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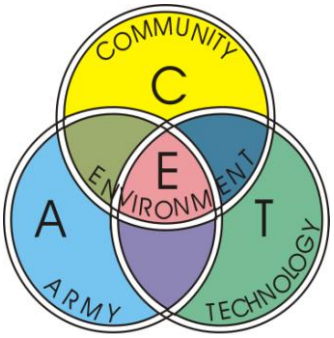

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and

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on May 19-21, 2015

as an official accompanying programme of the International Exhibition of Defence and Security Technologies and Special Information Systems

IDET 2015

Conference objectives:
Experience and information exchange in the field of:

- the current status and prospects of distance learning and e-Learning in the preparation of military professionals and other target groups;
- using the computer modelling and simulation, especially (but not only) in the command and control process;
- language education of military professionals and other target groups, current and future communication systems, their development and usage.

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CONTENT:

SAFE PATH PLANNING USING CELL DECOMPOSITION APPROXIMATION

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Abstract: *Motion planning is an essential part in robotics domain; it is responsible for guiding the robot motion toward the goal. It generates a path from one location to another one, while avoiding the obstacles in the way. The planning modules could be configured to check the optimality, completeness, power saving, shortness of path, minimal number of turn, or the turn sharpness, etc., in addition to path safety. In this paper the cell decomposition approximation planar is used to find a safe path; the quad-tree approximation algorithm divides the workspace into manageable free areas, and builds a graph of adjacency between them. New methods are proposed to keep the robot far away from the obstacles boundaries by a minimum safe distance. These methods manipulate the weights of adjacency graph's edges. They utilize and reflect the size of free cells when planning a path. These approaches give a lower weight to the connection between big free cells, and a higher weight to the connections between the smaller cells. The planner after that searches for the lowest cost path based on these weights. The safe path in this work is the path which keeps the robot far away from obstacles by specified minimum safety distance and it bias the robot's motion to follow the bigger areas in the workspace. The shortest path is not considered. However a tradeoff between the real path cost and the safe path cost is considered when choosing the weight values.*

Keywords: motion planning, cell decomposition, quad-tree, safety path, path planning.

INTRODUCTION

Motion planning is one of the most challenging tasks in robotics fields. The main task for this problem is to find a suitable path between initial states and desire states. Many approaches were proposed to solve this problem and many efforts were done to overcome the complexity and difficulty of this problem. Some of these methods are exact and based on static environment, like Cell-decomposition algorithms [1]. Another type of these methods based on sampling-based algorithms, for example, potential field algorithm [2], or probabilistic algorithm, e.g. probabilistic road map [3], and rapidly exploring random tree [4].

From work principle point of view, some approaches are real time and require low computation cost. They based on local sensors to generate local path based on surrounding space, e.g. Bugs [5], VFH [6]. The main advantage is the tolerance to the environment changes, and main drawback of this algorithm is local minima. Other approaches are global planning which overcome local minima problem. The planners of these types produce full path form initial position to goal position. However, they have less tolerance to environment change.

In this paper we study the path safety problem in static workspace, for omnidirectional robot. The generated path in this work consider as safe if the robot translate far from obstacles by

a specific distance and follow the large open areas. The cell decomposition approximation is used for path planning. The algorithm generates a graph of adjacency for free cells.

1. CELL DECOMPOSITION

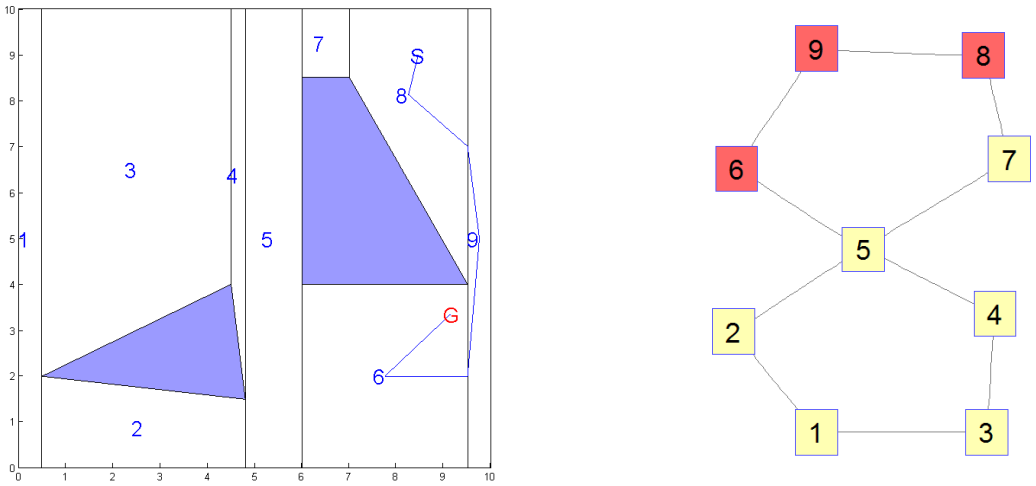
Cell decomposition algorithms are old applicable solutions for path planning. The idea of these methods is to find obstacles-free regions, and build a graph of adjacency for them [4, Ch. 6], [7]. The idea of dividing the space into manageable sections is presented in many researches. In general two categories of cell decomposition algorithms are existed; the exact cell decomposition methods and approximation methods [8].

The first category uses geometric based algorithms to explicitly determine the obstacles and build the cells [9], [10]. The union of all generated cells is equal to the free space exactly. However, finding exact free cells is not an easy task especially in high dimensions, that lead to the second category which uses the approximation techniques to divide the spaces, e.g. quad-tree, octree division, and voxel grid, etc. [1], [11].

In motion planning applications, this algorithm is utilized by dividing the free robot's workspace into smaller regions called cells. Then it builds a connectivity graph according to the adjacency relationships between the free cells. The graph's nodes represent the cells, while graph's edges represent the adjacency relations between the cells. From this connectivity graph, a continuous path can be found by following the adjacent free cells

1.1 Exact cell decomposition

The trapezoidal decomposition method or vertical cell decomposition decomposes the free space into trapezoidal and triangular cells. It draws parallel segments from each polygon's vertex in the workspace to the exterior boundary. The generated cells form the nodes of connectivity graph. The adjacent nodes in the workspace are linked to form the edges in the connectivity graph [12], [13]. The path in this graph corresponds to sequence of striped free cells.



(a) (b)

Fig. 1. Trapezoidal cell decomposition. a: the generated vertical free cells. b: the graph of adjacency which corresponding to paths between cells.
Source: own

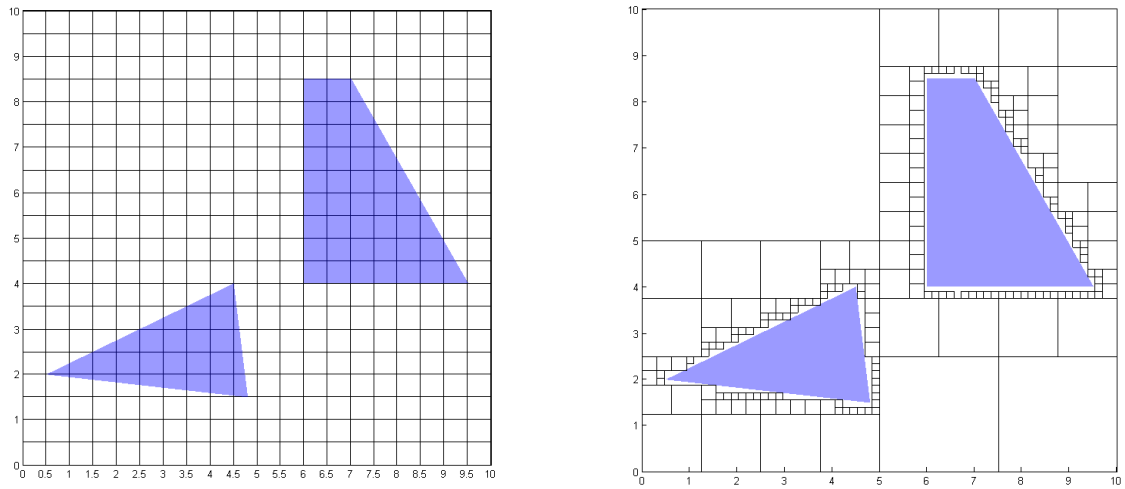
When planning query is establish, the planner finds the start and goal cells, then it searches for a path between these two cells, if a path is found the planner connect the start and goal locations through the free cells on that path [14]. Fig. 1-a. shows the principle of cell decomposition planner. Fig. 1-b. shows the generated graph and the corresponding path from start's cell to goal's cell.

Another example of exact cell decomposition is decomposition based on obstacles edges. This method considers each edge like a line. It finds the intersections with other edges or cells, and then it builds the free cells in the free space based on these intersections [1].

1.2 Cell decomposition approximation

The approximation methods were proposed due to the high computation and geometric calculation which are required by exact cell decomposition. The most forward approximate cell decomposition method is voxel grid. It uses regular voxel grid or pixel grid, Fig. 2-a. It excludes the cells on obstacle areas and builds a graph of adjacency for cells on free area. This method is efficient for low dimensions space. However, it generates large number of cells. This method is resolution complete; which means the algorithm's completeness depends on how fine the grid is [1], [11].

Another improvement for approximate cell decomposition was by using quad-tree decomposition. This approach uses a recursive method. It recursively subdividing the cells until one of the following scenarios occurs
1- Each cell lies completely either in a free space or in the C-obstacle region.
2- Or, an arbitrary limit resolution is reached.



(a) (b)

Fig. 2. Cell decomposition approximation. a: voxel approximation methods. b: quad-tree approximation methods
Source: own

Once a cell fulfils one of these criteria, it stops decomposing. After decomposition steps, the free path is found by following the adjacent free cells [14], [15]. This method is used in 2D [11, Ch. 14]. Fig. 2-b. shows the generated cells of this method. In similar way the Octree approximate the decomposition in 3D spaces. It decomposes the cell to 8 parts [16].

The quad-tree and octree methods are resolution complete. They can work efficiently for low dimensions workspaces; three or less [17].

2. PROPOSED METHODS

In this work the path safety problem in static workspace is studied. The path is considered as safe if 1- It passes through obstacles without colliding with them. 2- If it navigates while keeping the safety distance R far from obstacles boundaries. 3- If it follows the large open areas on workspace when it possible. We utilize the cell decomposition approximation algorithm to find an approximation of free areas, and exploit the resolution feature to satisfy the minimum distance condition. The resolution R corresponds to the smallest cell's edge (box's edge). We have proposed that the robot pass through the center of the cell when execute the path; based on that assumption the R is chosen to be equal to 2*(safety distance).

In this work new methods have been proposed to plan a safe path. These methods manipulate the graph edges' weights in order to make the planner chooses the largest cells when translating toward goal position. The first approach uses equal weights for translating from one cell to another. The idea behind this proposal is to minimize the total number of cells in the path, which in consequence force the planner to use bigger cells, when searching for lower path cost.

The Second method introduces a penalty for translational between different cells size. This penalty is added to edge's weight, and it is disproportional to cells size, which means the weight of translating between the larger cells is smaller than the weight of translating between the small cells, while the weight of translating between same cells size is kept fixed. This proposal forces the planner to make the translating in large cells when it possible and at the same time keep some trade-off between making the translation in large cells, and planning a path much longer then the shortest path.

The last proposed method is very similar to the second approach in spite of it introduces disproportional penalty not only with different cells size, but also with cells have the same size. The benefit of these methods is to push the path toward large cells when it possible by adding more penalties when translating between small cells, in addition to the benefits of second approach.

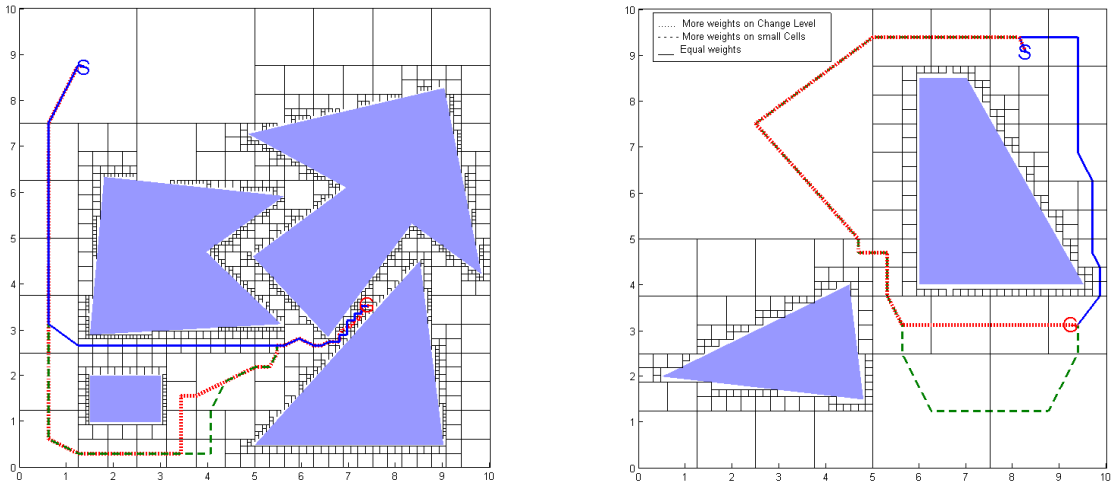
The proposed methods direct the planner to use the large cells more than small cells for planning a path, at the same time they bias the motion to translate in large cells. In practice when a robot executes the path, it follows a safe path, because this path keeps the robot far from obstacles' boundaries at least by safety distance.

3. RESULTS AND DISCUSSION

The path safety problem in static workspace is discussed in this paper. We utilize the cell decomposition approximation algorithm to find an approximation of free areas. The generated path is considered as safe path, if the robot passes through obstacles and keeps a safe distance far from them. The value of this safety distance is given as resolution limit to the algorithm.

In the first proposed method, the weights of edges are uniformed to cost of 1, which corresponding to the cost of translating from one cell to another one, regardless to cells' size.

In the second proposed method, we associate to each cell of the free cells a level; this level disproportional to cell size. The level is used when calculating the new graph' weights. The edge' weight between two cells is set to be equal to the biggest level between these cells. I.e. if cell 1 has level of 2, and cell 2 is smaller and has the level of 4, the edge's weight between them has the value of max(2,4) which is 4. The translation between cells from same level is fixed to the weight of 1.



