as the integration of a new network of information flows to control processes and systems, are key technologies in the development of smart networks. Currently, the power industry is being transformed into three classes: infrastructure improvement («strong network in China»); adding a digital layer that is the essence of the smart grid and transforming business processes that make smart grids profitable. Most of the work is focused on upgrading electrical grids, especially concerns the distribution and automation of substations, which will now be included in the overall concept of smart networks, but other additional capabilities are also developing.

Smart grid system is a concept of a fully integrated, self-regulating and renewable energy grid, which has a network topology and includes all generating sources, mains and distribution networks, and all types of electric power consumers, managed by a single network of information, control devices and systems in the mode real time.

At the current stage of sustainable energy development, technical means of intelligent systems, as well as advanced technical solutions of semiconductor power converters [6, 7, 8], play a decisive role in the implementation of the provisions of the Smart Grid concept [9]. Promising hardware can be divided into the following main groups:

- intelligent sensors of information, control and measuring instruments, accounting and control devices;
- systems for collecting and transmitting data containing distributed intelligence devices and analytical tools for maintaining communications at the level of objects of the grid;
- intelligent systems of forecasting, support and decision making (in particular, intelligent adaptive systems of protection and automation with automatic restoration function);
- improved topologies of semiconductor transducers and implementation of active power components of the electrical network;
- integrated information exchange systems.

The transition from the usual power system to Smart Grid, which meets the requirements of Industrie 4.0, includes 6 stages.

1. Computerization. Under computerization means the supply of means for the digital management of all major components of the system.

2. Network interaction (connectivity). At this stage, isolated technologies are combined into a common network that meets the requirements of the power system. Usually, for this purpose, use an Internet Protocol (IP) connection, thus creating the Internet of Things. Network interaction allows to combine CAD/CAM automated design and manufacturing procedures with Manufacturing Execution System (MES) process management tools, organize remote maintenance.

3. Visibility. Under the visibility understand the creation of a digital display or a virtual double system. The fall in prices for sensors and other digital equipment makes it possible. The more sensors, the more accurate the reflection. The presence of mappings associated with PLM, ERP, and MES systems allows operators to
see the state of the system in real time and make the necessary decisions.

4. Transparency. Transparency in this context means the connection of the digital mapping with analytical systems, more widely known as a system of work with large data. At this stage, the following tasks are solved:
- conversion of output "raw" data into a form suitable for analysis;
- actual data analysis;
- interpretation of data;
- application of the obtained results in practice.

5. Predictive capacity. Go to real-time planning tasks based on reliable information on the state of the energy system.

6. Adaptability. Provide automatic control system response to most industrial situations. That is, this solution, which is created individually for the particular equipment and individually tuned, thereby allowing the system to trigger automatic reactions to production events.

If the first two stages of the Digitalization group, ie the development of digital approaches, are purely technological, then the other stages, according to Industrie 4.0, are more cybernetic because they embody system principles [10, 11].

The schematic diagram of the power system that does not meet the requirements of Industrie 4.0 is shown in fig. 1.

![Fig. 1. The schematic diagram of the power system that does not meet the requirements of Industrie 4.0](image1)

The existing energy system has a number of shortcomings, including:
- low efficiency coefficient due to the presence of significant active resistance in the contact network and the presence of a passive voltage rectifier that has high static energy losses on the diodes;
- absence of the possibility of energy recuperation to the contact network;
- significant emission of higher harmonic components of current into the AC power supply network and higher voltage harmonics in the DC network;
- low power factor;
- high mass-size indexes.

Apply the concept of the Smart Grid to the existing system in order to improve the system characteristics is shown in fig. 2.

![Fig. 2. The schematic diagram energy system with the concept of Smart Grid](image2)

Computerization should be carried out both on the side of the system that conducts the collection and analysis of data (operator), and on the side of the energy system, which is installed directly on the rolling stock.

The system of data collection and processing (operator) includes:
- personal computer;
- GSM module connected to the computer;
- database.

A personal computer (PC) connects to the GSM module. With GSM module the PC receives information from systems installed on the rolling stock.

With the availability of relevant software, the PC operator can conduct a current analysis of the data received. Analysis results can be saved to the database.

The GSM module for connecting to a PC should have a communication interface (USB, Ethernet or RS-232). Main requirements for GSM modules:
- reception and transmission of SMS;
- reception and transmission using GPRS;
- work with serial interfaces RS-232 or RS-485;
- allows to manage the reception and transmission of data through serial interfaces RS-232 or RS-485 with AT commands according to GSM 07.05 and GSM 07.07.

Modern industry provides a wide range of similar modules [12, 13]. Among foreign samples:
- Siemens MC35i Terminal (GSM900/1800 + GPRS standard);
- 3G UMTS / HSPA + Wi-Fi Router UR5i v2 Libratum.

Among the domestic analogues:
- GSM/GPRS modem OWEN PM01;
- GSM modem iRZ MC52iT;
- SQUID-1H and SQUID-2H.
time-reliable data, and maintain priority queues. To enter data into the record, often a sensor or input device tracks the state of the physical system and updates the database with new information that reflects the physical system more accurately. When designing a database system in real-time, it should be considered how the facts will be related to the real-time system. Need to think about how to represent the values in the database so that transaction processing is correct and the consistency of the data has not had any violations.

The information collection and processing system (rolling stock) includes:
- software logic controller;
- a system of sensors and signaling devices;
- GSM module;
- PC.

According to the parameters, programming tools, features of the modules' association and appearance, controllers for automation systems can be divided into the following groups: programmable relays, modular programmable logic controller (PLC), person machine interface + programmable logic controller (PMI + PLC).

Programmable relays are the simplest and cheapest programmable devices that were created to automate simple systems that do not require a large number of inputs/outputs. They have a full range of technical resources necessary for use in industrial automation, engineering or manufacturing at the lower level of automation [14, 15, 16].

The Ukrainian market offers programmable relays of the following manufacturers:
- Siemens – series Simatic-S7;
- Eaton (Moeller) – series Easy;
- ABB – series CL;
- Mitsubishi – Alpha;
- Schneider Electric – Zelio Logic;
- OWEN PR100 and OWEN PR200.

Modular PLCs are characterized by expanded structure. The basic unit can function individually, and usually contains at least 8 inputs/outputs, and if necessary, their number can be expanded by additional modules to 65536 discrete/4096 analog channels. This gives greater flexibility when creating process automation systems based on modular PLCs.

The following modular PLCs are represented in the Ukrainian market:
- Siemens – series SIMATIC-S7;
- Eaton (Moeller) – series XC100, XC200;
- ABB – series AC500;
- Mitsubishi – series System Q;
- Schneider Electric – series Modicon.

Modular PLCs support the function of programmable relays, but additionally have built-in network interfaces and the ability to expand the internal memory and inputs/outputs modules to a wide range. PMI + PLC systems are used to visualize the process and create simple SCADA systems. Depending on the model of the device, the PMI may not support the PLC functions, but it necessarily has a graphical display for displaying the technological process and a developed input device that the operator uses to influence the technological process. For communication with other elements of the automation system, such devices use network protocols CANopen, Profinet-IP, etc. PMI + PLC systems have the following functionality:
- visualization of the parameters of the technological process in text or graphic modes;
- management and processing of emergency messages, registration of time and date of occurrence of emergency messages;
- manual control using the function buttons or the touch screen;
- the ability to freely schedule schedules and configure the function keys;
- drawing diagrams and charts, outputting a report.

Display of information about the technological process is carried out using a character or graphic screen, the size of which depends on the requirements of the technological process, and for the input information used pushbutton or sensor controls.
The Ukrainian market is represented by means of PMI + PLC of the following major manufacturers:
- Siemens – series SIMATIC HMI IPC;
- Eaton (Moeller) – series XV1, XV2, XV3, XV4, M14, MFD4;
- ABB – series CP400, CP400;
- Mitsubishi – series Vision 1000, E1000, IPC1000, GOT1000;
- Schneider Electric – Magelis series STO, STU, XBT GT, XBT N. Compact iPC, Panel PC.

The system of sensors and meters include:
- sensors of electrical parameters of the network: currents, voltages, active and reactive power;
- temperature sensors;
- humidity sensors;
- pressure sensors.

The system includes a computer connected to the system using the wireless channel of GSM. It allows connecting several power systems to a single network with minimal communication costs [17, 18].

The network interaction of intelligent sensors is realized with the help of GSM modules, which connect to PLC modules using the interface RS-485. GSM modules operate at frequencies of the decimetre range (about 2 GHz), the data transfer rate is over 2 Mbps (3G standard). This allows you to arrange the connection between the power systems and the operator.

The availability for inspection is organized by installing the corresponding software on the operator’s computer. The software builds a model that is a complete copy of the power system, based on the data obtained from real power systems. The operator has the possibility of flexible analysis of the operating modes of the system.

3. Results and discussion

The energy grid based on the Smart Grid concept should simplify the interconnection of distributed generation and power storage systems. The distribution of distributed generation will create new opportunities for the network due to its more mobile storage systems. The distribution of distributed generation will simplify the interconnection of distributed generation and power systems. The possibility of flexible analysis of the operating modes of the system.

4. Conclusion

The energy system built in accordance with the Smart Grid concept has the following benefits:
- the power factor is close to one;
- the possibility of energy recovery from the contact network to the general network;
- higher efficiency (it is possible to increase by 5+8 %);
- a lower coefficient of harmonic distortion;
- the possibility of monitoring the state of the power system in the online mode;
- ability to regulate and stabilize the voltage in the system’s contact network in online mode;
- the possibility of connecting alternative power sources to the contact rail contact network.

One of the components of the successful implementation of the Smart Grid concept is the efficient use of the existing elemental power electronics base.

A review has been conducted of power electronics conversion devices, which can be used in Smart Grid.

5. References


THE AMBIENT TEMPERATURE INFLUENCE ON DEAERATOR EXERGY EFFICIENCY AND EXERGY LOSSES

PhD. Mrzljak Vedran1, PhD. Orović Josip2, PhD. Poljak Igor2, PhD. Culin Jelena2
1Faculty of Engineering, University of Rijeka, Vukovarska 58, 51000 Rijeka, Croatia
2University of Zadar, Maritime Department, M. Pavlinovića 1, 23000 Zadar, Croatia
E-mail: vedran.mrzljak@riteh.hr, jorovic@unizd.hr, ipoljak1@unizd.hr, jculin@unizd.hr

Abstract: The exergy analysis of deaerator at three different steam power plant loads is performed in this paper. Also, the influence of the ambient temperature change on deaerator exergy efficiency and losses is analyzed. From the exergy viewpoint, deaerator operation shows the best characteristics at middle and high power plant loads. The lowest deaerator exergy destruction of 363.94 kW and the highest exergy efficiency of 93.27 % will be obtained at middle power plant load and at the ambient temperature of 3 °C. The highest deaerator exergy destruction of 1349.99 kW and the lowest exergy efficiency of 81.83 % will be obtained at low power plant load and at the ambient temperature of 45 °C. Deaerator operation is preferable at the lowest possible ambient temperature, regardless of the current power plant load.

KEYWORDS: DEAERATOR, STEAM POWER PLANT, EXERGY ANALYSIS, THE AMBIENT TEMPERATURE CHANGE

1. Introduction

Steam power plants in general, regardless of their type, characteristics or developed power, have a complex condensate/feed water heating systems. Such systems are mounted between main steam condenser and steam generator. Its main function is condensate/feed water heating before it enters steam generator. Condensate/feed water heating is ensured with steam extracted from the main turbine. The usage of such systems results with fuel savings in steam generators and simultaneously with increasing of steam power plant overall efficiency.

In conventional high-power land based steam plants condensate/feed water heating systems can be assembled of a large number of components (heaters, pumps, and pressure reduction valves) [1], [2]. Number of components in condensate/steam water heating systems from marine steam power plants is much smaller due to insufficient space. This fact for marine steam power plants used in ship propulsion is valid regardless of the marine steam power plant has steam re-heating [3] or not [4].

Each condensate/feed water heating system is divided in two parts - the first part is a low-pressure condensate heating system and the second part is a high-pressure feed water heating system. The deaerator is a component which makes that division in any steam power plant. As any deaerator has a dual function (water heating and deaerating), it is very important for the entire steam system that deaerator operation is efficient and optimized.

In this paper, exergy analysis of deaerator from low-power cogeneration power plant is performed. Analyzed deaerator exergy efficiencies and losses were investigated at three different power plant loads, according to turbine developed power. The ambient temperature variation shows that exergy efficiencies and losses of the analyzed deaerator are sensibly dependent on the current ambient temperature.

2. Description and operation characteristics of deaerator from cogeneration power plant

The deaerator is a constituent component of any condensate/feed water heating system in any steam power plant [5], which is used for increasing condensate/feed water temperature before returning it to steam generator. Complete condensate/feed water heating system is therefore mounted between main steam condenser and steam generator.

Deaerator divides condensate/feed water heating system at two parts - first part is the low-pressure condensate heating system (between the main steam condenser [6] and deaerator) and the second part is the high-pressure feed water heating system (between deaerator and steam generator [7]).

In operation, deaerator has a dual function. The first function is condensate/feed water heating-deaerator is open condensate/feed water heater with direct mixing of water and superheated steam extracted from the main power plant turbine. The second deaerator function is to remove dissolved gases from condensate/feed water (deaerating) to prevent fast and intensive corrosion of steam system components and pipelines.

A deaerator analyzed in this paper, along with necessary operating points for the exergy analysis is presented in Fig. 1. Deaerator has four flow stream inputs: first is condensate flow stream from low-pressure condensate heating system (condensate is delivered to deaerator by condensate pump [8]), second is steam extracted from the main turbine, third is make-up water which is used to replenish the system with the lost water and finally fourth is condensate (condensate obtained from heating steam) from the first high-pressure feed water heater (this condensate is delivered to deaerator through pressure reduction valve [9]). Only output from the analyzed deaerator is feed water stream which passed through high-pressure feed water heating system for additional heating before entering the steam generator.

Fig. 1. Scheme and operating points of the analyzed deaerator

3. Deaerator exergy analysis

3.1. Exergy analysis equations for a control volume

The mass balance equation for any control volume in steady state, regardless of the number of inputs and outputs, can be defined according to [10] as:

$$ \Sigma \dot{m}_{IN} = \Sigma \dot{m}_{OUT} $$

(1)

The main exergy balance equation for a control volume in steady state is defined according to [11] and [12] as:

$$ \dot{X}_{heat} - P = \Sigma \dot{m}_{OUT} \cdot e_{OUT} - \Sigma \dot{m}_{IN} \cdot e_{IN} + E_{ex,D} $$

(2)

Where the exergy transfer by heat ($ \dot{X}_{heat} $) at temperature $ T $ can be defined according to [13] by an equation:

$$ \dot{X}_{heat} = \Sigma (1 - \frac{T_L}{T}) \cdot \dot{Q} $$

(3)
Specific exergy, similar to specific enthalpy, represents a heat content of any fluid flow with taking into account the conditions of the ambient in which fluid flow operates (specific exergy does not take into account the ambient conditions). According to [14], specific exergy can be defined as:

$$e = (h - h_o) - T_o \cdot (s - s_o)$$  \hspace{1cm} (4)

The exergy power of any fluid flow can be defined, according to [15] as:

$$\dot{E}_{ex} = m \cdot e = m \cdot \left[ (h - h_o) - T_o \cdot (s - s_o) \right]$$  \hspace{1cm} (5)

The exergy efficiency definition depends on the type and operation principle of a control volume. In general, exergy efficiency can be defined according to [16] by an equation:

$$\eta_{ex} = \frac{\text{Exergy output}}{\text{Exergy input}}$$  \hspace{1cm} (6)

3.2. Exergy analysis equations of deaerator, according to presented operating points

For the deaerator analyzed in this paper, exergy analysis equations are defined according to operating points from Fig. 1. Deaerator exergy analysis equations are written in the same manner as exergy analysis equations for any other open heater (heater with two fluids mixing).

Deaerator mass balance:

$$\dot{m}_3 = \dot{m}_1 + \dot{m}_2 + \dot{m}_3 + \dot{m}_4$$  \hspace{1cm} (7)

Deaerator exergy balance:

→ Exergy input:

$$\dot{E}^{in}_{ex} = \dot{m}_1 \cdot e_1 + \dot{m}_2 \cdot e_2 + \dot{m}_3 \cdot e_3 + \dot{m}_4 \cdot e_4$$  \hspace{1cm} (8)

→ Exergy output:

$$\dot{E}^{out}_{ex} = \dot{m}_3 \cdot e_3$$  \hspace{1cm} (9)

→ Exergy destruction:

$$\dot{E}^{ed}_{ex} = \dot{E}^{in}_{ex} - \dot{E}^{out}_{ex} = \dot{m}_1 \cdot e_1 + \dot{m}_2 \cdot e_2 + \dot{m}_3 \cdot e_3 + \dot{m}_4 \cdot e_4 - \dot{m}_3 \cdot e_3$$  \hspace{1cm} (10)

→ Exergy efficiency:

$$\eta_{ex} = \frac{\dot{E}^{out}_{ex}}{\dot{E}^{in}_{ex}} = \frac{\dot{m}_3 \cdot e_3}{\dot{m}_1 \cdot e_1 + \dot{m}_2 \cdot e_2 + \dot{m}_3 \cdot e_3 + \dot{m}_4 \cdot e_4}$$  \hspace{1cm} (11)

4. Deaerator operating parameters at three different loads

The deaerator is analyzed at three cogeneration power plant loads (low load, middle load and high load). Data for the deaerator analysis (temperatures, pressures and mass flows) of each fluid stream flow, according to Fig. 1, at each power plant load were found in [17]. The power plant load is directly proportional to main steam turbine produced power which amounts 24.3 MW at low plant load, 27.3 MW at middle plant load and 27.5 MW at high plant load.

At each power plant load, for every fluid stream flow (analyzed deaerator fluid streams are condensate/feed water and steam) specific enthalpies and specific exergies were calculated with NIST REFPROP 9.0 software [18] (by using temperature and pressure of each fluid stream).

Data for the deaerator analysis are presented in Table 1 for power plant low load, in Table 2 for power plant middle load and in Table 3 for power plant high load.

Specific exergies of each deaerator fluid stream (in each operating point from Fig. 1) depend on the ambient conditions. Data for the deaerator analysis are presented for the ambient pressure of 1 bar and the ambient temperature of 25 °C, as proposed in [19]. This ambient state is considered as a base state.

First, the deaerator exergy analysis is performed for the base state (at all observed power plant loads). After that, the same deaerator exergy analysis is performed at different temperatures. The ambient temperature range in which the deaerator was analyzed is selected on the basis of the real expected ambient temperature change for the cogeneration power plant through the whole calendar year. During the ambient temperature change, ambient pressure was kept constant (and equal to 1 bar), because in real power plant operating conditions significant change in the ambient pressure cannot be expected.

<table>
<thead>
<tr>
<th>OP*</th>
<th>Temperature (°C)</th>
<th>Pressure (bar)</th>
<th>Mass flow (kg/s)</th>
<th>Specific enthalpy (kJ/kg)</th>
<th>Specific exergy (kJ/kg)</th>
</tr>
</thead>
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<tr>
<td>1</td>
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<td>5</td>
<td>68.528</td>
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* OP = Operating Point (according to Fig. 1)

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<th>OP*</th>
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<th>Pressure (bar)</th>
<th>Mass flow (kg/s)</th>
<th>Specific enthalpy (kJ/kg)</th>
<th>Specific exergy (kJ/kg)</th>
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* OP = Operating Point (according to Fig. 1)

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<th>Temperature (°C)</th>
<th>Pressure (bar)</th>
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<th>Specific enthalpy (kJ/kg)</th>
<th>Specific exergy (kJ/kg)</th>
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<tr>
<td>4</td>
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<td>7.9</td>
<td>2.944</td>
<td>932.9</td>
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<tr>
<td>5</td>
<td>169.89</td>
<td>7.9</td>
<td>33.611</td>
<td>719.8</td>
<td>115.160</td>
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* OP = Operating Point (according to Fig. 1)

5. Deaerator exergy analysis results and discussion

5.1. Deaerator exergy analysis results at the ambient base state

At the base ambient state (25 °C and 1 bar), deaerator exergy power input and output are the highest at low plant load, Fig. 2. An increase in power plant load (from low to middle load) resulted with a significant decrease in the deaerator exergy power input and output, while a further increase in plant load (from middle to high load) resulted with a slight increase in both deaerator exergy power input and output.