(a) (b)

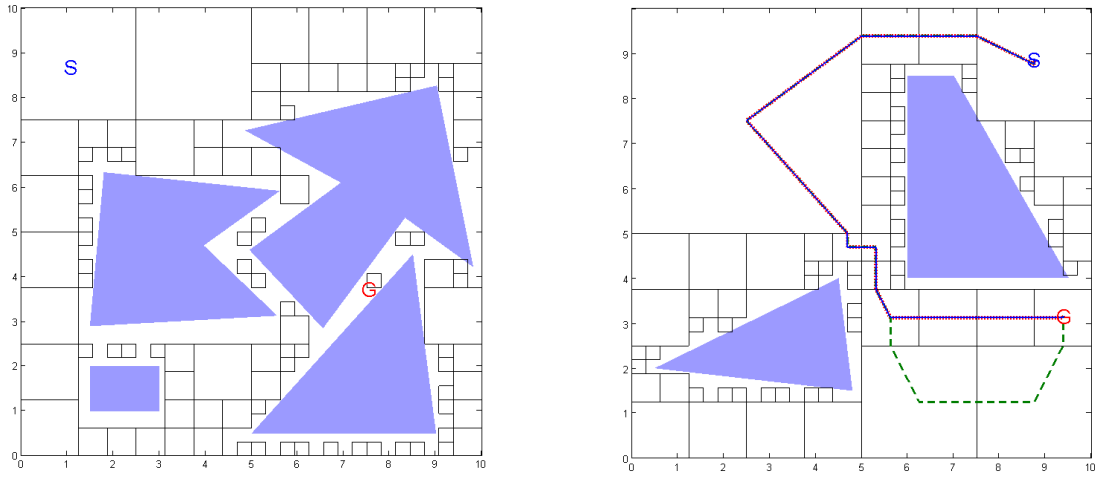
Fig. 3. Results of safe path generation; a and b are the testing workspace. The solid line represents the first methods (equal weights of translation), ... line represents the second methods (disproportional penalty to change cells size), --- line represents the third methods (disproportional penalty to size of cells). The safe distance is set to be 0.1
Source: own

The weights in the last proposed method are calculated in the same way as in the 2nd method, but here the transition between same cells size is vary also based on cell's level. For example the translation's weight between the cells which have level of 3 will take the value of 3.

The Dijkstra algorithm as graph search algorithm is used to find the path over the graph. The Dijkstra Algorithm finds the minimal cost of the path efficiently.

The tests are done in two workspaces with three value of safety distance {0.1,0.3,0.75}. The results are shown in Fig. 3, Fig. 4., Fig. 5. respectively.

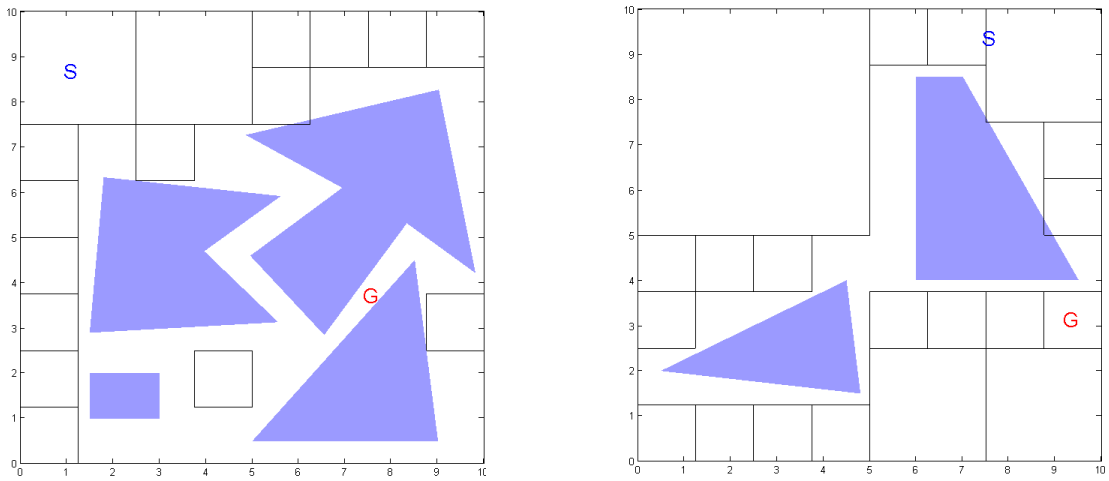
We can infer from the results that the proposed methods generate a path respect the safety distance condition. The first method try to minimize the number of cells as shown on Fig. 3-(a,b), where the solid line represent the first method. The path keeps the safe distance but not follow the large areas. The second method (the dotted line) is better in this criterion. It forces the planner to go to large cells in order to minimize the cost. However, it follows the large cells but not if smaller cells are adjacent to each other; in that case the algorithm plan through these adjacent cells. The last approaches solve this drawback (dashed line), and it plans in large open regions when it possible.



(a) (b)

Fig. 4. Results of safe path generation; a and b are the testing workspace. The safe distances 0.3, the goal in a is unreachable. All methods in b have the same results.
Source: own

The Fig. 4-a shows unreachable path based on the safety distance. The same in Fig. 5-(a,b). That because the algorithm excludes the collided cells with obstacles, which break the continuity of graph's edges. Fig 4-b. shows the same results for all methods.



(a) (b)

Fig. 5. Results of safe path generation. a and b are the testing workspaces, the safe distance is 0.75, the goal is unreachable in both workspaces.
Source: own

CONCLUSION

In this paper the cell decomposition approximation planar is used to find the robot's path; the quad-tree approximation algorithm divides the workspace into manageable free areas, and builds a graph of adjacency between them. Three approaches have been proposed to plan a safe path. These methods manipulate the edges' weights in order to make the planner chooses the largest cells when translates toward goal position. That keeps the robot far from obstacles by safe distance. The proposed methods show the ability to plan the desire path. And force the planner to plan the path in the large open areas over the workspace.

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THE CEFME PORTAL – DISTANCE PREPARATION AND SUPPORT OF THE NATIONAL ADMINISTRATORS

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Abstract: *The paper describes the Portal CEFFE (Central European Forum on Military Education) for military universities cooperation. The goal of the CEFME system is to support the cooperation among the community of ten universities in education, research, social area, and staff and students exchange. The system is derived from the MilUNI (Military Universities), a knowledge management system (KMS), based on Topic Maps theory using the ATOM software. Special attention is given to the distance system administration of the national administrators. Discussion and ideas for father work closed the paper.*

Keywords: knowledge management system, military university, cooperation, portal administration, CEFME, ATOM.

INTRODUCTION

The goal of the CEFME (Central European Forum on Military Education) group (see Tab. 1) is to support education and training of military professionals and cooperation of the participating universities in teaching, research, exchange of teachers and students; increase mutual awareness and facilitate the organization of joint events.

	State	University
1	Czech Republic	University of Defence
2	Estonia	Baltic Defence College
3	Croatia	Hrvatsko vojno učiliste "Petar Zrinski"
4	Hungary	National University of Public Service
5	Poland	Akademia Obrony Narodowej
6	Austria	Austrian National Defence Academy
7	Romania	Carol I National Defence University
8	Slovakia	Armed Forces Academy of Gen. M. R. Štefánik
9	Slovenia	Poveljstvo za doktrin, razvoj, izobraževanje in usposabljanje
10	Serbia	Military Academy Beograd

Tab. 1. Universities of the CEFME group
Source own

That goal of the community CEFME should be supported by the Portal, solution of the research team, dealing with the Knowledge Management Systems (KMS) at the University of Defence (UoD). The solution is based on Topic Maps principle [3], using software ATOM [2]. The first project of the KMS was prepared by the team for the Ministry of Defence (MoD) of the Czech Republic in area Network Enabled Capability [5] in years 2008 – 2011.

The portal CEFTE is still under construction, see the project plan at the Tab. 2. The main feature is a user friendly access to the information about the structure of the universities, their

main educational areas or programs, list of departments, research and conference activities, etc.

Data for the portal was accessed from the open sources; nevertheless, wherever possible, the information was evaluated and confirmed by using different sources on the Web or from official papers. The future of the portal processing is in the self-service of the participating universities in including and editing data of the portal content.

Project definition, team establishing	05/2014
The concept CEFME portal presentation	05/2014
Update of the MilUNI solution	10/2014
Presentation of the portal at the CEFME meeting	11/2014
Training of the university administrators	12/2014
Update of the CEFME portal	02/2015
Organization of the portal processing	03/2015
Team work finishing	05/2015

Tab. 2. The CEFME portal production plan
Source own

1. CHARACTERISTICS OF THE CEFME PORTAL

The portal is derived from the KMS "Military Universities" (MilUNI) providing a platform for the cooperation of military universities in teaching, research and exchange of teachers and students [1, 6], but it is adapted to the new user needs. The ontology (structure of the KMS) consists of classes or objects: university, university-part, organization, product, geo-tree (counties and cities), person, conference, collection (journal, conference proceedings, or other form of set of articles), article, venue, activity (program, project, and product), and domain tree (areas of interests).

The new classes of the KMS are: meeting, action, workgroup, and function. The objects' information is linked to the World FactBook [7] in order to use information about countries and cities. The portal is an internet accessed application; its processing is fully outsourced by SW ATOM developer Company AION CS, Zlín [2], with excellent cooperation.

The structure of the portal is organized by a knowledge principle. It means that information is in context and builds the network; it is possible to browse in a query from one portion of information to another without interruption. System contains the powerful full text search engine and integrate information about objects it selves and with the GIS information. Portal consists of the 3 types of pages:

1. The title (main) page, see Fig. 1.
2. The search result list, see Fig. 2 (set of meetings).
3. The detail of object information, see Fig. 3 (person).

Fig. 1. The title page of portal
Source own

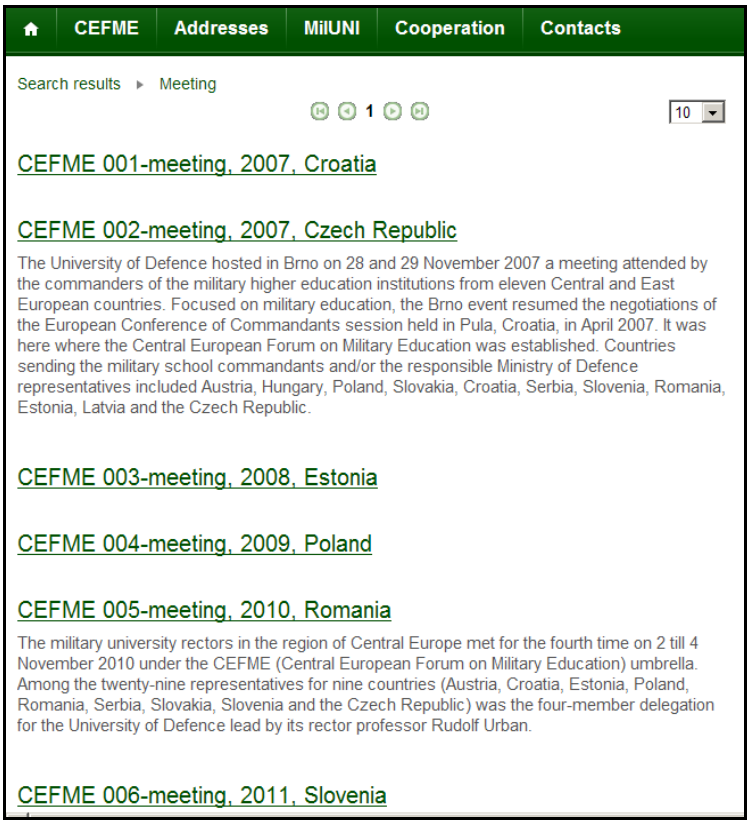

Fig. 2. The search result list of the portal – meetings
Source own

The title page of the portal displays the news and offers the introductory access menu with special boxes. The menu structure and content is defined in the ontology and is possible it to change. The search result list offers set of objects to choose as a result of the search procedure. The detail page of an object displays information only about selected item.

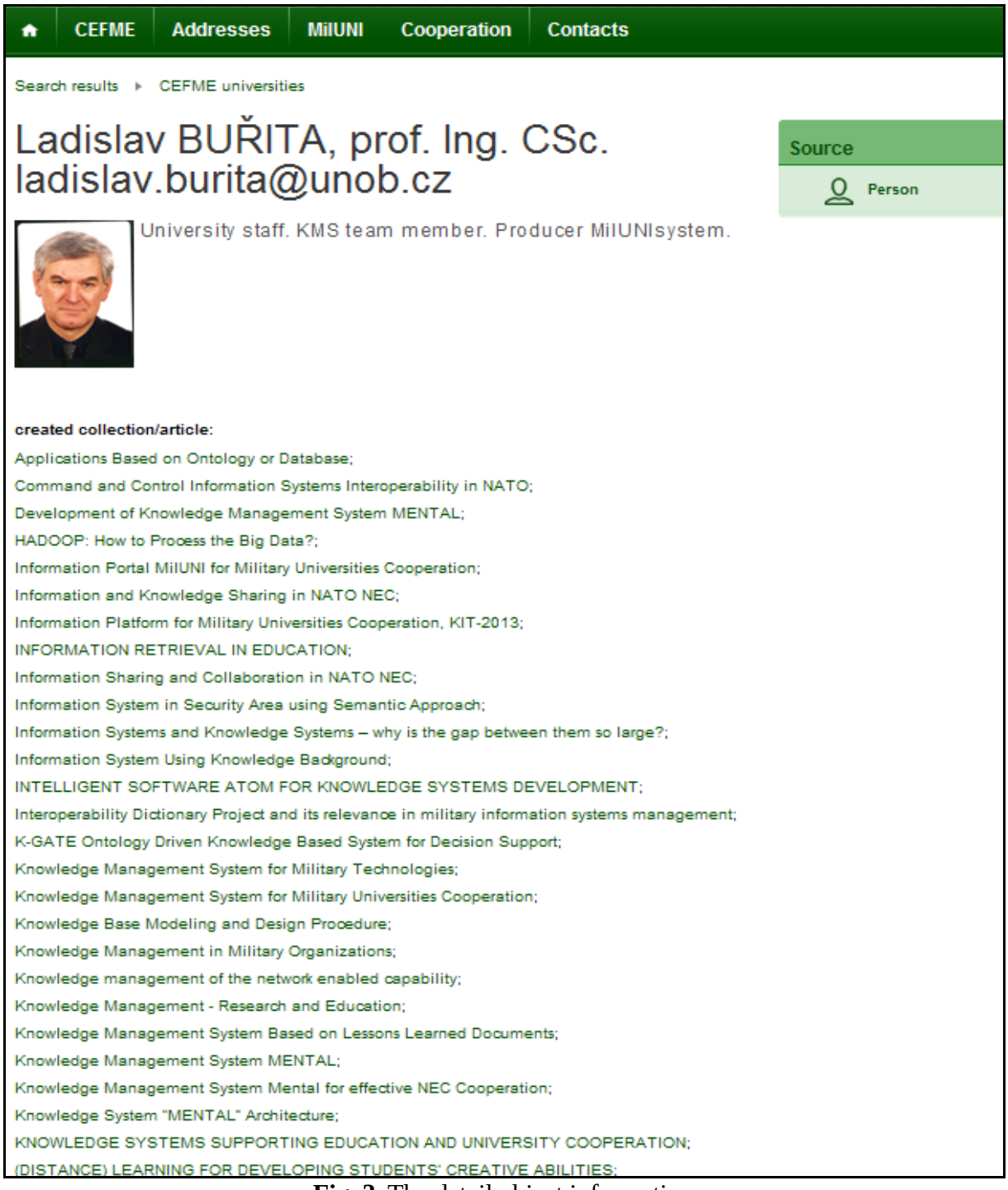

Fig. 3. The detail object information
Source own

The main feature of the portal is a user friendly access to the information about the university structure, its main educational areas, the program of the education, list of departments and university members, their research and conference activities and offer a basis for wide cooperation.