At the observed power plant loads, range of deaerator exergy power output change is between 8701.57 kW and 3853.68 kW, Fig. 2. An increase in power plant load (from low to middle load) resulted with a significant decrease in the deaerator exergy power input and output, while a further increase in plant load (from middle to high load) resulted with a significant increase in the deaerator exergy power input and output.
from low to middle load resulted with a significant decrease in deaerator exergy destruction. At middle plant load deaerator exergy destruction is the lowest and amounts 393.76 kW, Fig. 3. Further increase in plant load (from middle to high load) resulted with a slight increase in deaerator exergy destruction (from 393.76 kW at middle to 439.80 kW at high plant load).

The lowest deaerator exergy efficiency can be seen at low power plant load, Fig. 3. An increase in power plant load from low to middle load resulted with a significant increase in deaerator exergy efficiency (from 87.37 % at low to 90.73 % at middle plant load). From middle to high power plant load, deaerator exergy efficiency slightly decreases (from 90.73 % at middle to 89.80 % at high load).

According to presented results, at the base ambient state, the deaerator optimal operation will surely be at middle plant load because at that plant load deaerator has the lowest exergy destruction and the highest exergy efficiency. Operation at high plant load will also be acceptable for the deaerator - at high power plant load deaerator exergy destruction is just slightly higher and exergy efficiency is just slightly lower than at the middle plant load.

Deaerator exergy analysis results during the ambient temperature change

Change in the ambient temperature shows that deaerator exergy destruction increases with an increase in the ambient temperature (and simultaneously decreases with a decrease in the ambient temperature), Fig. 4. Ambient temperature was varied between 5 °C and 45 °C, which is expected ambient temperature change through the whole calendar year for observed cogeneration power plant in which analyzed deaerator operates.

As can be seen from Fig. 4, the highest deaerator exergy destructions, regardless of the ambient temperature, are at low power plant load. The lowest deaerator exergy destructions are obtained at middle plant load, while at the high power plant load deaerator exergy destructions are slightly higher when compared to middle plant load.

In the observed ambient temperature range (from 5 °C to 45 °C), deaerator exergy destruction shows the highest change of 185.04 kW at low power plant load. At middle power plant load, in the observed ambient temperature range, deaerator exergy destruction shows change of 59.79 kW, while at high plant load deaerator exergy destruction change is equal to 54.32 kW.

Deaerator operation at low plant load is highly influenced by the ambient temperature change (change of the ambient temperature for 10 °C resulted with a change in deaerator exergy destruction for 46.26 kW in average), while deaerator operation at high plant load is slowly influenced by the ambient temperature change (change of the ambient temperature for 10 °C resulted with a change in deaerator exergy destruction for 13.58 kW in average). At middle power plant load, change of the ambient temperature for 10 °C results with a change in deaerator exergy destruction for 14.95 kW in average.

Deaerator exergy efficiency decreases with the ambient temperature increase (and simultaneously increases with a decrease in the ambient temperature) at any observed power plant load, Fig. 5.

At any ambient temperature, the highest deaerator exergy efficiency can be seen at the middle power plant load, while the lowest deaerator exergy efficiency is noted at low plant load, Fig. 5. At high power plant load, deaerator exergy efficiency is slightly lower when compared to middle plant load, regardless of the ambient temperature.

In the observed ambient temperature range (between 5 °C and 45 °C) deaerator exergy efficiency shows the highest change of 9.23 % at the low power plant load and the lowest change of 6.24 % at middle power plant load. Between the observed ambient temperatures deaerator exergy efficiency at high plant load shows the change of 6.64 %.

Deaerator exergy efficiency at low plant load is highly influenced by the ambient temperature change (change of the ambient temperature for 10 °C resulted with a change in deaerator exergy efficiency for 2.31 % in average). Low plant load and high ambient temperatures are the worst combination for deaerator exergy efficiency - at low plant load and with an increase in the ambient temperature from 35 °C to 45 °C deaerator exergy efficiency will decrease for more than 3 %. Change of the ambient temperature for 10 °C results with a change in deaerator exergy efficiency for 1.56 % in average at middle plant load and for 1.66 % in average at high plant load.

7. Acknowledgment
This work has been fully supported by the Croatian Science Foundation under the project IP-2018-01-3739.

8. Nomenclature

<table>
<thead>
<tr>
<th>Latin Symbols</th>
<th>Greek symbols</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E )</td>
<td>( \varepsilon )</td>
<td>the total exergy flow, kW</td>
</tr>
<tr>
<td>( h )</td>
<td>( \eta )</td>
<td>specific enthalpy, kJ/kg</td>
</tr>
<tr>
<td>( m )</td>
<td></td>
<td>mass flow rate, kg/s</td>
</tr>
<tr>
<td>( p )</td>
<td></td>
<td>pressure, bar</td>
</tr>
<tr>
<td>( \dot{Q} )</td>
<td>( D )</td>
<td>heat transfer, kW</td>
</tr>
<tr>
<td>( s )</td>
<td>( \text{ex} )</td>
<td>specific entropy, kJ/kg K</td>
</tr>
<tr>
<td>( T )</td>
<td>( \text{IN} )</td>
<td>temperature, °C or K</td>
</tr>
<tr>
<td>( X_{\text{heat}} )</td>
<td>( \text{OUT} )</td>
<td>heat exergy transfer, kW</td>
</tr>
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</table>

9. References


ANALYSIS OF CROSS-COUNTRY DIFFERENTIATION OF CONFORMITY OF WAGES AND LEVEL OF EDUCATION

PhD in Economic, Associate Professor Pochekutova E.
School of Economics, Management and Environmental Studies – Siberian Federal University, Russia

Abstract: The early 21st century introduced a new market paradigm: a high level of education of the employed should ensure high productivity and correspond to a high level of wages. Countries with developed economies provide promising opportunities for education, but efficiency of human resources use is still different. Differentiation in the correlation between labor productivity and wages in the “high income” and “upper-middle income” countries is a fairly high. The efficiency improvement of national economies should be based on the diversification of the sectoral structures based on technologies that would replace labor with capital, ensure high wages and the demand for income” and “upper-middle income” countries.

Keywords: diversification of the sectoral structures based on technologies that would replace labor with capital, ensure high wages and the demand for income. "Upper-middle income" countries is a fairly high. The efficiency improvement of national economies should be based on the diversification of the sectoral structures based on technologies that would replace labor with capital, ensure high wages and the demand for a sufficiently high level of education of employees.

1. Introduction

The existing demographic models of population reproduction play a significant role not only in the formation of sources of national labor supply, but they also become the determining factor for business when choosing manufacturing techniques. Countries with a high level of economic development have to objectively invest in new technologies that replace human labor, in response to the reduction of manpower. Replacement of capital by labor, in turn, imposes new requirements on the workers’ skills and competencies, which should lead to new educational models. Education should not just be much-in-demand and accessible, but governments should create incentives for education. Decent payment for labour remains one of the most important factors for the choice of the sphere for employment, without denying the importance of personal fulfillment, creativity and other attributes.

Payments should correspond to the level of the employees’ education, prevent the incurrence of poverty traps by means of inefficient redistribution – poverty traps, and fit adequately to the level of efficiency. At the turn of the XX century, businesses developed a fairly stable idea that off-shoring of manufacturing in low-wage countries will improve the competitiveness of their products. Export of technology is impossible indefinitely, on the one hand. On the other hand, countries that have successfully embraced such investments and new technologies have achieved economic growth. They have formed their own innovative and educational potential, and successfully compete with economically developed countries. These countries have a high self-employment potential, a high level of demand for education, which leads to an increase in both productivity and wages. In the future, these countries will become the main area of development and implementation of technologies.

At the same time, the extremely high differentiation of the population by income, the lack of equal access to education, the inability of the state to ensure equal social conditions, to leave a significant part of the labor force in these countries in the sectors of traditional economy with a low level of technology and low wages.

2. Results and discussion

The information source of the research is statistics from the International Labour Organization Department of Statistics (ILOSTAT), the UN. For analysis of the inter-country differentiation of wage compliance with the level of education, the following indicators were used: “hourly labor cost per employee” (measured in U.S. dollars), and “employment by education”. ILOSTAT estimate the employees’ education at five levels: (1) less than basic, (2) basic, (3) intermediate, (4) advanced, (5) level not stated. The age group “15+” was selected for the study, since the conjugate indicator - “hourly labor cost per employee” - is calculated on all the employees in the national economy. For the formation of the initial data array, the last time period - 2016 - was chosen, and simultaneously the information on employment by education and hourly labor cost per employee was presented. It should be noted that the analysis was based on the most time-related data, under the conditions of lack of a complete set of baseline data for any given year. Israel, for example, gave the latest information on the employment by education in 2013, while the results of monitoring the parameter hourly labor cost per employee are presented annually. Some countries provided the baseline information only on the labour productivity category, and the others reported on the hourly labour cost per employee.

These nuances prevent the use of methods of correlation and regression analysis, but lead to the traditional grouping of countries according to the level of labor productivity per employee, calculations and modeling of which were carried out by ILOSTAT in November 2018. It is the parameter labor productivity per employee that allows to evaluate not only the level of economic development of the country, and to identify the social orientation of government and business. The ILOSTAT estimates the incomes of workers with advanced degrees are significantly higher in comparison with those who completed high school but never attended college. The study is based on the principle “the higher the level of education of the employees, the higher the level of their productivity, and the higher are their incomes”.

We first analyzed a group of countries with the level of labor productivity exceeding 88,089 US dollars in 2016 (Table 1). Of the countries represented in this group, the highest proportion of the employed with Advanced level of education is in Canada, it makes 65.7 % (rank 1), while hourly labor cost per employee is the lowest in this group and makes only $26.8 there (rank 13). According to the parameter labour productivity, Canada ranks last but one (rank 12). Conditionally low labor productivity determines the low level of wages. Paradoxically, the high level of education of the employed is insured by accessibility of education as a social good, as well as the high educational potential of the migrants, which is determined by the government policy.

During the observed period of 2000-2016, the share of employees with Advanced level of education increased from 52.3 % to 65.7 %, the labor productivity for the same period reached 10.92 % [4, 6]. Over these years, Canada moved from the group of upper-middle income countries to the group of high income countries, which indicates an increase in the efficiency of the national economy. Low wages may indicate some weakness of the institutions for protection of workers’ rights. For the period 2008-2016, hourly labour cost per
that these countries have currently recovered their productivity levels after the crisis periods of 2008 and 2014 [8], but have not brought back the recovery in wages.

Table 2 reveals the data on the level of labor productivity, level of education and hourly wages in the upper-middle income group of countries. In contrast to the previous set, there is a very high level of differentiation between the level of education of the employees and the level of education. The six countries – Israel, Cyprus, Lithuania, United Kingdom, Spain, Estonia – have a share of employees with the Advanced level of education of more than 40%.

The leader in this group is Israel, despite the fact that they reported the data just for 2013. The share of the employees with Advanced level of education for the period 2009–2016, when the dynamics of wages was shown, decreased by 0.4%. The dynamics of this relative indicator as such does not allow to draw conclusions about the negative trend. During this period of time, the number of employees with this level of education increased by 274 thousand people in absolute terms, which makes 83.79% of the total increase in employment. It can be concluded that Israel currently continues to hold a leading position in the world in terms of education of employees. The leading position of the country is supported by the active government strategy to increase the accessibility of education and to live up to educational potential of the employees. With an average annual labor productivity growth rate of 0.91%, the average annual wage growth made 4.25%. However, the scale and sectoral structure of the economy did not allow to ensure the income of employees at the level of the European Union.

Quite interesting is the situation in the analysis of interrelation between education and income of employees in Cyprus. Narrowly focused specificity of the sectoral structure of the national economy does not allow providing high level of wages. The government policy aimed at ensuring access to education, including for the foreign citizens, provides good educational opportunities for population, but the obtained professional knowledge and skills can be implemented only in industries with a conditionally low level of labor productivity.

Education of the employees on Cyprus corresponds to the level of education of the employed group of high income countries, and wages – a group of upper-middle income countries. It should be noted that Cyprus's position in terms of productivity is in the second half of the group, and it is almost at the level of post-socialist countries of Eastern and Central Europe. The conclusion is as follows: the availability and accessibility of education provide an opportunity to receive a high level of education in areas corresponding to the sectoral structure of the national economy, but due to the narrow specialization of the country's economy, it might be impossible to be decently paid.

The salary level on Cyprus corresponds to the salary level of the countries, where the share of employees with the Advanced level of education is 26.0% or Malta – 25.6%; interestingly, the figures are almost two times less than for Cyprus. Against this background, there should be no paradox between the level of wages and the level of education for the post-Soviet States: Estonia, Lithuania, and Latvia. In this subgroup of countries, high demand for education is a historical phenomenon, and a traditional model of household behavior. Citizens keep building their trajectories of behavior in the labour market, starting with compulsory Intermediate, and later Advanced educational level. Education has traditionally been the leading branch of the national economies of these countries. The transition to a market economy significantly changed the sectoral structure of the national economies of these countries, which led to the devaluation of the human capital and determined new requirements for professional knowledge and skills of the employees. However, the increase in the share of employees with the Advanced level of education for the three Baltic States remains important and has a multidirectional trend.

Thus, Estonia shows the rise of the total number of the employees exactly due to high level of education: increase in the number of the employed amounted to 58,000 people over the period of 2000–2016, which is 9.9% of total employment in the economy. Latvia, due to
the decline in the competitiveness of the country’s economy for the period under review, demonstrates decrease in the total number of employees by 49,000, or 5.2%. The growth of the number of employees with the Advanced level of education amounted to 134,000 people, or 68.02%. Structural changes in the share of employees with the highest level of education in Lithuania are determined by the reduction in total employment of 58,000 people, or 4.09%. The share of employees with the Advanced level of education decreased to 47,000 people, or 7.24%. The ratio of the level of education and wages in the Baltic States indicates serious lack of demand or even immunity of the economy of the educational level of the population. Labor productivity and wages in this subgroup of countries corresponds to the level of Chile, while the share of employees with the Advanced level of education in Lithuania is twice lower and makes only 16.3%.

Generalizing characteristic of the group of countries with upper-middle income productivity (excluding the United Kingdom, Israel, Spain, and New Zealand) is a combination of high level of education and low wages. The national educational strategies developed by these countries according to the global trends are ensuring high availability of education and supporting multivariate areas of education, but they cannot ensure the full realization of the labor potential of the employed. All the countries of the group doubled the share of the employed with higher education over the period 2000-2016. However, this education remains unclaimed, which indicates the low efficiency of labor resources usage. This is caused by the low level of labor productivity, both as a result of the crisis of recent decades and the impact of institutional changes for post-socialist countries.

### 3. Supporting data

<table>
<thead>
<tr>
<th>Name of the country</th>
<th>Output per worker (GDP constant 2010 US $)</th>
<th>Share of the employees with Advanced level of education (%)</th>
<th>Hourly labor cost per employee (US $)</th>
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<tbody>
<tr>
<td>Luxembourg</td>
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<td>178,436.15</td>
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<td>157,719.80</td>
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<td>122,818.71</td>
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<td>115,798.07</td>
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<td>111,402.42</td>
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<td>43.36</td>
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<td>37.94</td>
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<td>Italy</td>
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<td>30.75</td>
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<tr>
<td>Germany</td>
<td>91,586.13</td>
<td>28.9</td>
<td>36.50</td>
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</table>

### 4. Conclusion

All things considered, in the future, the numerical strength of labor resources and the level of wages will determine introduction of technologies reducing human participation in the production process in the national and international labor markets. New technologies and wage growth will ensure demand for available and accessible education, which must be guaranteed by the governments. Boston Consulting Group (BCG) experts note that education plays a crucial role for improvement of the efficiency of public productivity [2].

BCG experts believe that while developing countries need to focus on ensuring the universality and basic quality of education, educational systems of developed countries should work on updating curricula and providing lifelong learning for the wider population [2]. For their part, the governments of economically developed countries have fulfilled their “part of the obligations”: they have formed educational systems that provide households with an opportunity to receive a high level of education. Without the receptivity of economies to sufficiently high level of education, high expectations might be trapped; by constantly improving their level of education, households cannot find an application for their professional knowledge, or receive wages corresponding to a lower level of education.

Analyzing the dynamics of changes in the structure of employment by level of education, it can be concluded that modern national education systems of groups of low income and lower-middle income countries, over the observed time period of 2000-2016 (ILOSTAT) offer households the opportunity to get a fairly high level of education. But the high level of education for a number of countries of the significant part of the group of upper-middle income countries is not always perceived by the national economies, and the level of labor productivity and, as a result, the level of wages remain quite low. BCG experts consider ten aspects for improving productivity of national economic systems, and highlight diversification of the sectoral structure of the national economy as a factor of greater sustainability and productivity [2].

Transformation of the sectoral structures of national economies will increase the demand for the existing professional knowledge of the employees, ensure growth of their incomes, and the quality of life of households. Moreover, it can be assumed that in today’s post-crisis conditions businesses should concentrate on the creation of high-tech industries in the lower-middle income countries, in order to increase the competitiveness of manufacturing. Traditional guidelines for selecting countries for technology transfer, just to name a few, low taxation, low wages, lack of entry and exit market barriers, need to be changed.

Post-crisis situations of the last decade are characterized by almost instantaneous response of business to reduce labor costs. A relevant position for the governments should be to protect the interests of the employees while providing preferences for businesses refusing the withdrawal from the country, implementing investments in new technologies that require a smaller number of the employees, but securing a high level of productivity. Lower-middle income countries, paradoxically, should refer to the experience of countries that have successfully mastered the export of technologies, which
provided them with economic growth. Competition for attracting technology and business with the lower-middle income countries with a high level of education will not initially lead to an increase in wages of employees, but will provide the necessary diversification of the sectoral structure of national economies and the demand for the level of education of households.

5. References


1. Introduction. Essence of sustainable construction

"Ensuring the sustainable development of humanity is the most important problem faced by the world community." This statement was made in 1987 by the UN General Assembly. Since then, it has not lost its significance. The concept of sustainable development has been actively discussed by world leaders today [1], [2], [3], [4].

Climate change and its impact are becoming increasingly important and attracting attention worldwide. Thus, climate change and sustainability issues are becoming a priority for governments, stakeholders, construction industry leaders and companies.

The impact of sustainable construction has environmental, social, economic and other aspects.

The consumption of a lot of energy in modern construction of buildings and their maintenance have negative consequences, which calls for the buildings’ refurbishment and renovation. Ecological aspects also include excessive water consumption, environmental pollution (noise, vibrations, fumes, etc.) as well as disturbance to biodiversity. Social aspects concern the creation of a more comfortable environment for the building’s inhabitants.

Sustainable construction does not tolerate the waste of materials, energy and raw materials (such as water and air, for example), encourages the use of recyclable products, and draws attention to the technological solutions that ensure the proper exploitation of a building and the comfort of the residents. Reducing the impact of buildings on the environment throughout their life cycle, but also optimizing their economic value, quality and efficiency - this is the main goal of sustainable construction.

![Fig. 1 The triple bottom line approach for sustainability green building](image)

It sets out best practices in the design, implementation, maintenance and reconstruction of buildings.

Sustainable construction is not only wishful thinking, but a trend driven by a number of factors, such as increasing resource prices, climate change, and last but not least, the concern about nature. But let’s define what the criteria for a building to be green (or sustainable) are. First of all, this is the reduction of costs of natural resources, greenhouse gas emissions, electricity, water and natural gas, waste disposal and environmental impact (Fig.2).

![Green Buildings Can Reduce](image)

Also the use of renewable resources and recyclable materials as well as the use of alternative energy sources.