The most common way to obtain the required information is by browsing the knowledge base of a selected class, such as UNIVERSITY; required data about the university can be obtained, then its field of study, the list of its academic staff and students, and perhaps even their publications at conferences. Another way is based on the global hierarchy search procedure using the field present at the top of the page. This procedure searches the full text of the entire KMS, passing through all classes and attributes, and regardless of the ontological structure it displays an overview of occurrences.

The portal has been created based on the specifications of the research team. A complete set of user requirements is not accessible, because it is unknown who will create it all (except the group of trained administrators). But this is a problem of leadership CEFME, not the research team; to deliver the required specifications. It works with the development of most information systems. Managers require only something vague (e.g. portal) and are willing to give up the result.

2. THE PORTAL ADMINISTRATION

The portal adoption and using depends on meeting the requirements of users. One of the requirement is the timeliness of information, which can only be achieved by involving national administrators and their active participation at own university. The first step towards this activity was achieved by completing training at the UoD in December 2014. It was attended by 15 members from 9 universities, mostly members of the IT department or departments on Foreign Relations.

Administrator should act at its own university as initiator and stakeholder in working with the portal in the CEFME community. The research team is trying its task to simplify as possible. In the research team was designated a person responsible for communication with the national administrators - organizer cooperation. Cooperation must be prepared so that every problem of the national administrator in portal data input or edit is solved as soon as possible. It could be stated that administrator is a “Portal Champion” and it would convey the idea that he would help bring about the culture change needed in the participating universities to ensure that the portal is fully used and its benefits realized.

For this, are in the structure and content of the portal supporting elements, which will further expand. First, there is list of addresses of contact persons, addresses national administrators and contacts to the research team and supplier organization. Furthermore, it is an overview of the underlying changes in the portal, a FAQ (Frequently Asked Questions), set of predicted queries to the portal with the appropriate answers. In the portal can be used a range of sample model objects for editing own data. Still is lacking context-sensitive help, but software ATOM contractor is working on it.

To communicate with the national administrators can be used the "mailing list", which is based on registration that ensures automatic messaging. One can easily imagine that the content of the report may be a requirement for an action of administrator, or alert to changes in the structure of the portal, or rules of inserting or updating data. All the above measures can facilitate a distance administration of the portal and an effective cooperation between national administrators in the maintenance and improvement of the portal CEFME.

3. FURTHER PORTAL DEVELOPMENT AND IMPROVEMENT

The existing state of the CEFME system needs its further improvement regarding the user needs. The primary requirement of such a system is its utilization by users. The research team assumes that this process will take minimal one year. It is necessary to address the national administrators from the universities, to encourage university colleagues to use the CEFME system by universities cooperation and collaboration at its improvement.

Naturally, an interest group will form using of the portal, including and editing of the existing data about each university, and then, step by step, its members will add further information to meet the objectives of the KMS. The other direction of the portal development is to adoption of other communities than the CEFME group. The potential groups that should be added to the portal are iMAF (International Military Academic Forum) and LoD7 (Line of Development – a working group established by the European Security and Defence College).

CONCLUSION

The article presents the CEFME KMS for the collaboration among military universities. It collects public available information on the structure, people, education and research at the universities; the participation in conferences, offer for activities and other related information. The creation of the system constitutes a starting point for its use; its further development depends on its acceptance by users. The important role in that process plays the national administrators. The measures for the best collaboration with the national administrators are the important part of the paper.

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POSSIBILITIES OF EDUCATIONAL PROCESSES SIMULATIONS IN THE VIRTUAL UNIVERSITIES CYBERSPACE

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Abstract:
Based on the information sources of the world analysis and the analysis of selected educational systems, modern trends in the use of information and communication technologies (ICT) for system management, modelling and simulation with respect to creation of models related to educational processes at virtual universities; the simulation has been framed in the new concept of cybernetic space. The aim of the paper is to introduce some partial results of the pat of the specific research from the point of view of possible trends of e-learning and system use of ICT. The described models of modelling and simulation provides us with a complex view of making new views of models of multi-layer spatial cybernetic systems in the field of increasing quality of education and speed of changes occurring in the state space of cybernetics of knowledge economy and ICT technologies.

Keywords: virtual universities, information and communication technologies (ICT), educational process simulation, cybernetic space (cyberspace), e-learning trends.

INTRODUCTION

Possibilities of educational processes together with competitiveness of enterprises [7] will be primarily linked to new cybernetic and system oriented learning of knowledge staff in the environment of tradable data, information, knowledge and visions.

In the new electronics opto-electronic and bionic environment, it will be especially represented by high-quality system identification and definition of system levels of recognizing real environment designed for educational process, information gathering, safe communication using well-articulated and necessary knowledge, experience, habits, skills and behaviour utilising value parameters and quantities in the dynamic environment of information and communication technologies (ICT) of the civilized and cultural world. Learning and acquiring knowledge in the world [6] of abstract concept of systems and the world of learning processes related to it will form inseparable part of educational institutions virtual environment – called virtual universities from the point of view of university education.

Ability to learn [1] is inherent to human beings as well as some intelligent technical devices or advanced information systems specified within the field of existing smart ICT tools. In information sources there is a variety of views of the area; for example, understanding learning as process leading to permanent change in personality, which influences the way human beings understand information. Learning is interpreted as permanent process, which is influenced by knowledge the person already has and it is part of individual maturing, upbringing and education influenced by the surrounding culture. Learning consists of

acquiring, imprinting, organizing, understanding and retention (embodiment in the system of understanding the world around us).

Learning of people and related life-long learning will be [5] one of the key activities of human resources development influenced by culture within organizations, by its organizational classification, scope of responsibilities and authorities. Learning and educational processes leading to acquiring new skills will form the base for every profession.

Related professions [3] and scientific fields are, apart from the already mentioned information and communication technologies, the newly interpreted and applied in all areas of social and technical environments of the civilized world: especially cybernetics (as "*the area of management and communication in living and non-living organisms*" – Norbert Wiener, 1946) and in the newly system defined environment especially internet technologies which enable to find necessary knowledge in the virtual environment of the world information sources in the new concept of cybernetic space (cyberspace).

Human resources management (Human Resource) and knowledge management represent related areas of management, especially the area of enterprise management and economy.

To secure the system defined dynamic process [4], [2] in the knowledge society, major role will be played by using ICT trends in the knowledge economy cyberspace. From the point of view of the development trends interpretation and system definition of this contribution, the solution to the existing possibilities and also of the selected perspective trends in educational processes during their modelling and simulations as non-traditional views of the new concepts of systems in the area of increasing quality of education and the speed of changes in the state space of cybernetics at virtual universities, which are necessary for knowledge economy and intelligent robotic ICT technologies.

1. METHODOLOGY AND DATA

The real environment identification process (Fig. 1) in the cybernetic space [2] is expressed through the following steps:

- ✓ the real environment selection together with the expression of abstract system and its surroundings of importance,
- ✓ careful expression of structure and behaviour of the system with the aim to analyse hierarchic spatial and time specified environment of the cybernetic system (with controlled and controlling subsystems defined including the executive information links and related feedbacks),
- ✓ transformation of the system in the real environment with the aim to identify principal features of the analysed environment and to get the corresponding model, with the aim to create environment suitable for modelling and simulation in the new cyberspace from the point of view of educational processes possibilities at a virtual university of the future on PC.

In the group of selected modern methods applied to get models and create modelling including simulation the following have been chosen:

- ✓ especially **system approach** and system definition according to the rules of the general theory of systems (on the given recognition level with the expression of the significant surroundings of the identified system as well as its hierarchic classification

expressed in the model through the n-dimensional matrix of states and relations in accordance with the principles of the concept of state space in **cybernetic systems**) – (matrix expression of the model in MATLAB),

- ✓ **expression** of the identified system **model** using **mathematical language means** in the deterministic environment of analyses and modular expression of partial adaptable modules suitable for **PC simulation processes creation** in the selected simulator language (MATLAB, SIMULA),
- ✓ expression of system approached **modelling and simulation processes** leading to the new level of training and learning of the educational model for the selected new modelling process using **artificial intelligence methods** (NEURON NETWORK).

System based approach to the chain of cybernetic interpretation of the new modelling was made in accordance with the principles of the general system theory as a concept for thinking, analysis of the real world simulations, decision making and actions under complex reality conditions.

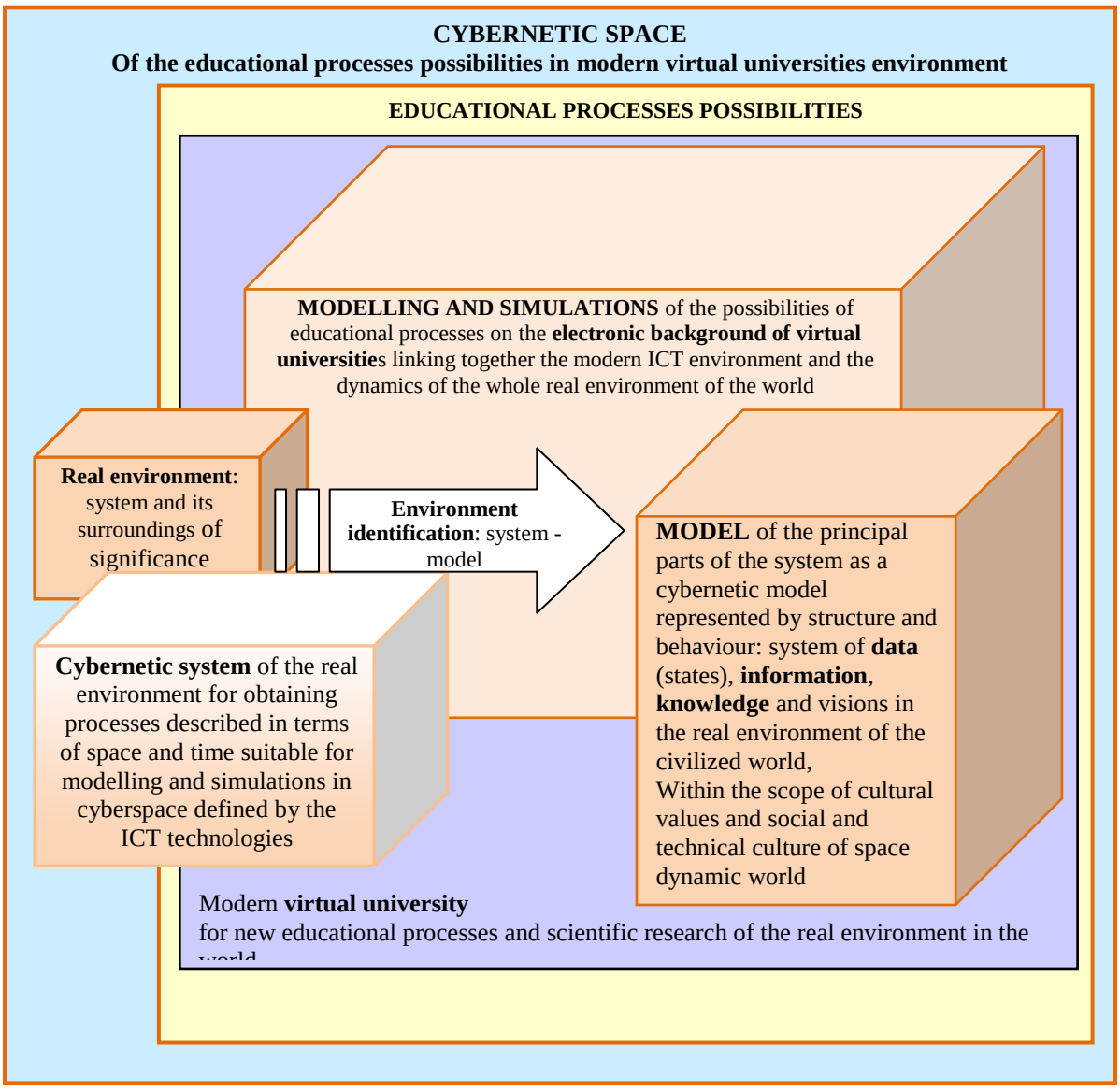


Fig. 1. System based transformation of the real environment in the cyberspace of modelling and simulation for modern virtual universities
Source: the author

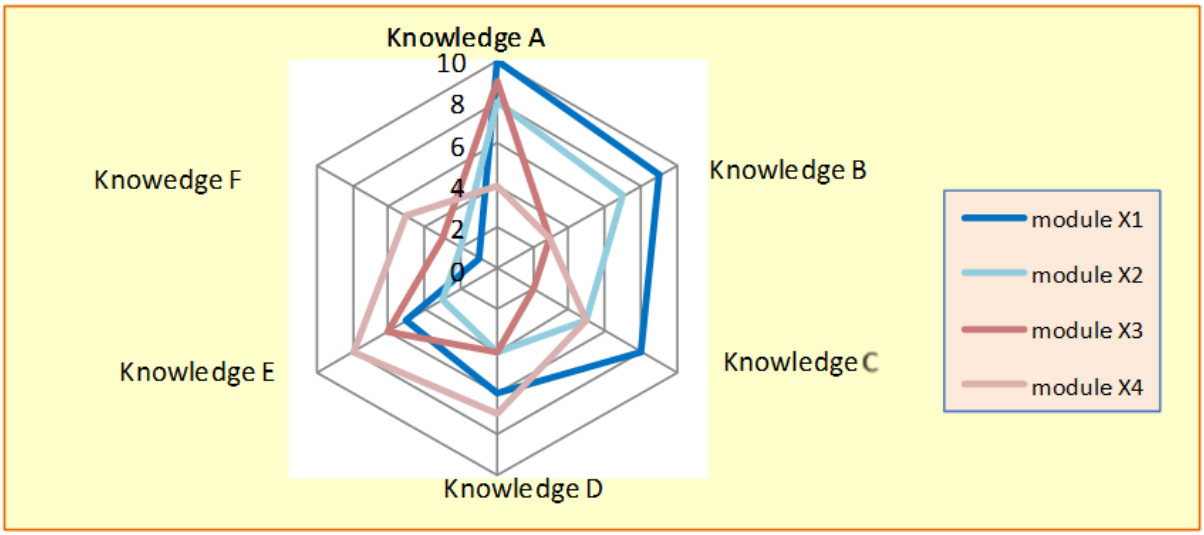
Data necessary for the model creation and preparation of simulations were gathered by the means of questionnaire in cooperation with the ACONTE company, which is an expert in designing and realization of the ICT technologies and which also focuses on the educational process for staff, modern ICT and Internet users with respect to the process of education designed for virtual universities cyberspace.