2. Sustainable green construction

2.1. Principles of sustainable green construction

The concept of sustainable development in construction can be traced back in time to the energy crisis of the 1970s and the ensuing environmental protection initiative. The aim is to have more energy-efficient and environmentally friendly building technologies. There are many reasons to build sustainable - ecological, economic and public benefits. At the same time, an integrated approach is needed both for the design of new buildings and for the renovation of existing ones.

Sustainable / Green Building combines a wide range of techniques and practices that aim to reduce and ultimately eliminate the impact of newly built buildings on the environment and human health. This often draws attention to the use of renewable sources such as solar radiation for electricity generation, water heating, or rain water for irrigation and domestic purposes, or the construction of roof and rainforest gardens. While good practices and technologies continue to evolve and slight variations in the countries where they apply, it has basic principles that really define what sustainable construction means: location and construction, energy efficiency, water efficiency, quality of inputs, indoor air quality, optimization of operating costs, reduction of household and toxic waste.

One of the most important, however, is the principle of Sustainable Development. This Principle requires each generation to satisfy their needs without depriving future generations of the opportunity to satisfy their needs, which is a high form of humanism. The principle of Sustainable Development is addressed and sets requirements for the current generation. It affects all generations of inhabitants of the planet from the time of its adoption and application. In this aspect, it is universal and generally valid for...
the human species. Moreover, referring to the attitude or rather the regularity of satisfying needs - human activities, the principle of Sustainable Development does not make any difference and does not create conditions for political forms of governance of societies, of religion and of faith. Observing it is an objective necessity inherent in the human being and guaranteeing its survival in the future.

2.3. Characteristics of green buildings.

The concept of a “green” building is a sustainable approach. This sustainable approach focuses on managing our needs with the resources available without affecting the needs of the future.

Ideal green buildings are a building project that can save most of the natural atmosphere. Development and exploitation can stimulate a healthy atmosphere for all interested parties and will not disturb the earth, water, resources and energy in and around the building. This is often the definition of “green” buildings (Fig.3).

![Fig.3](image)

**Fig.3** The future of our 21st century seems more promising and healthier thanks to green building. It will reduce the risk and impact of climate change on our planet.

The green building creates structures and processes that are responsible for environmental and resource efficiency throughout the building's lifecycle - from land-use planning and design to construction, operation, maintenance and renovation.

**What makes a Green Building?**

Many countries have experience and a positive result has been achieved in implementing the practice of setting up an environmental management system and green building.

Eco-labels apply to products, eco-friendly construction projects are realized within the framework of “sustainable development and green construction”. As a result of these “pilot” projects, environmental principles and standards have been formulated in different countries and a “sustainable construction” tactic.

For example, according to documents approved by the British government, “sustainable construction” is construction that respects the principles of:
- Effective use of energy, water and other alternative resources;
- maintaining a healthy economy that guarantees quality of life while preserving the quality of the environment;
- minimizing damage to the environment and biodiversity and the danger to human health;
- optimal use of non-renewable resources.

Within the framework of “sustainable construction” the concepts of “ecology”, “eco-city” and “eco-creativity” appear in different countries. For example, the term “Green Building”, which appears, means a building that fits into the environment and interacts with it safely. The environmental requirements are as follows:
- optimal use of daylight and sunshine;
- natural ventilation;
- energy saving;
- reuse of excess heat;
- improved insulation;
- use of local renewable materials;
- minimal use of non-recyclable materials;
- use of materials with reduced emissions of dangerous substances in the environment.
- Using renewable energy, such as solar energy;

- Use of sustainable building materials to construct the building;
- Measures to reduce pollution and reduce waste, and hence the possibility of reuse of materials and employment;
- Good air quality indoors;
- Using materials that are non-toxic, ethical and preserve ecological balance;

2.4. Guidelines and barriers for sustainable construction.

At the beginning of the 21st century, the concept of sustainable development is increasingly being accepted by the construction industry and increasingly influencing the design, construction, management, market and real estate trade (Fig.4). Knowledge of green building procedures is a must for organizations that offer construction, building maintenance and real estate management. Certified and evaluated “green buildings” are constantly growing.

![Fig.4](image)

**Fig.4** The green building a powerful way to reduce carbon emissions and mitigate climate change.

However, this breakthrough does not lead to massive application of the principles of sustainability in the well-developed traditional building industry. Difficulties come not only from an economic and financial point of view, but there is a need to rethink many things in the sector: designing new class of construction plans, changing construction processes and maintaining new market mechanisms. Difficulties of financial nature are related to green materials prices, certification costs, and so on. Factors influencing these processes can be divided into guidelines or factors with positive effects and factors - barriers such as financial and research factors.

**Positive effects are:**
- Rapid development of the systems for assessment and certification against the requirements for sustainable construction.
- Conducting targeted government policies from countries.
- Existence of public and private initiative;
- Continuous striving of professionals in the construction industry to improve their skills and to apply good practices;
- Significant advances in green building technologies.

The construction sector is gradually embracing the idea of building sustainable buildings as an investment linked to ecology and efficiency and part of the overall concept of sustainable development. Discussions and events are organized to familiarize the public with this initiative, with concepts such as building sustainability and energy efficiency.

All this is tied to the EU directive until 2020 to achieve the following targets [5]:
- to reduce electricity consumption by 20%;
- 20% of electricity production to come from renewables
- 20% reduce greenhouse gas emissions [6].

Also, after 2020, all newly built buildings should have almost zero energy consumption. For public buildings this is already mandatory after 2018 [7].

The directive obliges governments to also adopt an appropriate regulatory act that will ensure the achievement of these objectives and will introduce the assessment criteria. The Bulgarian Standard
for Sustainable Construction is under development. Meanwhile, Bulgaria is applying three of the world-wide recognized standards for sustainable buildings: the American LEED, the British BREEAM and the German DGNB. More and more investors are paying attention to the advantages of "green" buildings and the return of their investments, albeit in a longer term.

The World Council for Sustainable Construction (WorldGBC) presents an international report on sustainable construction practices, bringing together the best examples of practice and research. The report demonstrates the benefits of sustainable buildings globally and is geared towards market leaders in this area. The new detailed report highlights the advantages of sustainable buildings explored and received by different stakeholders throughout the building's lifecycle [8].

3. Improving the professional skills in green constructions through online training

The Erasmus+ project (No 2017-1- LV01-KA202-035483) is being developed by an international team of 5 partners from 4 countries. The project analyzes the latest trends in the rapidly developing construction sector and its needs for workers with appropriate skills in the green sector.

The questions we are asking today are: Are the construction sector workers sufficiently qualified for modern requirements? Do our modules and training programs meet these requirements?

Since VET in Europe is driven by demand, the incentives for regulatory adaptation are usually derived from the economy itself. It can be concluded that qualifications are in principle responsive and guided by the needs of the labor market. Therefore, a specific VET strategy is needed to achieve the 20-20-20 targets.

In addition to the issue of high demand for construction workers in the industry, this project aims to examine whether construction workers have the necessary qualifications for green building and energy renovation of buildings.

This finding applies both to the field of the energy efficiency and renewable energies and to green building. In the partner countries of our project there is a wide range of specific curricula for training our target group, some of which can be successfully adapted to ongoing changes in work organization in the green construction sector. Moreover, as only minimum standards are provided in training regulations, it is always possible to update a specific curriculum with certain modules in order for the training to respond to innovative developments in the green construction sector. If these opportunities are not enough and because of one or another administrative obstacle they cannot be implemented for a partner from our project, the only solution should be to create and accredit new curricula.

The educational product to be created under this project is 4 interactive multimedia modules. The modules must meet the established and latest needs of the construction labor market in line with the new EU Green Skills program.

Based on a survey and analysis of labor market needs in the green skills of construction workers and an analysis of the needs of environmental skills training programs, the project team identified the content of the modules for improving green building competencies at a special meeting with all participants in the project.

On the basis of the studies and analyzes carried out in the four European countries by the international project consortium, unanimous agreement was reached: developing the following 4 modules for e-learning in the next phase of the project:

- Materials for green construction.
- Energy efficiency and green technology.
- Passive house technology.
- Glossary "Green construction" - foreign language (Bulgarian, German, Hungarian, Latvian).

3.1 Analisys of the WEB wased distance learning environment

The study in to the project analyzes two platforms Learning Management System (LMS), MOODLE and The Blackboard Learning System (i.e., WebCT) (Fig.5).

The analysis showed preference for the MOODLE system:
- According to the full description, this platform allows it to be adapted to many operating systems (Windows, Linux, Sun and UNIX) and software environment (MySQL, Postgre SQL, MS-SQL Server, Oracle and Access).
- MOODLE can be installed on an institutional server and allows creation and maintenance of courses of different categories stored in a portal page catalog. This can cover a wide range of themes and themes.
- MOODLE supports more services than other courses. The teacher organizes the modules so students can use them. The order is flexible and editing is possible at any time. Available modules are: Assignment, Choice, Forum, Journal, Resource, Quiz and Survey that meet the needs of our project.
- The available course formats (Weekly, Themes, and Social) provide templates to set the course, making it easier for teachers to design work.
- There are capabilities for uploading files from different formats that allow the use of materials from previous regular courses and easy extension of existing courses. A link to the web directory that contains the files can also be given.

- MOODLE supports multiple languages with the ability to add extra languages.

As far as functionality is concerned, there is no predominance. The Moodle organization for learning content is more transparent and built-in constructivist style. Blackboard seems to require prior training for instructors and students, while Moodle is intuitive and easy to use. These aspects also confirm our preference for using our Moodle development as an Learning Management System (Fig. 6).
3.2. Methodological concept for the development of learning modules

The structure of the training course and the learning modules in the system MOODLE is selected to have consistency and consistency in the learning process between the modules (Fig. 7). Initial is the "Green Building Materials" (first module) training, which goes on to the topics covered in the second module "Energy Efficiency and Green Building Technologies". At the third stage of the training are the topics associated with "Passive House" and the contemporary European standards related to the construction of such homes.

The aim of this course is to improve vocational education and training in the field of green building and to enhance professional skills in the field of environmental construction. The goal is to change students' approach to wise use and management of energy resources and create a sense of environmental responsibility - which is a prerequisite for providing a green future for future generations.