Data and information gathering with respect to the process (Pic. 1) was focused on the ***environment*** **identification** *within the scope of the specific research, especially on the* ***cybernetic system*** of the real environment and the structure and behaviour of the social system (studying the ICT applications introduced in the practice of enterprise). Electronic form of "questionnaire examination" was attended by the members of the **IT Operation Knowledge does not mean the modern education ability: "*Soft IT skills in practice*"** with the support of ACONTE, EFS, EU and OPVK.

Difficult identification incorporates the already existing ***n program modules*** $x_1, x_2, \ldots, x_n$ of the current education process in the real enterprise environment and also the modernized environment of lifelong learning realized by the enterprise suitable for modelling and simulation on the background of virtual universities. Furthermore in the environment of the cyberspace for ***m partial components of the education process*** $v_1, v_2, v_3, \ldots, v_m$ realized for ***p means of ICT cybernetic system of the real education processes*** $c_1, c_2, c_3, \ldots, c_p$ and embedded into the ***q database systems*** $d_1, d_2, d_3, \ldots, d_q$ containing state spaces (data, information and knowledge) of said cybernetic systems and the social system represented by ***r students educated in the environment of university*** $y_1, y_2, y_3, \ldots, y_r$ for particular cyberspace by a set of parameters, e.g.: point ***evaluation of student's knowledge*** (current grade evaluation: equivalent of A – E) by the value of quantitative expression of 5 (the highest level of knowledge acquisition after completing the limited process of atomic knowledge acquisition in the limit area of necessary knowledge and practical habits) – expression 0 (as insufficient evaluation of this level), point ***evaluation of selected ICT means quality*** for the knowledge acquisition evaluated by points – 0 (none) to 5 (maximum possible means of the technical and social background of the realized education process with selected Internet means), ***age limit of the education participants*** in the overall concept of the project for system based lifelong learning concept – expressed by the age of the training centre graduates from 20 to 50 years of age and other parameters illustrating the system based space in the sense of the new concept of economic cybernetics means to secure the social – technical environment of enterprises and also the new approach to new training forms and system learning in the future cyberspace of intelligent robotic – technical constructions worldwide.

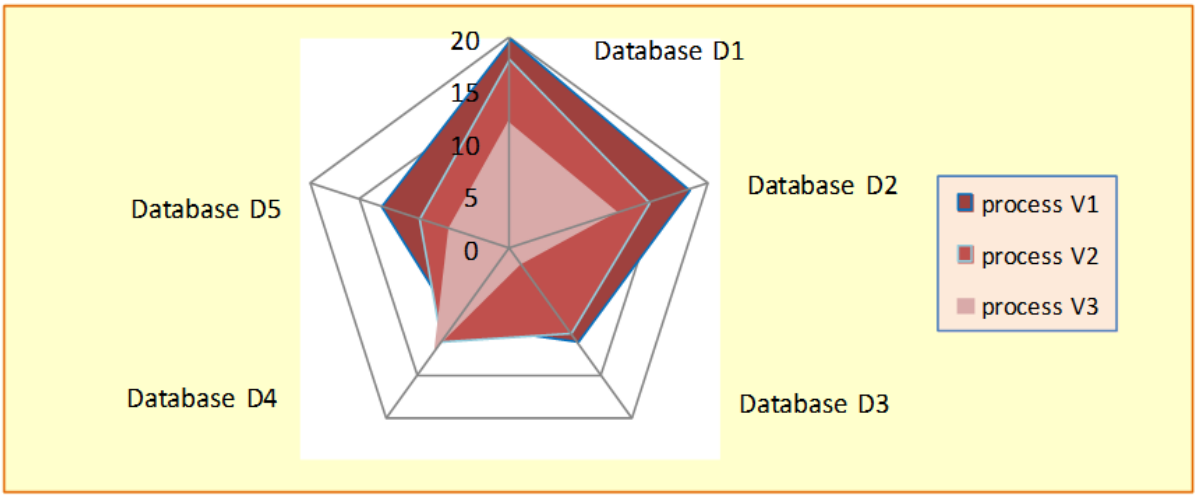
2. RESULTS

Some interesting partial results of the identification for the given modules creation are illustrated in the following graphs 1 and 2. Based on an inquiry in a real business environment, set of four software modules X was chosen (Graph 1 - randomly selected educational activities Word, Excel, PPT and Access). Graph 1 expresses six degrees of knowledge (A to F with a predetermined threshold of statistical significance - expressed with values from 0 to 10 in Graph 1). In this way it is expressed mathematically (with the char in this case) another possible model of state space part of identified environment for simulation of the educational process segment (in the text expressed with v_i and c_i).



Graph 1. Relation of the X program modules of the existing educational process for the assessment of the student's knowledge according to the A-F scale
Source: own

Graph 2 expresses more systematically defined view on the simulation process in the given inquiry. This graph shows the segments of the educational process. Values 0 to 20 represent the level of competence of selected three processes to five databases, from which it is formed a new group, expressed in solving tasks as a knowledge base for the possibility of a future simulation in cyberspace of virtual education system (herein referred as virtual university).



Graph 2. Relation between selected databases D systems containing state quantities and partial components of the V educational process in the cybernetic space of educational process possibilities in the existing model and the future PC simulator program
Source: own

3. DISCUSSION

Based on the amount of gathered data, information and other parameters modular structure for modelling and simulations is formed to make models and simulations of educational processes possibilities on the electronic background of virtual universities in the new concept of cyberspace and with development of the existing e-learning environment taken into

account. The scope of this research is significant, and gradually obtained partial results are conducted on a newly conceived system-defined environment of new understanding of cyberspace (especially in terms of management and communication). Further research process will depend on the economic, technical, personnel and organizational ensuring of research work of whole department.

CONCLUSION

The aim of the paper is to introduce some partial methods and possible solution to part of the specific research from a new angle of perspective which includes the social system (studying) and the technical environment (i.e. modelling environment represented by ICT technologies) in education and possible methods for modelling and simulations. All in a briefly expressed of the new point of view of multi-layer spatially expressed cybernetic systems models in the area of increasing education quality and speed of changes in the state space of cybernetics for knowledge economy.

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ETHICS AND VALUES EDUCATION WITH THE USE OF ICT

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Abstract: *"All real living is meeting" (Martin Buber). The ability to communicate and to build bonds between people starts in the womb. It's crucial, not to refuse the word, but to communicate in a positive way. We can say that communication is an ethical category which is realized by face-to-face-communication on the one hand, and by ICT on the other hand. The authors see a great chance in the ICT medium for philosophizing with children, to develop ethical issues like respect, tolerance, friendship and responsibility – to be seen on the EU-projects ETHOS (2012 – 2014) and ETHIKA (2014 – 2017).*

Keywords: values, communication, ethics, friendship, word, responsibility, philosophizing with children.

INTRODUCTION

The paper deals with the ethical learning for students aged 3 to 15. Based on Miroslav Hruby's presentation about Ethical Aspects of Current Distance Learning, this paper presents the actual European Research Projects ETHOS and ETHIKA. Knowing that Ethics is a science with the aim of acting (and not just speaking how to act), it's also necessary to distinguish what is right and what is wrong, what is good and what is bad, and to develop ethical behaviour and responsibility. According to Weinstein and M. Hruby there are "five basic principles of ethics that are common to all religions":
- *Do not* cause each other *harm.*
- Make things better.
- Respect others.
- Be fair.
- Be loving." (Hruby 2012, p. 67-68).

The authors want to discuss, how to teach values with the medium of Internet – using educational materials which were developed in the EU-project ETHOS: *Ethical Education in Primary and Pre-primary Schools for a Sustainable and Dialogic Future*.
First, communication in its ethical dimension will be presented. Then the necessity of words will be discussed (word was given to me so I am able to response and to become a responsible person). And finally, the Christian thinking about the Internet with regard to the subject values and Open Education Resources (OER) to foster value education will be presented.

1. COMMUNICATION IS AN ETHICAL DIMENSION

In his bisexuality the human being is interrelated; a person is normally created from the physical communication and relatedness of a man and a woman. And the life develops in the process of communication with the fertilized egg of the pregnant woman. Communication between mother and child is practized from the very beginning in the womb, from the daily division of the cells (Dohr 2007). The decisive feature of the biological body is the DNA that is created in pairs – as human being is biologically created in relation. The neurobiologist

Joachim Bauer explains that the person is not so much created for competition and 'survival of the fittest' but more for cooperation, communication, and creativity (Bauer 2008). The mystery of life is 'not that we survive at all costs, but to find someone to bind our feelings and desires' (Bauer [9]2006, 173).

Why can we understand each other intuitively? Why do we feel instinctively what others feel? And why do we act socially and for the good of all? The explanation of all these phenomena is found in mirror neurons which were accidentally discovered in 1996. These neurons enable us to be in emotional resonance with others, provide us with intuitive knowledge about people´s intentions close to us and let us share their joy or pain. They are the basis of empathy, intuition and the ability to love.

When does this ability begin to develop? The ability to imitate begins in the first days of life. The baby develops the first interpersonal relationships and searches for an agreement and it develops the basic feeling to live in a common emotional world. However, if no emotional resonance is possible, autism can occur: "The deficiencies of children and grown-ups suffering from autism can exactly be found in these abilities based on the function of the mirror neurons" (Bauer [9]2006, 73).

2. FROM THE GIVEN WORD TO THE ANSWER AND TO RESPONSIBILITY

The fundamental human gift is life. A baby needs to hear words for its development. People live through words. Only when we hear words, we can give a response, an answer (in German "Ant-Wort").

The best chances to develop personality are given by being aware of himself (Kegan 2005), by showing verbal and nonverbal acceptance. Just by communication with words, sight and embrace we can gain 'communio'.

Word and response are the basis for responsibility.

3. VALUES IN THE INTERNET MEDIUM?

At the last conference in Brno in 2013 the author Franz Feiner spoke about New Media in the Light of Documents of the Roman Catholic Church (Feiner 2013). The purpose of authors is to summarize the most important positions, which are relevant for the actual topic now.

"Agora" in ancient Greek and "forum" in ancient Roman time were public places, where much of the social life of the city took place. Nowadays the internet is like an "agora" or a "forum" – like John Paul II mentioned in the Message of the World Communications Day 2002. "The Internet offers extensive knowledge, but it does not teach values" (John Paul II, 2002, 4). The main question in the future will be how to cultivate "wisdom which comes not just from information but from insight, the wisdom which understands the difference between right and wrong, and sustains the scale of values which flows from that difference?" (John Paul II, 2002, 4)

The web is a symbol for connection; the Internet connects people all over the world. Pope Benedict XVI highlighted the role of the Communications Media as a "network facilitating

communication, communion, and cooperation" (2006). "It necessitates both seeking and transmitting what is the ultimate foundation and meaning of human, personal and social existence" (Benedict XVI, 2006, 2).

Pope Benedict XVI wishes "to reiterate the importance of three steps … necessary for their service of the common good: formation, participation, and dialogue" (Benedict XVI, 2006, 4).

Social communication requires a spirit of cooperation and co-responsibility, which leads to solidarity. Pope Benedict XVI emphasizes that he has been "confident that serious efforts to promote those three steps will assist the media to develop soundly as a network of communication, communion and cooperation, helping men, women and children, to become more aware of the dignity of the human person, more responsible, and more open to others" (Benedict XVI, 2006, 4).

4. ETHOS AND ETHIKA – TWO EU-PROJECTS

The projects ETHOS and ETHIKA give the chance to realize these values. Those projects for ethical education in primary and pre-primary schools for a sustainable and dialogic future address the needs of primary, lower secondary and pre-primary school teachers and other educators and offer them lifelong learning opportunities in ethics education, employing dialogical (philosophy with children) and integrative (holistic) methodology and approach. The main outputs of the projects are educational materials and tools for teachers that are prepared in relation to the previous User Needs Analysis (UNA) and then they are tested in piloting activities and test-beds by teachers and other educators in the classrooms. The core motivation for the projects was awareness that the challenges that the EU countries and the rest of Europe are facing now are not merely economic or political, but also societal, cultural and especially ethical.

The main objectives of these projects are to provide effective lifelong learning possibilities for teachers and educators in the field of ethics education; to develop, promote and disseminate teaching methods, materials and tools, to stimulate the rise in the level of ethical knowledge, awareness and critical thinking in schools (teachers, educators, students, parents) as well as to provide a wider support network (organizations, experts, teachers) and advocate ethics education (policy and decision makers).