The training on WEB-based interactive modules is related to creating and improving conditions for acquiring, expanding and developing interests, personal competences, professional qualification to increase competitiveness for employment, professional career and individual development of the beneficiaries of the target group of construction workers.

In the times of constant change we live in, times of new inventions and developments, happening faster than ever before, we are forced to (almost daily) adapt and continue to learn new things throughout our lives. The learning process itself and the learning technologies used also change. This is particularly relevant today with the introduction of ICT and digitization in the learning process. Learning is not a matter solely for school classes, lectures and exams. Contemporary learning especially in vocational education needs to adapt quickly to changes in the environment that surrounds us. Progress is so fast that things are constantly changing. This applies both to new materials that appear in construction and building technology.

The desire and motivation to learn new things and to participate in different educational programs is strictly individual to each person. Employers (developers), however, consider 'lifelong learning' as one of the most important opportunities to increase the qualifications of their employees. If they want to be successful on the market, they need to hire people who are capable and willing to adopt new information, develop independently, participate in different educational programs (including e-learning) and, respectively, successfully to apply everything they have learned in their work. Their desire is to do intensive courses and, possibly, through WEB-based modules to allow more rationally accumulated up-to-date databases and knowledge in the specific field.

With our interactive WEB based learning modules, we have endeavored to give learners a new approach to:

- the principles of sustainable development,
- new ecological building materials,
- energy and resource efficiency;
- environmental Protection.

The emphasis is placed on the interactions in the "environment - building - inhabitants" chain, through the construction of "passive homes".

Conclusion

It can be foreseen that the construction workers deficit in Europe beyond 2020 will increase if energy efficiency programs and activities continue at the same pace. As the employment rate of the professionally qualified citizens in the western part of the EU can only be increased to a limited extent, account should also be taken of the migration trend of construction workers from Eastern European countries to Western Europe. This trend is intensifying and will become dominant in the coming years. Therefore, the comparison of knowledge and skills of builders in both parts of Europe is of paramount importance. Success can be achieved only by creating unified programs and criteria based on modern learning technologies! This is all the more necessary because of the fact that a unified system for recognition of professional qualifications in individual professions has been adopted in Europe, including in the construction industry. That is why the adoption of uniform criteria for knowledge and professional skills, especially in the field of green construction, is of particular importance today in the VET.

Therefore, within the framework of the European Skills Initiative, of which our project is also a part of, aims to propose measures and actions to overcome the quantitative and qualitative shortcomings in the training and qualification of workers in the construction sector and especially in the area of the green construction sector.

Our project is also one of the first steps to develop a concept for staff development for construction workers based on the latest e-learning technologies - WEB-based training qualification modules in the field of energy efficiency and green constructions technologies.

Acknowledgment

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Reference

MASSIVE OPEN ONLINE COURSE “CS50 INTRODUCTION TO COMPUTER SCIENCE” BY HARVARD UNIVERSITY IMPLEMENTATION INTO UKRAINIAN EDUCATIONAL PROCESS

ВНЕДРЕНІЕ МАССОВОГО ОТКРЫТОГО ОнЛАЙН-КУРСА “CS50 INTRODUCTION TO COMPUTER SCIENCE” ГАРВАРДСКОГО УНИВЕРСИТЕТА В ОБРАЗОВАТЕЛЬНЫЙ ПроЦЕСС В УКРАИНЕ

Ph.D., Associate Professor Segol R.1, Ph.D. student Parkhomenko A.2
Department of Publishing and Editing 1, Department of Technical Cybernetics 2 – Igor Sikorsky Kyiv Polytechnic Institute, Ukraine

Abstract: Nowadays online learning is among the most progressive and most popular educational practices in the world. Both European and United States universities try to implement this way of learning into the educational process. Further development and popularity, the continued blended learning implementation in Ukrainian higher education institutions, requires high-quality new online courses in various fields of knowledge, adaptations and translations of existing courses for the further leading teaching methodologies used in the educational process. Among the best courses in the world for teaching and learning computer science’s basics is “CS50 Introduction to Computer Science” by Harvard University and professor David J. Malan. This course was translated in Ukrainian and introduces in the blended format in top-rated Ukrainian higher educational facilities. The comprehensive analysis makes possible further blended learning implementation in the technical educational process in Ukraine.

Keywords: CS50, COMPUTER SCIENCE, BLENDED LEARNING, DIGITAL LITERACY, LIFELONG LEARNING, MASSIVE OPEN ONLINE COURSE, ONLINE-LEARNING, PROGRAMMING.

1. Introduction

In the modern Ukrainian educational process in the higher education facilities, there is an uprising problem to implement cutting edge online-learning technologies to get Ukrainian education to the new level despite the lack of educational professionals, science professionals and restricted access to the world’s best learning practices. To overcome these obstacles Ukrainian largest open online courses platform Prometheus (founded in 2014) introduced blended learning technique into top-rated universities’ the educational process. Since 2016 over 40 universities in Ukraine have implemented worlds’ best online courses into their learning model. The first course that was implemented in blended format was the most popular Harvard’s University course “CS50 Introduction to Computer Science” by Prof. David J. Malan.

Modern trends in the world’s educational process and the labor market dictates new requirements to the quality of personnel and require the latest technologies to be implemented to the educational process [1]. Thus “CS50 Introduction to Computer Science” implementation is bringing new knowledge and new learning techniques to the Ukrainian students, despite the financial, health lack or other factors that can restrict access to the worlds’ best education.

“Computer Science 50 (CS50)” is Harvard University’s “introduction to the intellectual enterprises of computer science and the art of programming” for majors and non-majors alike, a one-semester amalgam of courses generally known as CS1 and CS2 [2]. The course was introduced in Harvard in 1989 and taught by David J. Malan since 2007. In 2014 David J. Malan has introduced this course in the form of massive open online course shot in the auditorium with a live audience and installed at edx.org for free access. From 2015 to 2016 the course was translated, voiced over and placed on the Ukrainian massive open online courses’ platform Prometheus. Since 2016 this course is streamed from Harvard’s auditorium to the Yale University auditorium. The same year “CS50 Introduction to Computer Science” was introduced in four Ukrainian top-rated universities during the blended learning pilot project (National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Ukrainian Catholic University, Lviv Polytechnic National University, Ivan Franko National University of Lviv).

In 2019 the latest version of the course was translated and adapted into Ukrainian by Prometheus platform for the further large-scale introduction in the educational process of Ukrainian higher educational facilities.

2. Preconditions and means for resolving the problem

Computer science in Ukraine is taught with a different methodology. Ukrainian universities have mostly fixed educational plans in which the percent of courses that students can choose by their own is very small. Because of that basic computer science in most universities is taught based on one specific programming language or technology, and further advanced courses usually introduce other languages and techniques of a higher level. This is different to the US approach, where students are faced with many different technologies in one basic course and then can choose which field they want to learn more deeply. Thus “CS50 Introduction to Computer Science” into Ukrainian educational process gives more opportunities to Ukrainian students.

The blended learning format is a formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home [1, 3, 4]. In Ukraine, we are at the beginning to introduce courses in the blended format, but after three years only the learning outcome shows that this format is better accepted by students [5] and gives an opportunity to include the best learning practices without financial or other additional efforts.

3. The solution of the examined problem

The first translation and adaptation for “CS50 Introduction to Computer Science” were released by Prometheus platform in 2016. The preparations, translations, editing, sound recording, and mixing were made by volunteers thus had some minor problems regarding content preparation. This project gave Prometheus an opportunity to launch a large-scale campaign to implement blended learning. The scientific team from all four universities regularly (once a week) have worked to create the way for different approaches to combine for course’s introduction into the curriculum in 2016/2017. The team proposed changes to the offline teaching workflow and to the supporting documentation. Due to the Ministry of Education and Science of Ukraine requirements, lecturers must produce the documentation package. There are no restrictions to use blended learning but till 2016 there were no official study cases to make it possible.

In the latest course’s version that was firstly presented in Harvard and Yale during the autumn semester in 2018, David J. Malan made a lot of changes compared to the 2014 version. First of
all, the course has 10 weeks (in 2014 it was 12 weeks), Malan has introduced a new and very popular programming language Python, also he included lection on databases and have completely changed his approach to different major computer science paradigms introduction (for example, binary system, search types, web technologies and so on).

Now the course’s curriculum is:

Week 1. C. Command Lines. Data Types.
Week 5. Networking. HTTP. HTML. CSS. Java Script.
Week 6. Python.
Week 8. Databases. SQL.
Week 9. Relaxing Week.

Thus, Prometheus has decided to replace the previous version with a new one and to attract new higher educational facilities to the blended learning implementation project.

The online courses translation, adaptation, and voice-over took almost 9 months to create. The latest course’s version includes 18 hours of main lectures, 5 hours of additional videos, 2 hours of walkthrough videos, 6 hours of seminars with the most prominent persons in programming, presentations, notes, problem sets and source code for all the problems described in class.

Lecturers in Ukrainian higher education institutions had a different way to introduce proposed course into the educational process. Firstly, some of them took the course in whole and replaced with it their own courses on basic programming skills or introduction to computer science. This approach was useful for technical students who are not studying to obtain a degree in computer science or in any joint field. For example, such an implementation way was introduced for the first-year bachelor students at the Department of Electronics and at the Department of Manufacture Engineering at National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” [5]. The results have shown that it was hard for first-year students to understand proposed lectures in full. Thus, lecturers have created stations at the auditorium to split students into several groups and to rotate course. Some students had to watch David Malan’s lectures again with a lecturer’s explanations due to the proposed material. Other students have successfully finished the lecture and have started working on the problem sets and additional course’s materials. Using this approach obtained certificates has become the final evaluation result at the end of the semester.

Another approach was chosen for students who are aimed to obtain a degree in computer science. They have basic knowledge in programming, and they need not to pass all the courses materials. Lecturers had to choose among the course’s lectures and additional materials. After that they needed to complete their own teaching program to enlarge it. This approach gave an opportunity to the lecturer to create a new course with parts of “CS50 Introduction to Computer Science” and to include own tasks, tests, and examples. The obtained certificates in this implementation version became the part of the final evaluations result.

In modern blended learning practice, lecturers use different models. The most popular for higher education institutions are a rotational model of various types, a flex model, a la carte model and an enriched virtual model [1, 4].