4.1 The main aims

The main aims set for these projects are:
(i) to provide effective lifelong learning possibilities using innovative methodology and integrative approach;
(ii) to develop, promote and disseminate educational good practices, including new teaching methods and materials; to develop or exchange experiences on information systems for learners, teachers or other education staff and develop new teacher training courses or course content;
(iii) to stimulate the rise in the level of ethical knowledge, awareness and critical thinking;
(iv) to stimulate social cohesion, awareness and skills in topics of ethics, critical thinking and green sustainability by utilizing reflective dialogue among participants;

(v) to foster social and civic competencies, build upon a notion of common humanity as a basic ethical postulate for dialogue, tolerance and respect as well as to combat all forms of discrimination;
(vi) to equip all young people to interact positively with their peers from diverse backgrounds, to stimulate intercultural dialogue how not to merely co-exist or tolerate each other but mutually enrich each other for a common future.

4.2 User Needs Analysis (UNA) of ETHOS

By using online survey (for teachers and parents) it was found out that teachers and parents that were involved in a survey have similar needs and expectations concerning:
a) what topics they consider as most relevant for ethics education;
b) on which thematic aspects they would like the educational material and tools to be developed.

Based on these answers of the focus group the researchers of ETHOS have created a shortlist of eight key ethical topics: moral values, respect, tolerance, responsibility, environment, social skills / conflict solving, relationship / friendship, different religions.

4.3 Results from the actual UNA of the project ETHIKA

On 4th and 10th February 2015 the Austrian ETHIKA-team organized two Focus Group Meetings attended by 27 teachers (teaching students aged 3 to 15), experts in moral education. To the question "*What topics are the most relevant in the process of teaching ethics and values education at school?*" most of the answers were about the dialogue: sensitivity to others, respect, tolerance, acceptance, empathy, self-worth, self-confidence, awareness, esteem, nonviolent communication, peace, solidarity …

Answers to the questions *"How do you manage to develop ethical sensitivity to ethical issues (e.g. cyber bullying ...) in the students, in the personal environment and globally?"* and *"How do you manage to teach in a character-building way so that students learn to stand for their opinions and actions?"* brought revealing results: self-perception, mindful dealing with each other, stating the personal opinion, sharing things, celebrating, negotiating rules, searching for good solutions, being appreciative, empathy, helping each other, comforting each other, honesty, trust, teamwork, fairness, personal relationships with the pupils, teacher as a role model, encourage good, individuality, permission to express emotions such as pity, compassion, joy, anger, gratitude.

The results of the UNA of ETHIKA-Austria are comparable with the results of the ETHIKA-UNA in all six participating countries: self-esteem, honesty, appreciation (as the psychological basis for communication), dialogue, relationships, respect, friendship, conflict solution, co-operation, responsibility, moral values, justice, acceptance, empathy, compassion, (as very important values in dialogic pedagogy) (presented by Evelyn Schlenk [FA-University Nurenberg-Erlangen] at the ETHIKA teacher training in Ljubljana on February 23rd 2015). In general we can say that teachers perceive the importance of communication in ethical learning processes.

5. EDUCATIONAL MATERIAL FOR PHILOSOPHIZING WITH CHILDREN

Based on the results of User Need Analysis (UNA) of ETHOS the eight ethical key topics were narrowed down to five central topics: respect, tolerance, responsibility, values and friendship. A set of educational materials on these topics was developed for different age groups. All this was then tested in piloting and test-beds activities. A project website with basic information about the project and its results is reachable at: http://www.ethos-education.eu/; Facebook page: www.facebook.com/ethoseducation.

The Information and Communication Technology (ICT) supports face-to-face-communication and is very useful for philosophizing with children. The set of educational materials for the use of teachers and educators for different age groups (ages 3 – 5, 5 – 7, 7 – 9, 9 – 11, 11 – 15) is presented in the internet. It can be used in the teaching process according to the Creative Commons Non Commercial Share Alike license.

Two examples are presented in this paper.

5.1 Example 1: "Friendship"

In the first power-point slide about friendship (ages 9 – 11) there appears a seal, who begins: "Good afternoon, kids. I'm a Mediterranean monk seal. Today we are under the sea surface. We are going to talk about something very interesting. Let's begin with the association game." In this game the terms belonging to friendship 'love', 'loyality'... are expected. After the key word „friendship" is revealed the seal continues: "So, we are going to talk about the friendship." And he asks the seahorse: "Do you think that friendship is an important part of our life?" And the seahorse answers: "Of course, it's important. Here it is, what Marcus Tullius Cicero says about friendship." Then Cicero appears and says: "Hi, kids. I'm Marcus Tullius Cicero, a famous Roman orator. I'm a philosopher, too, the same as you are. I wrote a book about friendship, and this is one of my friendship qoutes: *»Life without friendship is nothing.«*

The seahorse asks: "Do you agree with Cicero?" The seal continues: "Do you think that life without friendship is worth of living?" More questions follow – asked by the seahorse and the seal – for example: "Do you have friends?" "How do you choose them?" "Do you think that a friend is someone who talks badly about his friend 'behind his back'?" "Why?" Then a third animal, Bibi, the fish, appears asking: "What do you expect from a true friend?" "Is there anything that friends should never do to to each other?" "Are loyalty, trust and love important for friendship?" "So, what is real friendship?" The picture of Aristotle appears: "For me, *friendship is one soul in two bodies*." "Do you agree with that? Or can you say it is true just for the best friend?"

Plutarch: *"I don't need a friend who nods and agrees with me in everything, because my shadow does the same, or even better.*" "Is it possible for a true friend to become an enemy? How?" "Can we forgive our friend if he betrays us?" "Is a good friend someone who often cheats us, ignores us, someone who is not loyal?" "What connects you to your friends?" "How can friendship grow and become stronger?" More questions can be asked, even more philosophers can be included.

Kids should search for answers to the questions. Animals are also useful and great for evoking associations.

5.2 Example 2: Online discussion to the topic "respect"

Over a period of four months an online discussion was organized with the leading idea to motivate students to think and write about respect and to stand up for their thinking through written expression. Fundamental main questions were published every two weeks. Students discussed these questions and answered them. A moderator asked additional questions and guided the discussion.

The main questions that were discussed:
- Why we must respect someone or something?
- Who deserves our respect? Why?
- Do we respect a person because (s)he is good or we respect her (him) because (s)he is doing what (s)he does?
- How can we prove that respect is a positive thing?
- What is the main aim of respect?
- Will my respect towards authority be useful in my life?
- Who respects me? Why?
- Can we define respect?

CONCLUSION

The projects ETHOS and ETHIKA aim primarily to develop new and innovative curricula, Open Educational Resources (OER), educational methods and training courses.

The results also include establishment of a European network of ethics and value educations that will build synergy, reinforce cooperation and exchange good practices and experiences. In the future the ETHIKA researchers are planning to sustain and broaden network of associated organizations, provide support for users and provide space for exchanging experience and good practices.

The project will enhance innovation and internationalization in the school sector and strengthen cooperation (capacity building); critical thinking will raise the level of key competences and skills and encourage active participation in society (Erasmus+; EU 2020).

The main objectives of the project are to provide helpful lifelong learning possibilities for teachers and educators using innovative methodology and integrative approach in the field of ethics education and especially to stimulate the rise in the level of ethical knowledge, awareness and critical thinking. The website of the project will be kept alive (www.ethics-education.eu), where all the educational materials and tools will continue to be freely accessible. The authors believe in significant contribution of the project to ethics and value education.

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ADVANCED PERSISTENT THREAT AND SPEAR PHISHING EMAILS

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Abstract: *In recent years, cyber exploitation and malicious activity are becoming increasingly sophisticated, targeted, and serious. Advanced persistent threats or APTs are a new and more sophisticated version of known multistep attack scenarios. They are targeted specifically to achieve a specific goal, most often espionage. These APTs form a problem for the current detection methods because these methods depend on known signatures of attacks and APTs make heavy use of unknown security holes for attacks. In this paper we propose two blacklist-based detection methods for detecting a spear phishing email, which is the most common technique used in APT attack. The first method is malicious domain detection method, and the second one is malicious file hash detection method. The blacklists are automatically updated each day and the detection is in the real time.*

Keywords: Cyber security, advanced persistent threat, targeted attack, spear phishing email, malware, malicious domain, malicious file hash.

INTRODUCTION

In our increasingly interconnected world, threats to our national and cyber security can come from unexpected sources and directions. This is what one may label as a 360-degree challenge. In recent years, cyber exploitation and malicious activity are becoming increasingly sophisticated, targeted, and serious [1]. Cyber threats are becoming more sophisticated with the blending of once distinct types of attack into more damaging forms. Increased variety and volume of attacks is inevitable given the desire of financially and criminally-motivated actors to obtain personal and confidential information.

Advanced persistent threats or APTs are a new and more sophisticated version of known multistep attack scenarios [2], [3]. They are targeted specifically to achieve a specific goal, most often espionage. These APTs form a problem for the current detection methods because these methods depend on known signatures of attacks and APTs make heavy use of unknown security holes for attacks. The economic damages due to a successful APT attack can be very high as it is confirmed through many previous research findings on APTs [4], [5], [6]. The expected financial impact of attacks is the main influence on investments in security measures [7]. Spear phishing continues to be a favored means by APT attackers to infiltrate target networks [8]. In a typical spear-phishing attack, a specially crafted email is sent to specific individuals from a target organization. The recipients are convinced through clever and relevant social engineering tactics to either download a malicious file attachment or to click a link to a malware or an exploited site, starting a compromise.

In this paper we propose two blacklist-based detection methods for detecting a spear phishing email, which is the most common technique used in APT attack. The first method is malicious domain detection method, and the second one is malicious file hash detection method. We

applied our detection methods on campus live traffic and found that they can detect malicious domain and file hash connections in the real time.

The remainder of this paper is organized as follows. Section 1 defines APT attack and describes the life-cycle of this type of multistep attack. Section 2 presents previous related work to APT attack detection. Our proposed detection methods are explained in Section 3 and Section 4 shows our results.

1. ADVANCED PERSISTENT THREAT (APT)

APTs are a cybercrime category directed at business and political targets. APTs require a high degree of stealth over a prolonged duration of operation in order to be successful. The attack objectives typically extend beyond immediate financial gain, and compromised systems continue to be of service even after key systems have been breached and initial goals reached [9]. Figure 1 shows the steps of APT attack [10].

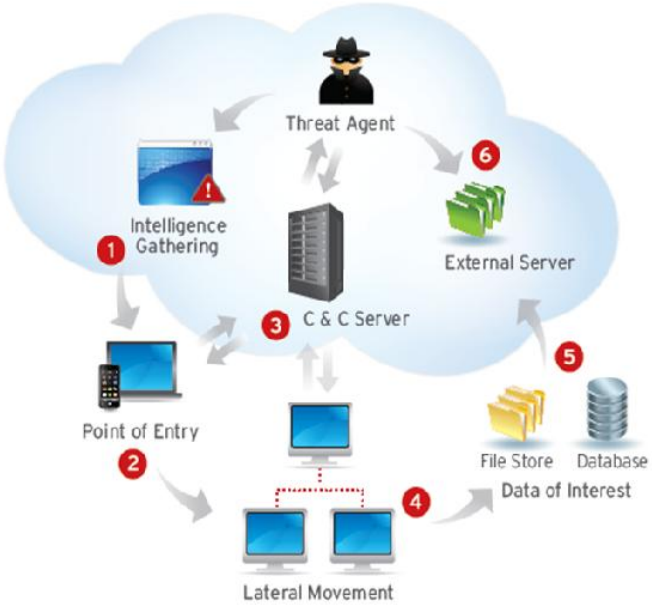

Fig. 1. Typical steps of APT attack
Source: [10]

1) Intelligence Gathering: Identify and research target individuals using public sources (LinkedIn, Facebook, etc) and prepare a customized attack.
2) Point of Entry: The initial compromise is typically from zero-day malware delivered via social engineering (email/IM or drive by download). A backdoor is created and the network can now be infiltrated.
3) Command and Control (C&C) Communication: Allows the attacker to instruct and control the compromised machines and malware used for all subsequent phases.
4) Lateral Movement and Persistence: Once inside the network, attacker compromises additional machines to harvest credentials, escalate privilege levels and maintain persistent control.
5) Asset/Data Discovery: Several techniques (ex. Port scanning) are used to identify the noteworthy servers and the services that house the data of interest.

6) Data Exfiltration: Once sensitive information is gathered, the data is funneled to an internal staging server where it is chunked, compressed and often encrypted for transmission to external locations.

2. RELATED WORK

The first widely reported APT was publicized by Google in January 2010, although it is believed to have begun some six months earlier. Known as Operation Aurora [4], the attack was extremely wide-scale and is believed to have targeted 34 organizations, including Yahoo, Symantec, Northrop Grumman, Morgan Stanley and Dow Chemical, as well as Google itself. Later on, other research findings on APT attack are reported in [11], [5], [6].

Some researches have been done on analyzing already identified of APTs. In [12], the authors showed how to determine, from a known targeted attack, the N most likely victims of the attack, they developed a search engine for APT investigators to quickly uncover the potential victims based on the attributes of a known APT victim, by improving the performance in terms of detection rate and false positives with regards to N-gram based approaches. In [13], they provided an in-depth analysis of a large corpus of targeted attacks identified by Symantec during the year 2011. Using advanced TRIAGE data analytics, they were able to attribute series of targeted attacks to attack campaigns quite likely performed by the same individuals. By analyzing the characteristics and dynamics of those campaigns, they provided new insights into the modus operandi of attackers involved in those campaigns. By using an undirected graph in [14], the authors showed that it is possible to associate attacks according to the targets shared between separate attacks and it is possible to build a map of APT activity and identify clusters that may represent the activities of single team of malware writers.

With regards to detect possible APT attack, in [15] they proposed a novel system that processes threat information collected on the users' side to detect potential targeted attacks. They used a combination of clustering techniques to identify groups of machines that share a similar behavior with respect to the malicious resources they request (e.g., exploit kits, drive-by downloads or C&C servers). They correlated the location and industry information in which these machines operate (e.g., oil & gas or government) to discover interesting attack operations and they implemented their system in a working prototype that they called SPuNge. An abridged version of initial Duqu analysis was presented in [16], Duqu is a new malware involved in APT attack against a European company aiming at stealing the information. They also described the Duqu detector toolkit, a set of heuristic tools that they developed to detect Duqu and its variants.

3. PROPOSED DETECTION METHODS

In this section we propose two detection methods for detecting a spear phishing email, which is the most common technique used in APT attack. The first method is malicious domain detection method, and the second one is malicious file hash detection method. Although the detection of a malicious domain or a malicious file hash does not necessarily mean that we have a spear phishing email, but it still gives you a good sign of detecting two techniques used in APT attack life cycle. As a future work, the outputs of both detection methods will be correlated with the outputs of other detection methods (like Tor connection detection method,

domain flux detection method, disguised exe file detection method and malicious IP detection method) to raise an alert on APT attack detection.

We have implemented both detection methods on top of Bro [17], [18]. Bro is a passive, open-source network traffic analyzer. It is primarily a security monitor that inspects all traffic on a link in depth for signs of suspicious activity. The most immediate benefit that we gain from deploying Bro is an extensive set of log files that record a network's activity in high-level terms. These logs include not only a comprehensive record of every connection seen on the wire, but also application-layer transcripts such as, e.g., all HTTP sessions with their requested URIs, key headers, MIME types, and server responses; DNS requests with replies; and much more.

3.1 Malicious Domain Detection Method

This method is based on a blacklist of malicious domains which is publicly published [19], [20], [21], [22], [23], [24], [25]. As it is shown in Figure 2, we monitor the network traffic and filter only DNS traffic. Then we match the query of each DNS request with the blacklist. The blacklist of malicious domains is automatically updated each day and the detection is in the real time.

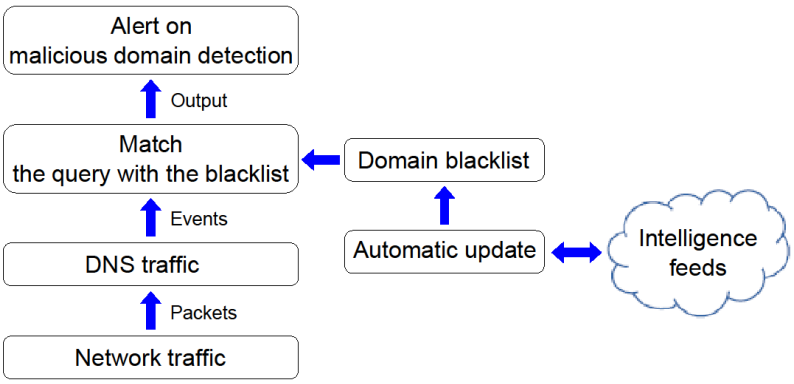

Fig. 2. Proposed methodology for malicious domain detection
Source: own

In implementation of malicious domain detection method, we have made use of *Bro Intelligence Framework* [26], this framework enables you to consume data (which is here the domain blacklist) from different data sources and make it available for matching.

As an output for this detection method, we write the detected information (time of detection, malicious domain and connection source and destination IP addresses) into a special log, *blacklist_detection_domain.log*. We also send an alert email about malicious domain connection detection to RT (Request Tracker) where the network security team can perform additional forensics and response to it [27]. As we have mentioned before, this detection method is one of other detection methods for detecting other techniques used in APT attack life cycle. The output of this detection method will be correlated with the outputs of other detection methods to raise an alert on APT attack detection; therefore we generate *domain_alert* event about malicious domain detection to be used for alert correlation [28].

3.2 Malicious File Hash Detection Method

This method is also based on a blacklist of malicious hashes which is publicly published [29], [30]. As it is shown in Figure 3, we monitor the network traffic and for each file seen transferred over the connections we calculate MD5, SHA1 and SHA256 hash using special functions in Bro. Then we match the file hash with the blacklist. The blacklist of malicious hashes is automatically updated each day and the detection is in the real time. In implementation of malicious file hash detection method, we also have used *Bro Intelligence Framework* to match the calculated hashes with the blacklist.

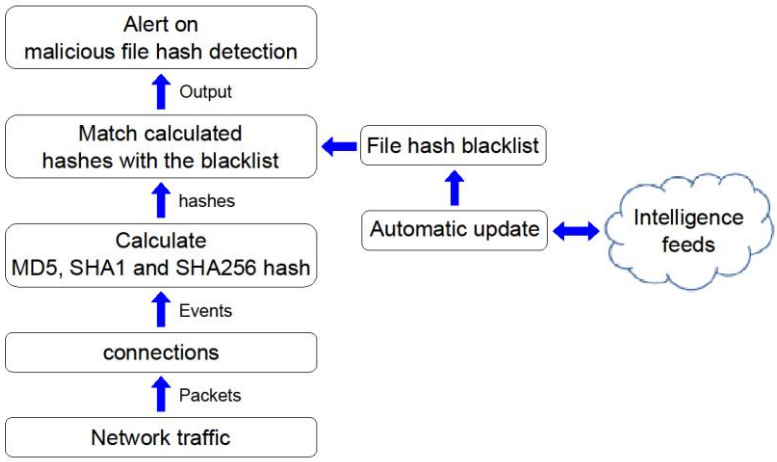

Fig. 3. Proposed methodology for malicious file hash detection
Source: own

As an output for this detection method, similar to malicious domain detection method, we write the detected information (time of detection, malicious file hash and connection source and destination IP addresses) into a special log, *blacklist_detection_hash.log*. We also send an alert email to RT and generate *hash_alert* event to be used for alert correlation.

4. EVALUATION AND RESULTS

We set up a server hosting our detection methods and passively analyzing the campus live traffic. The monitoring was performed for one month. We correlated the list of hosts involved in malicious domain and malicious hash connections with results of a malicious IP address detection method. As it is shown in Fig. 4, 22 hosts were detected involved in malicious domain connections, 16 in malicious file hash connections and 37 in malicious IP address connections. Of these, 14 hosts were detected involved in both malicious IP and domain connections, 9 in both malicious IP and file hash connections and 5 in both malicious domain and file hash connections, indicating that they were infected with malware.

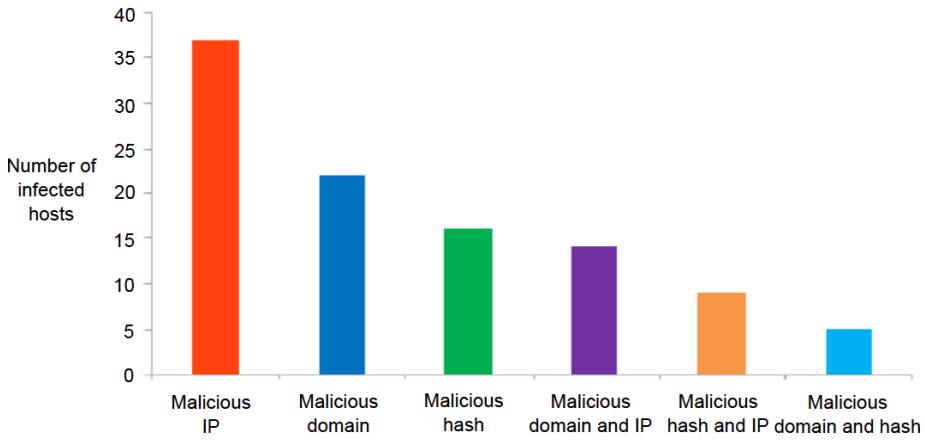

Fig. 4. Detected hosts by malicious domain, file hash and IP detection methods
Source: own

CONCLUSION

In this paper we have presented two blacklist-based detection methods for detecting a spear phishing email, which is the most common technique used in APT attack. The first method is malicious domain detection method, and the second one is malicious file hash detection method. The blacklists are automatically updated each day and the detection is in the real time. We applied our detection methods on campus live traffic and found that they can detect malicious domain and file hash connections in the real time. For future work, the outputs of both detection methods will be correlated with the outputs of other detection methods (like Tor connection detection method, domain flux detection method, disguised exe file detection method and malicious IP detection method) to raise an alert on APT attack detection.

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INTERCONNECTIVITY SIMULATION TOOLS - TOWER SIMULATOR OF AIR TRAFFIC CONTROLLERS

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Abstract: *The development of information technologies, dynamic environment and hardly predictable situations are the main attributes of why we must continually look for new and effective solutions for education and training of personnel. Air traffic controllers are the latest powerful link in the air traffic management system and have an absolute responsibility for their decisions. In order to avoid air traffic controllers acquire bad habits during their trainings a whole variety of trainings at credible and certified simulators are needed at such as real HiFi sim or alike. Taking into account the financial capacity, the state of domestication of current simulation tools was designed and a new tower simulator platform for constructive and virtual simulation was built. The article presents actual results and the contributions of experimental computer assisted exercises and also defines the area of training and points to the fact that simulations are optimal alternative solutions of the training process linked to theoretical as well as practical knowledge.*

Keywords: simulation tools, air traffic management, constructive and virtual simulation, OTB, LETVIS.

INTRODUCTION

While the number of airplane accidents caused by technical failure has been decreasing during the last decades the number of airplane accidents caused by human factor has been decreasing much slower. This implies that measures intended for reducing the occurrence of human failure were not as efficient as the measures intended for technical failure. It is obvious that when we talk about increasing the security in the air transport in general, more emphasis is put on human error as a cause of failure. Good air traffic controllers are not being born. One might have an excellent eyesight, hearing, reflexes or knowledge of procedures, but an experienced controller is a result of a long term training and continuous procedures directly or indirectly related with the air traffic control. Air traffic control is a specific area where accuracy and speed of reactions is required as well as some kind of comfort which allows the air traffic control members a maximum concentration to ensure a responsible performance of their functions. Job performance is associated with high demands on personal qualities, knowledge and skills as well as the personal responsibility of an air traffic controller. Air traffic controller is the last executive part in the air traffic management system and takes full responsibility for his decisions. In order to avoid air traffic controllers acquire bad habits during their trainings a whole variety of trainings at credible and certified simulators are needed at such as real HiFi sim or alike.

1. SIMULATION TOOLS

The introduction of simulators and drive-simulators in the Air Force has begun in the ‘70s of the last century; however the technical level of these simulators was corresponding to that

time. The production and introduction of the new generation of simulators based on virtual reality has begun in the second half of 1990s. We can say that Slovakia was in the forefront of the former Warsaw Pact countries.

New methods and forms of staff preparation using simulations and simulation technologies cannot in any case replace „On The Job Training“ and has to be an inseparable part of their training.

Situation in recent times can be characterized by a series of budgetary measures and the need to realize training on certified simulators (presenting significant financial difficulty) while keeping security in the area of the air traffic management.

Simulators and drive-simulators are irreplaceable in times of lower flight activity when it’s necessary to keep the right habits, practice procedures in special occasions during flight and other activities that rarely occur in so called „live“ operations and are very difficult to simulate without disrupting the flight security.

Simulation technologies monitored, from the beginning of their inclusion to training, mainly the requirement of increasing the effectivity and interoperability of staff preparation for events and situations that can be difficult to simulate in reality.

It is financially difficult to build highly specialized simulators and therefore, in the recent period, a domestication of simulation tools enabling their wider use and interconnection of synthetic environment occurs.

This interconnection enables broad-range utilization and creates new possibilities in the area of training and preparation, not only in the air forces.

The advantages arising from the implementation of different types of simulation technologies point to the increased interest and social need of their exploitation in the process of preparation of air traffic controllers.

Each simulation is realized on a certain model and based on mathematical methods and on a wide use of modern computer, information and communication techniques and technologies. Process and methodical procedure of its realization mainly depends on the type of used simulation and parameters of the created model on which simulation is realized. Simulation has lots of benefits which incite its continuous development and dissemination into new application areas.

Simulations in Slovak military aviation are currently fully established in training in the form of constructive simulations and virtual simulations.

1.1 Constructive simulation

The term constructive simulation describes a simulation which is being realized essentially through logical-mathematical models of deterministic or stochastic character.

It is the most used universal method with a wide application spectrum. This simulation is realized by distributive form using computer and other information technologies. Its primary

use is to train commanders and officers in their decision making process, verification of information flows, and also solving real mission of the armed forces.

In the conditions of Slovak Republic is the constructive simulation represented by the simulation tool „One Semi Automated Forces Testbed Baseline“ (hereafter „OTB“). Entities simulated in OTB are able of independent decision making which means they can move, perceive, communicate and respond to the occurred situation without the intervention of an operator. Simulation is partly autonomous. Operator performs only critical and tactical decisions and is able to intervene anytime to the automated behaviour of entities.

Entities can communicate and interact within the constructive simulation as well as virtual simulators and drive simulators.

OTB is a system with open software architecture. Architecture enables real time parameter modification. Model parameters used in the construction of OTB are included in the parameter database. User can simply add models and group of entities, simulate their behaviour, change reaction to the different situation, and also allow observation of synthetic environment in real time with the possibility of monitoring the state, for example aerial entities.

OTB system can represent aerial and ground entities, and also entities of operating personnel. Their behaviour is identical with real conditions and influenced by geophysical parameters of terrain databases.

3D visualization software of virtual space is an integral part of the constructive simulation system. Its task is to reliably visualize objects, structures, entities and other parts of terrain and simulation as such at all.

1.2 Virtual simulation

It is the most modern type of simulation which is rapidly and constantly growing. In simple words, virtuality presents modelling and simulation of complex or partial objects and processes of armed fight with the realization at the virtual models. Means of the virtual simulations are simulators – drive-simulators. In a larger extent, virtual simulation is used by an individual, and it is used for acquisition of the environment and getting practice and skills.

However, linking up the different types of virtual simulators in the network type for example LAN allows „to create“ a distributed interactive virtual simulation. Its effect is multiplied by the number of simulators, given that, it allows large interaction of subjects which are involved in it.

Air Visual Information System (LETVIS) is used as a drive simulator in terms of Air Force of the Slovak Republic. This system is mainly used for the collection, elaboration, presentation and distribution of radiolocation information for ensuring tasks in air traffic services and for performance of tasks connected with commanding and managing of active means of air and army air defence. Main task of the training on this simulator is practical training including simulation of unusual and extremely difficult situation for development and maintenance of practical skills of members of the air traffic control system.

Architecture of simulator is modular in order to prevent the reduction of pseudo pilots, mutually independent parallel running exercises and methods of input/output data.

Simulator is designated for the training at the following types of workplaces of air traffic control and navigation of Air Forces:

- Air traffic controller of the OAT sector in the area control centre,
- Air traffic controller at the workplace Tower,
- Radar controller of flying and controller of landing at the workplace Radar Centre,
- Ground control interceptor at the workplace Operational centre.

2. SIMULATION INTERCONECTIVITY – 3D TWR SIMULATOR

3D simulator of the Air Traffic TWR workplace was designated as an interconnection of already used simulation tools with the aim to minimize financial charges, using the hardware and software capacity, and also human potential without the need of realization of specialized trainings.

Simulator is based on more types of simulations which communicate among each other by more types of communication standards.

Simulator of the air traffic control uses for the connection with other simulators the AviationSimNet® technology which was created in order to connect air simulators and air traffic control systems.

AviationSimNet® technology is based on these communication standards:

- High-Level Architecture (hereafter „HLA“) for exchange of simulating data[1],
- Transmission Control Protocol/Internet Protocol (hereafter TCP/IP) - protocol for reliable connection[2],
- Distributed Interactive Simulation (hereafter „DIS“) for radio communication[3].

AviationSimNet® 2.1. contains its own superstructure of HLA which, after connecting units into federation, requires from the connected units a sequence of information about their readiness for starting the simulation. In addition, it uses its own information during the simulation to stop and continuation of the simulation and information about the disconnection of unit from federation.

Constructive simulation system OTB was in this connection designed for simulating airport ground operations. Units and modules used for airplane landing and takeoff, and manipulation of airplanes such as scrolling, its pushing and pulling were supplemented to OTB. In order to

[1] High-Level Architecture is general purpose architecture for distributed computer simulation systems. Using HLA, computer simulations can interact (that is, to communicate data, and to synchronize actions) with other computer simulations regardless of the computing platforms.

[2] TCP/IP - Transmission Control Protocol/Internet Protocol - primary transport protocol. It includes a set of protocols for communication in the network, and it is a major protocol in global network.

[3] Distributed Interactive Simulation is a standardized protocol. It presents the platform for conduction of war gaming in real time via more host computers, and is used worldwide, primary for military use.

illustrate the whole situation at the airport, there were implemented entities and functionalities (task and editor) for controlling aircraft landing gear, lightening units and lights of the airport. OTB does not contain the support for HLA communication standard; it supports only communication through DIS protocol.

VR-Vantage Stealth – 3D imaging software used for five channel 3D visualization views from TWR workplace contains the support for communication through DIS and CIGI[4] in its own version. Communication through HLA requires relevant plug-in of the given version of HLA protocol for library librti *.dll and libfedtime*.dll. New 3D models of entities and new terrain databases of military airports were created for this application.

For the connection of systems using communication protocols HLA and DIS, software OneSAF v5.0 International was designed and is used as a new system of constructive simulation.

This software was chosen due to the following reasons:

- Allows to modify the source code for HLA interface, so that, this interface could support also the sending of initialization messages after the connection into federation with AviationSimNet® technology;
- supports connections by using DIS protocol;
- allows the implementation of automatic extension of landing gear and lights for the aircrafts simulated by LETVIS system;
- allows the support implementation for manual control of landing gear and lights simulated by LETVIS system.

Restriction that comes with using OneSAF is that one instance of OneSAF can only have one type of communication interface configured, that is, there are two instances of OneSAF necessary to connect HLA and DIS. To connect systems based on HLA standard, it is required to use MAK RTI[5] application. This application provides services for RTI. Application presents the implementation of HLA standard into the software libraries, and it supports the creation of federation and connection of units into the created federation. MAK RTI without licence has full functionality, but it has restriction for connecting maximum two units. This amount of units is sufficient for the simulator of tower control.

[4] Common Image Generator Interface – is open simulated protocol for communication between the host entity and image generator.

[5] Runtime Infrastructure - high performance communication infrastructure, which is needed for each program communicating via HLA protocol.

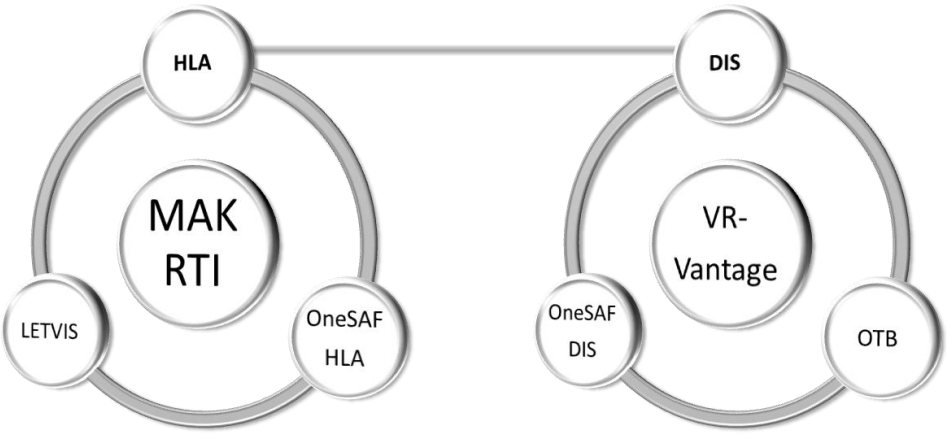

Fig. 1. Connection diagram of simulation tools and protocols
Source: own

2.1 Supported entities and terrain databases

For the tower simulator were created new entities into the individual systems. A different 3D imaging of the same unit was defined in order to keep the variability of training. Into the OTB were created new aerial and ground entities which current database did not support. For each type of imaging, its own unit in OTB had to be created. In OneSAF were created only aircrafts from the required units. Aircraft in OneSAF had to be created due to mapping of aircraft at HLA interface (aircraft vs. LETVIS identification) and DIS interface (aircraft vs. DIS entity number). Databases of all simulative tools are correlated to each other (with exception of some aerial entities). This means that LETVIS database system (BADA[6]) is identical with databases in OTB and OneSAF. BADA of LETVIS system does not support models for helicopters, and in FOM[7] a definition for the object of helicopter type is missing. In order to display aerial helicopters simulated in OTB system on the radar screen of LETVIS system, HLA interface of OneSAF system was set in such way that in HLA interface were helicopter represented by other type of ultralight aircraft. For simulation of ground situation and visualization of airport were created special entities for the airport lightening and new terrains of military airports in OTB system in 2D interface and in VR-Vantage presentation in 3D interface were generated. A great emphasis is being put on the terrain databases with the aim of having a detailed representation of virtual space with maximum displaying of details as terrain characteristics, and also details of individual entities.

For this purpose were generated terrain databases with 10x10 km dimension. This dimension represents also direct visibility in the case of good weather conditions.

3. BENEFITS AND OUTLOOKS

Interconnecting simulation tools, defined above, in order to create a new simulator for the needs of air traffic management is a clear demonstration of the need for implementation of

[6] Base of Aircraft Data – aircraft database developed and updated by EUROCONTROL through the active cooperation with the producers.
[7] Federation Object Model – describes shared objects, their attributes and interactions for the entire federation.

connecting various simulations into one synthetic environment. Air simulators are costly investments, and therefore their expansion of additional modules, accessories and linking with other simulators relying on virtual reality needs to be divided into several stages and then gradually build so called "Aviation Training Centre" as a complex system. It should be noted that the procurement of new specialized simulators is financially unbearable for educational organizations; therefore the use of existing capacities and infrastructures is much more efficient. We can objectively say that this new simulator based on interconnectivity of simulation tools is about seven times cheaper than when purchasing a new one. But we must also mention the fact that buying a new specialized simulator enables to practice only specialized areas and the personnel is needed to be trained, making the process considerably more expensive. These disadvantages are eliminated when linking already established simulation tools in simulation centres.

By this interconnection we have defined a practical platform for connecting any simulation tool whose location can be virtually anywhere in the world. This is how we achieve interoperability of simulation systems used in aviation in Slovakia with systems used in other NATO countries and also in joint tactical training and preparation for air operations.

During the last 10 years different types of simulation tools were interconnected[8], but only to transfer certain information to other simulator without the possibility of interaction. Tower Simulator, in other words linking different simulation tools, aimed at the interaction of different entities and modules is considered fraud. This connection has not been made yet. The link is preset to enable the access of different air simulators to the synthetic environment in the form of full/basic mission simulators or air reconfigurable simulators and thus obtain a maximum level of training. Such links can be defined as a distributed interactive simulation, which represents a collaboration of models whose behaviour, activities and happening are taking place in real time. In this environment, it is not just about the use of a common database, standards and protocols, but mostly about the higher forms of interaction of participants working towards a common goal, even though they are located in different places.

By full-fledged implementation of blended simulation[9] into the environment of education and training would the Air Force of SR obtain a comprehensive modern aviation training system that would allow practicing a wide range of missions. Total benefit would not only be on the level of partial exercises alone, it would help to highlight the deficiencies on the management level and problems in coordination and synergy between the various levels of command and control. Among the possible scenarios we will mention a few:
• COMAO (Composite air operation) - deployment and joint action of a larger number of aircraft and helicopters of various air bases with unified command with the support of the air defence,
• SAR (Search and Rescue) - implementation and coordination of drills during natural disasters, with an emphasis on rapid decision-making process,
• overcoming simulated enemy of the air defence and on contrary air defence against airplanes and helicopters,
• joint action of aviation and air defence with a focus on interaction,

[8] For example, in 2007 linking identical simulation tools of OTB constructive simulation in various simulation centres of SR or in 2009 linking OTB system with means of instrumented manoeuvring training MILES.
[9] By 2010, using the term federation simulation.

• simulation of complex air action involving all reconnaissance stations with the emphasis on special in-flight cases and the practice and playback of problem situations,
• simulating the interception against flight airspace intruders (renegade) involving all components of blended simulation.

CONCLUSION

Simulator which was created by linking up simulation tools with the support of standardized protocols simulates the operation of the airport and enables to create complex virtual space of the airport. Implementation of new modules, entities, tasks for simulating activities and linking up individual types of simulations and 3D visualizations allowed creating the airport TWR workplace simulator. Simulator uses the OneSAF simulation environment and as a GUI uses the simulator of OTB constructive simulation. By this simulator it is possible to perform a training of the airport TWR workplace staff, simulate and visualize operation of the airports. Tower simulator enables to simulate day and night mode, twilight, reduced visibility and a wide range of weather conditions such as rain, fog and snow. Due to the fact that the tower controller manages aircrafts - entities in sight of the airport tower, the training with this type of linking becomes full-value, because the tower controller has the output of the radiolocation information for disposal. This simulator creates unique work environment which is identical with its real work environment.

Fig. 2. TOWER simulator, 3D
Source: own

The aim of linking simulations, creating new synthetic environment and blended simulations has positive influence, especially in matters of training, education, and also in financial saving. Implementation of this simulator extends training and educational possibilities of the simulation centres and the possibility of providing their services in favour of any airport, respectively airport surface.
In the near future, the aim of the simulation technologies in the aerial environment is to create a big virtual environment which will involve not only aircrew (pilots, aerial technicians), but also ground forces personnel and other support units who will take part in the fulfilment of joint tasks and objectives.

The result of the created blended simulation supporting interaction of individual types of simulations would be the achievement of high level of interoperability and compatibility.

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JAVA BASED DEVELOPMENT OF ONLINE EXPERIMENTS

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Abstract: *The paper is devoted to the development of remote experiments, i.e. experiments that approaches a real plant and make it available for experimentation to remote users. Our solution is based on Matlab/Simulink simulation environment whereby all levels of application architecture are built in Java programming language. Matlab environment serves for control of real plant and Java is used for communication with Matlab and for preparation of web application. The solution is based on a new developed Matlab Adapter tool that enables to build Matlab based online applications. It was built in the form of web service that is available via REST API. In this way the client application can be developed in any programming language.*

Keywords: online experiments, Matlab, Simulink, JMatLink, MatlabControl, Java, REST.

INTRODUCTION

Experimentation is very important part of engineering study. Students of technical specializations need to obtain not only theoretical knowledge but also practical skills. Without the real work in the laboratory it is not possible. However, there always exist some limitations (time, costs, space, technical staff, etc.) that prevent to give students as much space for individual solution of practical problems and tasks as it is really needed and required.

Online experiments bring partial solution of this problem. They start to be not so rare and their number is constantly growing. Some examples of online experiments can be found e.g. in [1-11]. Development of these examples was done using various technologies both on the server and client side, as well. The paper demonstrates service based approach to remote control of plants.

The presented approach was tested on the educational laboratory thermo-optical plant (its picture is presented in one of widgets in Fig. 3) that enable to control two physical quantities: temperature and light intensity that are influenced by the built-in bulb, led diode and fan. The experiment is mostly used as the system with one input and one output. Other inputs that are not currently used for the control of the required output can be used as the disturbance variable.

The whole system can communicate with a computer via a USB interface. No special card is required. Since the plant is quite small and compact, it is not problem to borrow it to students also for home use. However, in such a case we would need one plant for one student. In the case of remote setup of the experiment one plant can serve to several students. Of course, the good reservation system is mandatory. The ideal scenario is to introduce the plant to students during one-two face-to-face laboratory presentations where they could try to accomplish first

real measurements and control. After this introductory phase, they can start to work with the plant also via Internet.

1. ONLINE USE OF MATLAB

Matlab was primarily oriented to computations that are carried out on a local computer. However, in the present time with Internet as main communication medium, it is desirable to provide Internet-based control of Matlab applications. There exist several solutions how to use Matlab online. Some of them are delivered directly by MathWorks Company, Inc. and other ones are provided by third parties.

1.1 Solutions supported by MathWorks

The Matlab Web Server [12] was the first standard solution that enabled to deploy Matlab capabilities over Internet. Later, this very simple approach was substituted by other three products: Matlab Builder for Java (generating Java classes from Matlab functions), Matlab Builder for .NET (generating independent .NET or COM components from Matlab algorithms) and Matlab Compiler. The newest version of Matlab (R2015a) brings another change of the product structure. It introduces Matlab Compiler SDK™ that extends the functionality of Matlab Compiler to enable to build C/C++ shared libraries, Microsoft .NET assemblies, and Java classes from Matlab programs. Neither from products Matlab Builder for Java and Matlab Builder for .NET will be supported more individually. Anyway, the components generated by Matlab Compiler SDK can be integrated with various end applications including web applications.

1.2 Solutions based on Java

In [8] one can find several third party solution that enables to communicate with Matlab via Java programming language. The web page [13] also tries to summarize various similar approaches and introduces several Java APIs that enable to interact with Matlab. The benefit is that all introduced solutions are categorized into 4 different categories:

- controlling the Matlab application,
- controlling the Matlab engine from Java,
- controlling multiple sessions of Matlab from Matlab using Java,
- running or modifying Matlab code without Matlab,

that facilitate orientation for new interested developers.