For proposed online course Ukrainian lecturers have used the rotational model with three interaction types between the lecturer and students. First, the rotational model at the stations, when students move from one part of the audience to another, from the station to the station with a change of activity [4]. For example, the first station provides video lectures viewing, at the second station we have practical use on the chosen equipment, the third station provides testing, etc. The stations and the order of their use are chosen by the lecturer according to the course tasks or the lecturer, together with the students, to determine the type of work that will be most convenient for all participants in the educational process. One of the successful practices in a rotational model at stations usage is to create own classroom based on the materials of the discipline and to further use such to consolidate the knowledge and repeat the material traversed.

For “CS50 Introduction to Computer Science” the rotation model was used in different educational institutions, but all shared some ways to implement: the most common was viewing course’s additional materials or course’s main lectures in an auditorium to discuss proposed material. This way was used in all four universities during the pilot project and in 6 universities during the second stage.

The students who have successfully completed the course on the platform, receive personalized certificates from Prometheus. The certificates are generated automatically upon successful completion of graded tasks (Problem Sets) of the course.

The automatic grading system for the course is based upon Open edX xqueue_watcher – open source implementation of a polling XQueue client and grader [7, 8]. Custom developed grading module for xqueue_watcher has a modular structure of 22 Python classes, one for each graded problem in Problem Sets. It uses the underlying Docker-containerized check50 software – an open source tool, that enables black- and white-box testing of students’ code, developed by CS50 course team [9]. As long as several Problem Sets need two files to be checked simultaneously, the original Open edX’s Advanced problem XBlock was modified in such a way, that it can accept data from more than one input fields representing different files that are being passed to check50.

Graded problems of the latest version of the course are:

Week 1. Hello, Mario (less), Mario (more), Cash, Credit.
Week 2. Caesar, Vigenere.
Week 3. Whodunit, Resize (less), Resize (more), Recover.
Week 4. Speller.
Week 6. Hello (Python), Mario (less) (Python), Mario (more) (Python), Cash (Python) , Credit (Python), Caesar (Python), Vigenere (Python), Bleep.
Week 7. Similarities.
Week 8. Finance.

This approach gives an opportunity to have a generation of reliable certificates for successful students, which is not relying on third-party services hosted elsewhere, that are likely to be changed or discontinued in some period. As a result, we can provide an objective grade for each student, on which lecturers who use the course in blended format can base their own grade.

4. Results

As it was mentioned in previous studies [1, 4, 10, 11, 12, 13], blended learning provides an opportunity to overcome the general lack of skilled staff in all areas of knowledge, especially in Ukraine. Specialists in Ukraine do not have free access to most of the world’s scientific developments, but due to the openness of massive open online courses and the possibility of using lectures by leading specialists in the field via Prometheus platform in Ukrainian gives an opportunity to overcome the gap in knowledge and provide students with relevant and substantiated material which was fully implemented during “CS50 Introduction to Computer Science” introductory project. Students get access to the best starting a course on programming in the world and professors had an opportunity to change the traditional way to teach with up-to-day technologies and try USA approach in Ukraine.

The online course’s “CS50 Introduction to Computer Science” first implementation in 2016 was an unprecedented and successful way to share knowledge in Ukraine which led to the large-scale blended learning implementation, further development of courses’ translation and implementation in higher education institutions. The second approach gave an opportunity to use separately or to combine both courses and have an opportunity to show how online
learning can grow and update through the years. In 2019 these gave Prometheus platform to relaunch blended learning implementation and to engage in this process over 20 universities in Ukraine.

The study has shown, the students’ progress in the first version of “CS50 Introduction to Computer Science” in the first-year students in comparison with the previous first-year students increased by 13%, and the students' progress in the second-year students was 17%. The number of successful completion certificates of the online course on the platform was 62% of all students who listened to discipline in a blended format [5]. For the second version, we will obtain statistic at the end of the semester (in late June) but now we can argue based on students’ statistic both in an auditorium and at the Prometheus platform that these results will increase for at least 5-7%.

5. Conclusions
Massive open online course “CS50 Introduction to Computer Science” was successfully implemented into Ukrainian educational process during 2016-2019. In 2016 the first version of the course launched a large-scale blended learning implementation in Ukraine.

Developed a grading system and modified Open edX modules can be used in further versions of the “CS50 Introduction to Computer Science” and other courses that need a specific approach for grading based on the execution of containerized students’ code.

It is planned to carry out the updated version of the course in universities that have already launched it in blended format since 2016 and to continue the implementation in other Ukrainian universities. Provided a technical basis, materials, Ukrainian translation of this course gives the opportunity to introduce it all over Ukraine (at least, at 12-14 national universities) and to create a way for further best world’s courses implementation. This will to give Ukrainian students access to the best educational approaches and techniques from all over the world. And will improve the process of getting an education in Ukraine, in general, considering one of the major educational problem in the country – professionals lack.

References:
1. Segol, R. Blended learning in publishing and editing specialists’ trainings. Kyiv, The printing horizons, 2016, P. 81-90 (Segol R.)
6. Harvard University. Online course “CS50”, https://cs50.harvard.edu
9. Check50 Documentation, GitHub, https://github.com/cs50/check50
13. Segol R. Massive open online courses’ implementation in blended format as a new approach in Ukrainian higher education, Modern modeling problems, Melitopol, 2018, P. 140-146 (Segol R., Parkhomenko, A.).
PROFESSIONAL-COGNITIVE INTERESTS – A WAY OF SUPPORT

Associate professor Doctor Sonya Georgieva
Angel Kanchev Ruse University, Bulgaria
sonia1956@abv.bg

Abstract: They speak about a variety of children’s phenomena in the recent years – crystal, indigo children, etc. This data brings number of challenges before the professional preparation of the future teachers. Alongside, the children with Special Educational Needs (SEN), children with intellectual potential within the norms of their age and ones that are talented also present in the educational environment. These features of educational environment put the teacher’s role at a different level – of creator and mediator.

KEYWORDS: COGNITIVE, MEDIATOR

Introduction

Professional competency in the 21st century has seriously moved its focus from giving knowledge towards possibilities for creative activities and manifestations of insight, planning activities in time deficit, making decisions, prognosticating. This imposes a different point of view regarding professional preparation.

Curricula and educational programmes also is subject of correction as well as the direct work during university students’ theoretical and practical preparation. They have to find their way to forming civil consciousness that correlates to the responsibility from their work’s result, skills for integrating with professionals from other fields and with the parents’ community, and representatives of associations and non-governmental organizations.

Change of the professional competency and attitudes is necessary also in the partner organizations. The issue is not new, but this does not mean it is solved. It comes to rationalizing the labour as value and responsibility and to accepting professional result as mission. These issues move the efforts towards creating motivation.

Key Theory

Theory bristles with theories about motivation, some of them controversial. The theses of: Harry Harlow and Edward Deci as well as the ones of Frederick Herzberg and Abraham Maslow are accepted as basic. With no detailed review of the various theories, we share us accept the following inside motivators as leading:

- Inherent personal needs, mainly related to career and surviving.
- Genetic predispositions’ impact.
- Satisfaction by the type of labour, the interest toward it.
- The feeling of self-respect.
- The power of freedom related to the own value and the power.

The factors that overlap some of the leading theories called sometimes „external“ are not of less significance. The ones we define as the most significant, are:

- The type of managing and inter-personal relations.
- Material dimensions of labour.
- The feeling of security and protection.
- The possibilities for social status change.
- Work conditions.

The pointed motivation factors are starting points towards variants for supporting professional-cognitive interests.

The goal of the paper is to direct mainly to guidance for satisfying the realized needs for quality product of the labour.

The tasks are multi-directional because of the fact that:

- In psychology, the problem with the interests is sought in relation and depending on the motives and needs, where tendencies of the personality are also accepted.
- In didactics, interest is associated with the organization of educational process and the educational contents (interesting, difficult, complicated, under the learners’ level).
- In philosophy, personal values are put in the foreground.

They include:

- Block A
  - Submitting variety of possibilities for individual and group work, accompanied by preliminary announced criteria for interstitial achievements and for the end product.
  - Studying the motives and needs.
  - Studying the fears and the expectation.

- Block B
  - Putting tasks for execution after instructions – individually.
  - Organizing work in mobile groups with common goal.
  - Giving tasks of various levels of difficulty and complexity for solving after the Kanban method.

- Block C
  - Conducting an interview for the satisfaction, where the participants are directed to present what needs they have satisfied through the work.
  - Conducting a social training for self-knowledge, where the participants have the possibility to rationalize what particularly helps/obstructs them for the tasks’ completion, what contributes to them being/not being satisfied and what else they would like in the process of training.

The leading hypothesis supposes that if the educational process is structured in a way, where the trainees’ intellectual needs are satisfied, the organization preconditions extending the field of understanding and the difficult becomes easy, the complicated – simple and there are surmountable tasks for solving left, then the professional cognitive interest would significantly increase.

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The directions for solving that problem are within the following parameters:

- Passing from learning through answering questions to learning to ask questions.
- Restructuring of practical tasks from following steps and performing technologies, to creating ones.
- Submitting tasks for execution at choice, where number of credits is pointed for each one according to the quality of execution.
- Studying means and materials for making product at choice.
- Action in modeled situations in time deficit, where the decisions have to be made by the learner.
- Prognosticating.

Three parallel in time studies were undertaken in the period October-April 2018 among different in age and specialty and degree of education (children of 10 years of age, first-year university students from pedagogical specialties and learners of professional hairdresser’s skills).

The group includes seventy two learners totally, as follows:

- Twenty eight children in the fourth grade – respectively, twelve girls and sixteen boys.
- Thirty two university students – two males and thirty females.
- Twelve from hairdresser’s course – all females.

The criteria for evaluating the professional-cognitive interest are two types – quality and quantity:

To the quality ones fall:

- Satisfaction by the process and the product.
- Elaborated life scenarios related to profession.
- Availability of competencies for restructuring tasks.
- Degree of acquaintance with the materials.
- Adequate solutions.
- Quality of tasks’ execution.

To the quantity ones fall:

- Number of structured questions, relevant to the task.
- Number of tasks’ solutions.
- Number of tasks executed at choice.
- Number of created technologies.