1.3 Solutions interacting with Matlab from Python

Complementary to previous solutions there exist a group of solutions enabling interaction with Matlab from Python scripting language that can be used for building server side of web applications. From this set we can introduce four solutions:

- PyMat [14] presented possibly one of the first Python to Matlab interfaces. It exposed the Matlab engine interface allowing Python programs to start, close, and communicate with a Matlab engine session. In addition, the package allowed transferring matrices to and from Matlab workspace. On the base of this solution pymat2 [15] was developed.

- OMPC [16] allowed running MATLAB's m-files using Python interpreter. OMPC read m-files and translated them into Python compatible code. The problem is that the solution was developed just for Python version < 2.5.
- mlabwrap [17] allows to call Matlab via a python API. Mlabwrap is a high-level Python to Matlab bridge that lets Matlab look like a normal python library.
- pymatbridge [18] is another simple interface that allows Python to call Matlab functions. The advantage is that Matlab runs in the background as a server so it is not necessary to execute it each time when a Matlab function is called.

1.4 Other solutions

Of course, there also exist solutions that do not belong to any from previous categories. Let us mentioned at least two of them:

- Plotly Matlab Library [19] in very simple manner enables to publish Matlab figures to the web.
- Modelit Webservice Toolbox for Matlab [20] enables to create web services based on Matlab code and present results of Matlab computations on the web. It requires Apache Tomcat software, permission to set up port forwarding on the router and Matlab 2008b or later. The advantage is that the latest update of the toolbox was done in February 2015.

There can arise a question: why we are trying to find some other solution how to bring Matlab online when there exists a standard solution supported by MathWorks? The answer is quite simple. There were some attempts to use Matlab online still before introducing the Matlab Web Server. Its emersion brought a tool that enabled to build Matlab based online applications in a very simple manner. However, after some time its support was stopped. Subsequent standard solutions used completely other approach and were more complicated. All codes had to be rewritten. There were probably reasonably doubts, how long the new products will be active. Therefore the orientation to third party solutions was quite natural.

The paper introduces a new alternative to the standard Matlab solutions. We decided to create web service to Matlab environment/Simulink environment based on selected Java solutions. We devoted our attention to JMatLink [21] and MatlabControl [22] products. They both are based on Java programming language and can directly communicate with Matlab/Simulink.

2. MATLAB ADAPTER

Our solution is based on the Matlab adapter [23]. It is new developed server application that enables to offer Matlab functionality via web service. Since the control of the real plant is accomplished directly in Matlab/Simulink, we need to influence experiment via this environment. We developed several REST methods that enable to set parameters, to run simulations or experiments and to follow results.

The solution presented in Fig.1 consists of several components:

- *MatlabService* represents entry point to the application. It processes REST requests, calls appropriate MatlabFacade methods, and generates responses for the client application.
- *MatlabFacade* provides simple API for all tasks required by MatlabService. It encapsulates all methods of MatlabConnector instance and all needed operations into

a single method call on MatlabFacade instance. It makes the use of the service more transparent.

- *MatlabConnector* presents abstract Java interface that provide unified communication interface between Java and Matlab. The presented solution currently offers two implementations of MatlabConnector interface: MatlabControlConnector uses Matlab Control library and JMatlinkConnector uses JMatlink library. As it is evident form Fig.1, the MatlabConnector is also opened for next implementations of other solutions.

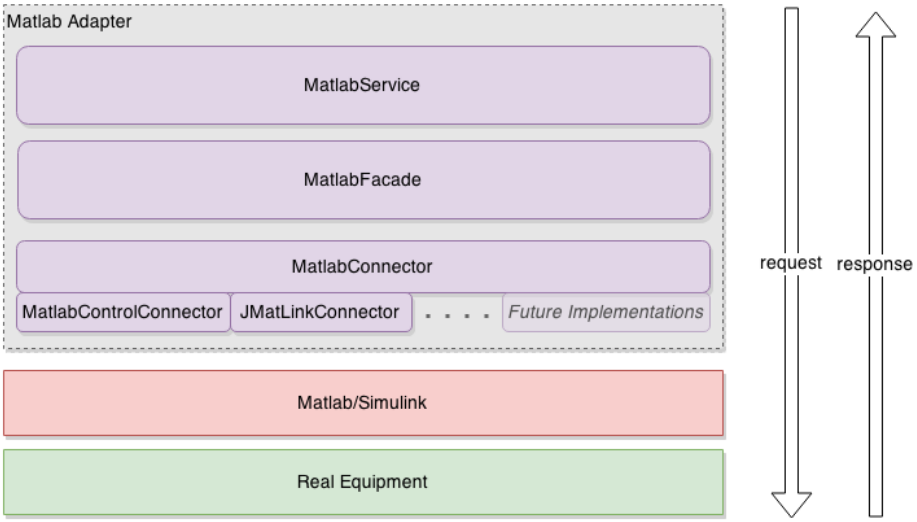

Fig. 1. The proposed architecture of the Matlab adapter
Source: own

3. WEB APPLICATION

On the base of the developed Matlab Adapter, it is possible to create the corresponding web application. One example is shown in Fig. 2 and Fig. 3.

Fig. 2 demonstrates variability of the developed web application. This part of application enables the privileged user to choose what dialog parameters will be accessible and editable to students (remote users) during the experiment execution. The whole process is done via illustrated Web User Interface. The administrator can see the list of all blocks with all dialog parameters that are contained in the scheme. The advantage is that the list is prepared automatically on the base of Simulink scheme by the web application and therefore the name of the variable cannot be mixed up. The parameters for experiments are chosen only by the selection of corresponding check box.

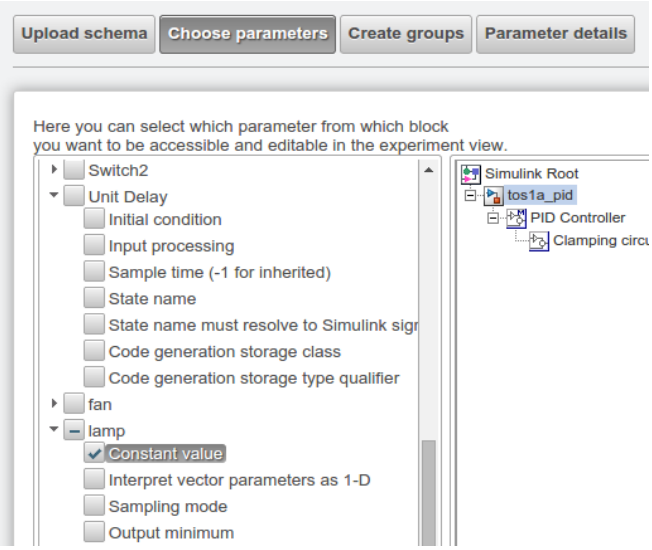

Fig. 2. Selection of interface parameters
Source: own

In Fig. 3 one can see so-called dashboard of the developed web user interface. It enables to execute the remote experiment and monitor its running. The dashboard contains several widgets: main control toolbar, parameter widget, graph widget, scheme view widget and video stream widget.

Mentioned web application and also the whole online laboratory architecture is described in more details in separate article [24].

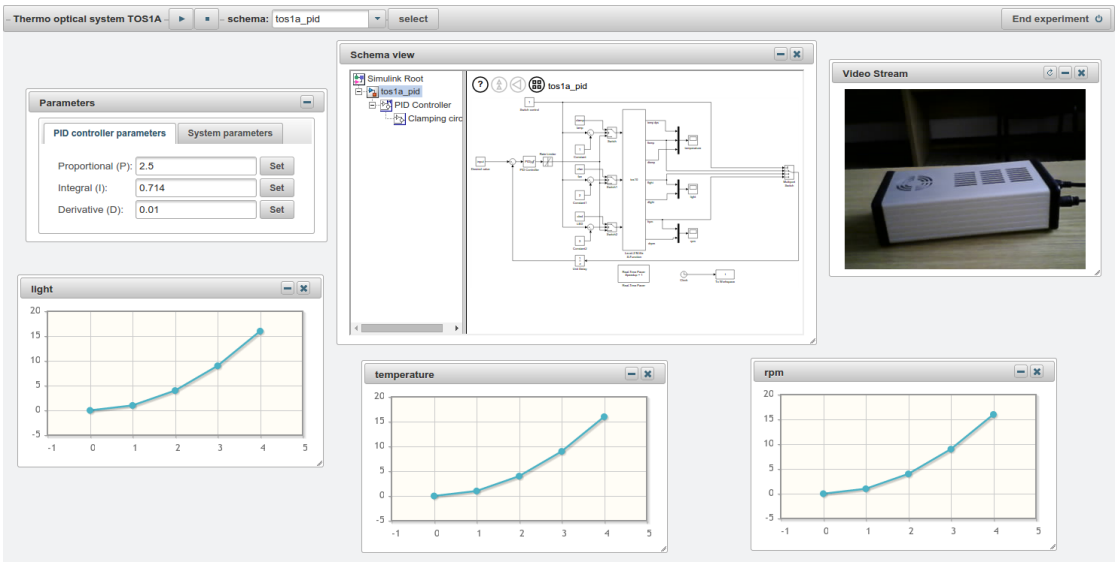

Fig. 3. Dashboard of the web application
Source: own

CONCLUSION

The developed application was verified for the system of the educational thermo-optical plant. The biggest problem was to set up communication with the plant in frame of Linux Ubuntu operating system. However, since the plant is based on Arduino platform, it was sufficient to install the support for Arduino directly in the operating system. Then, Matlab can communicate with the Arduino board over a USB cable.

It is to note that the described method of implementation is general and can also be used for other systems. The basic condition is that we need to be able to communicate with the given plant from Matlab/Simulink environment. Then, all communication with the plant can be accomplished via the prepared web service. In future we would like to extend the use of the platform also for magnetic levitation system provided by Humusoft company.

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E-LEARNING PROJECT – POWER ENGINEERING DICTIONARY

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Abstract: *Energy is undoubtedly a driver of economic growth - a crucial input to nearly all of the goods and services of the modern world. Stable, reasonably priced energy supplies are a key factor to maintain and improve the living standards of billions of people. This paper introduces the interactive e-learning project Power engineering dictionary developed in open source learning platform Moodle. The main aim of the project was to help children, youth and general public to clarify some questions from the field of power engineering, to bring them answers and especially to attract their interest. The ambition of authors was to create the dictionary with the large database of terms from energy sector and cover the most common generation, transmission, consumption and energy pricing terms. The access to Power engineering dictionary is free for all who is interested in this topic.*

Keywords: Electric Power Engineering, interactive e-learning project Power Engineering dictionary, Moodle.

INTRODUCTION

Electricity is an integral part of our everyday life and is directly linked with the survival of the human population. As Peter Voser explains in [1] "Without heat, light and power you cannot build or run the factories and cities that provide goods, jobs and homes, nor enjoy the amenities that make life more comfortable and enjoyable." Many of us take it for granted and use the electrical energy without understanding its complexity. Will the society build the future technologies without knowing what processes are required for the generation and transmission of electrical energy? New technologies are emerging. The question of saving electrical energy comes to the fore. To familiarize the general public with this topic is to create environmental and energy awareness that is one of the essential requirements!

One of the ways to quickly obtain the first information are dictionaries. Today in the age of the Internet come to the field of interest online versions of dictionaries. Power engineering and online dictionaries? What is the state of art? At first we take a look at Slovak sources. Online Energy dictionary of Nuclear and Decommissioning Company Javys [2] is really notable, focused on energy topic. Most of the terms are focused on nuclear energy. It is well arranged, has large number of words. The words have good description, not only terse definition. The words are linked with each other. Terms in Energy dictionary from the Slovak Innovation and Energy Agency (SIEA) [3] are also well descripted, but terms are not linked to each other. There are too few words and no pictures. Similar attributes possess also Dictionary of basic terms of electricity [4]. This dictionary is not online, but is available for the download. Other dictionaries are generally small glossaries containing only the words needed to better understand the data presented on the website [5], [6] and [7]. Among dictionaries on a good level we can also mention the Dictionary of terms available on site

Energy consultant PRE [8] and Energy dictionary on website Energetics (City of Pilsen) [9]. But both dictionaries are without linking of words and without explaining pictures and are available only in Czech language. The most of online power engineering dictionaries are in English language [10 - 13]. Electropedia [10] on International Electrotechnical Commission website offer the explanation for many words oriented on electrical engineering in 10 languages. The words are not linked and there are not enough pictures. A large number of words without pictures provide dictionaries and Glossary (U.S. Energy information Administration) [11] and Energy Central Glossary [12]. To mention one curiosity, there is the Standard electrical dictionary [13] – digitalized dictionary - book from 1897.

The considerations mentioned above and analysis of the free online dictionaries focused on Power engineering has led the authors to create e-learning project the Power engineering dictionary. Authors have focused on the general public and used their experience from previous projects aimed on popularization of Power Engineering. For instance Energy Dictionary published as a book [14] created especially for primary and secondary schools. The aim of this paper is to introduce the e-learning project Power engineering dictionary.

1. POWER ENGINEERING DICTIONARY

Power engineering dictionary was created in dictionary activity module in open source learning platform Moodle (Fig. 1). It allows participants to create and maintain a list of definitions, like a dictionary with full match lookup.

Fig. 1. The user view on Power engineering glossary
Source: own

The auto-linking feature will highlight any word in the course which is located in the dictionary. The words are also linked with each other. The result is that terms are easier to understand. Our original intention was to create a dictionary that uses appropriate language to explain individual terms, while give the attention to the renewable energy sources. In the process of e-learning material creation we have cooperated with experts from the Energy sector that are originally focused on Renewable energy sources [15 - 19]. Later we have gradually extended these intentions and now the vocabulary represents all energy sources [20 - 22]. Our ambition now is to create the dictionary with large database of the terms from energy sector and cover the most common terms used in energy generation, transmission, consumption and energy pricing.

The Power engineering dictionary consists more than 820 terms, but we are continuously updating and adding new terms. Every item has its own English equivalent (Fig. 2), what allows students a better orientation during online searching of individual terms. More than 129 of the terms in the dictionary are accompanied by the diagrams (Fig. 3) or images (Fig. 2). 60 terms have their own original illustrations (Fig. 4) and 6 terms are supplemented by the charts. In this way we ensure the most interpretative display of the terms with a goal to give the learner a better understanding and at the same time we took his attention.