The analysis of the data received after the criteria have been evaluated regarding the sum. The results give grounds for the following conclusions:

Regarding non-traditional training from the approbated type:

- Might be applied for great number of age groups.
- The training expediency is confirmed by the results as present cognition and desire for professional expression.
- Learning after the suggested model confirms the theory of Galperin for the stepwise forming but by using the Kanban method.

There was also post-effect observed:

- Manifested desire for the work to continue.
- Voluntary interaction between university students and school students and representatives of the business in the circumstances of study-circle by interests.
- Giving meaning to social roles and raising the sense of responsibility for the professional expressions in general.
- Expressions of respect towards the attracted trainers.

**Conclusion**

The conclusions about the entire restructuring of training with view to supporting the professional-cognitive interests come to:

- Grounding professional-cognitive interest as formation that is set up through theoretic-practical preparation as quality and quantity change, with its own dynamics.
- Creating individual conditions for professional-cognitive changes, according to: the type of learner, his interests and his basic preparation.
- Creating conditions and possibilities for self-evaluation, which to be base for setting goals, self-education and emotional satisfaction.

The presented changes could be realized when:

- Change is made in the contents structuring of curriculum the way the whole training is built not on memorizing but on constructing strategies for understanding and learning (from answering-to asking questions, from following steps that are pre-set, to solving and creating technologies, etc.).
- Possibilities for realizing inter-subject relations and for up-dating knowledge in compliance with the current changes in the scientific space are created.
- Making learning objective through trainees participation in active forms of training – solving causes, participation in debates, role games, trainings, etc.
- Giving possibilities for personal cooperation between trainer and trainee, where the trainee’s interest and his strong sides are leading.
- Establishing creative atmosphere, where each participant may share, make mistakes and succeed.

**Literature:**


PROBLEMS WITH INFORMATION SECURITY ON MOBILE DEVICES

Veselka Stoyanova, PhD
National Military University “Vasil Levski”, Artillery, AD and CIS faculty, Shumen
veselka_tr@nvu.bg

Abstract: The current report takes a look at possible problems with information security on mobile devices, analyzes them and suggests some of the possible solutions. We’re taking a look at problems with transferring information between mobile devices and how this information can be received without letting people outside the conversation get access to it.

Keywords: EDUCATION, COMPUTER GRAPHICS, IMAGE

1. Introduction.

With the advances in technologies and mobility of users, many of us carry with us devices, which a few decades ago existed only in science-fiction books, and only a few years ago, nobody thought that they will offer the functionality that the common user uses today.

In connection with this ubiquitous and necessary mobility comes the question, are the mobile devices and data of their users secure. There are risks of different nature about the security of information on mobile devices.

Providing information security is linked with identifying threats and pinpointing the possible solutions for providing informational security of data and apps of users in a given environment, it’s necessary to aim the efforts of dealing with the problems in different categories.

Given the fast growth of the smartphone market, mobile software developers suggest many applications, which let you hide information in different concealing objects [2], and a part of them are free to use. We must note the fact that owners of Android devices for 2015 are 17,2% of the total market share, for iOS being 14,1%, Microsoft at 4,9%, and Symbian was a complete monopoly for that period with it’s 50,2% of the smartphone market. In 2017 things look a little different, Android has taken the lead with it’s record 80,7%, iOS having 17,7%, Microsoft at 1,1%, other OS at 0,5%, and Symbian is no longer available (figure 1).

1. Model of measuring security of information

All of these facts lead to the conclusion that we’re in the era of smartphones and the conveniences they offer, the transfer of confidential messages will be supported and the whole process of communication and data delivery will be accelerated. The whole process of secret communication will be unnoticeable and natural, and dangerous in terms of data leak security due to the fact that it’ll be an almost instant process of just one touch on the screen.

The interesting part is the analysis of security of data shared in the computing cloud. Cloud technologies have a lot of pros as to be considered as the best solution by many IT organisations, the biggest of which is being able to pay only for the used resources therefore reducing costs or even eliminate the investments in IT structure. According to organisations like “Cloud Security Alliance (CSA), Cloud Computing Information Assurance Framework (ENISA), Information Security Forum (ISF) etc. part of the major threats to informational security of users in the cloud space are connected to: user authorization, data ciphering, physical safety of hardware, malicious traffic etc. [3].

The Bulgarian Institute for Standardization suggest multiple standards for informational security. On figure 2, you can see a model of measuring security of information [1].

Using the model of measuring security of information, you can define the stages, through which you have to go when securing information, which are the informational necessities and methods of measuring. Measuring results influence the process of controlling the security of information and for the effectiveness of defence be analysed. The model thus presented is relative to and the problem connected to information security on mobile devices.

There are many measures and solutions which are recommended to be used and applied, and not to rely on chance when securing confidential data, because in that case we can’t talk about security or prevention of malicious users.
3. **Problems with the safety of information on mobile devices.**

Problems with the safety of information on mobile devices that may occur, can be different, like:

- Physical safety of devices and data;
- Authorization of user access to data;
- Separation of user data;
- Cyphering data and connections;
- Not using Fire Wall;
- Consuming fake service;
- When carrying personal belongings;
- Internet of Things (IoT).

**Physical safety and authorization** is of great importance to the safety of information. When using mobile devices increasingly big amounts of information are being concentrated on a small physical space. The information can be personal as well as or officers. Some standard measures which would prevent the possibility of information being received by unauthorized users are the biometric identification, by securing the screen and applications with passwords and codes, regular check of the device location, surveillance cameras etc.

**Cyphering the data.** It’s suggested to cypher the communication channels and data. Usually when exchanging data over the web, internet providers can provide you with access to the data with a secure protocol HTTPS. When controlling data however, a problem may occur when the same key is used to cypher every account. This way the unauthorized spectator, getting access to the key could gain access to all the data too. A problem when cyphering data is the distribution of the keys. The most popular solution the provides cyphering of data and key is the OTFE etc. in which a special technology is used that allows a small physical space. The information can be personal as well as increasingly big amounts of information are being concentrated on the operating system. The question about the actual to this moment operating systems looks like this:

**Security in Android OS:**

The base of the Android platform is a Linux core, which is responsible for the drivers of the devices, for access to resources, for managing the electro-consumption and for other OS tasks [6].

It is accepted to divide the architecture of Android into four layers:

- Core layer (Linux Kernel);
- Implementation environment and library layer;
- Working framework of applications;
- Applications layer;

Android uses the ability of Linux which doesn’t allow root access to the operating system and it is the basis of the security of the Android OS. When installing the device, every application gets a unique user ID (UID) and a group ID (GID) [5]. UID is used for identifying an application for the whole period of it being installed on the device.

Android is the preferred operating system of hacker attacks. Usually the infection is caused by malicious applications, which are offered in online stores.

In this OS while installing a given application its permissions gets reviewed. All permissions, which are required by the application must be declared. Permissions represent access, which the application requires from the operation system so it can function properly. During the installation, the user can see a list of all permissions which are required by the application and can make an informed choice about the installation. A given application may require a permission to track your location by GPS, internet access, your contacts, developer tools, phone call register etc.

All Android applications are self-signed which means it’s not required to sign the applications using a certifying body. The signature of the application represents the author.

**Security is the iOS operating system.** iOS is basically a version of Apple OS with specific characteristics linked with control of the devices for which it is designed. It’s presented for the first time in 2007. [4] as iPhone OS – the operating system of Apples’ mobile devices. It’s later renamed to iOS, to underline the fact that it works on other Apple devices too. OS X and iOS are based on NeXTSTEP OS.

The model of security on iOS includes four layers:

- Security of the device;
- Security of data;
- Security of the network;
- Security of applications;

The security of the device aims to guarantee that a given device cannot be used by an unauthorized individual. The most common method of locking is with a PIN code or password. In the version for corporate users of iOS you are given the opportunity to set the minimal length, number of symbols to be used in the password and password history. Users can set extra settings to make the device automatically erase itself if a wrong password is entered too many times [10].

Security of applications is guaranteed using the Store, by starting them in the so-called “sandbox”. The apps started in the “sandbox” cannot gain access to other apps or their data, neither can they gain access to system files or other resources. The size of the memory and processing time that can be used by the app are being limited and so is the access to files outside the app folder.

In addition to limiting the resources of a given device, to which an app can get access, Apple has turned on application signature to keep an eye on the binary code allowed to be started on top of it. For an app to be allowed to run on iOS, it has to be signed by Apple or have a certificate given by Apple.

**Microsoft Windows operating system**

Windows Phone is the successor of Windows Mobile. The most sold version of Windows Phone is Windows Phone 8.1. Windows
Phone 8.1 got released on the market in July 2014 [8]. OC Windows Phone 8.1 by its characteristics is comparable to the latest versions of iOS and Android OS, supports multi-tasking with its personal cloud service, online store and Twitter integration. The built-in browser is Internet Explorer 11. The successor of Windows Phone 8.1 is Windows 10 Mobile [9], which came in use on chosen Lumia series smartphones in February 2015. Windows Phone is designed to be secure. A lot of the security features are turned on by default. An example is the apps that can be downloaded from the Store, which are tested by Microsoft and ciphered to prevent the installation of dangerous software by mistake.

4. Conclusion

Mobile devices may look harmless when using them as regular phones, as access to news, social medias or for relaxation in the form of games or entertainment apps. In reality mobile devices are under a constant threat of personal data and information, in the form of different kinds of inquiries for access to the data and receiving permissions to use them, are threatened by receiving malicious software or even spy programs. Developers of the leading mobile operating systems understand the importance of the security of personal data and information, and set apart a large resource for development and improvement of the mechanisms of securing information on mobile devices.

Some suggestions that could be useful for security of information on mobile devices are:

- Locking the screen with a Pin code or password;
- Avoiding remote services like: remote lock, remote format, GPS localization etc.
- Encrypting data when passing it through open channels;
- Using anti-virus software which battle malicious software and to avoid problems with banking, paying bills and finance management.
- Using safe Wi-Fi networks and to avoid unreliable ones like in cafes, airports or other points of connection that can allow access to personal data.
- Updating the OS, the apps used by the users and all other programs.
- Regularly making back-up copies of the data.

Reference: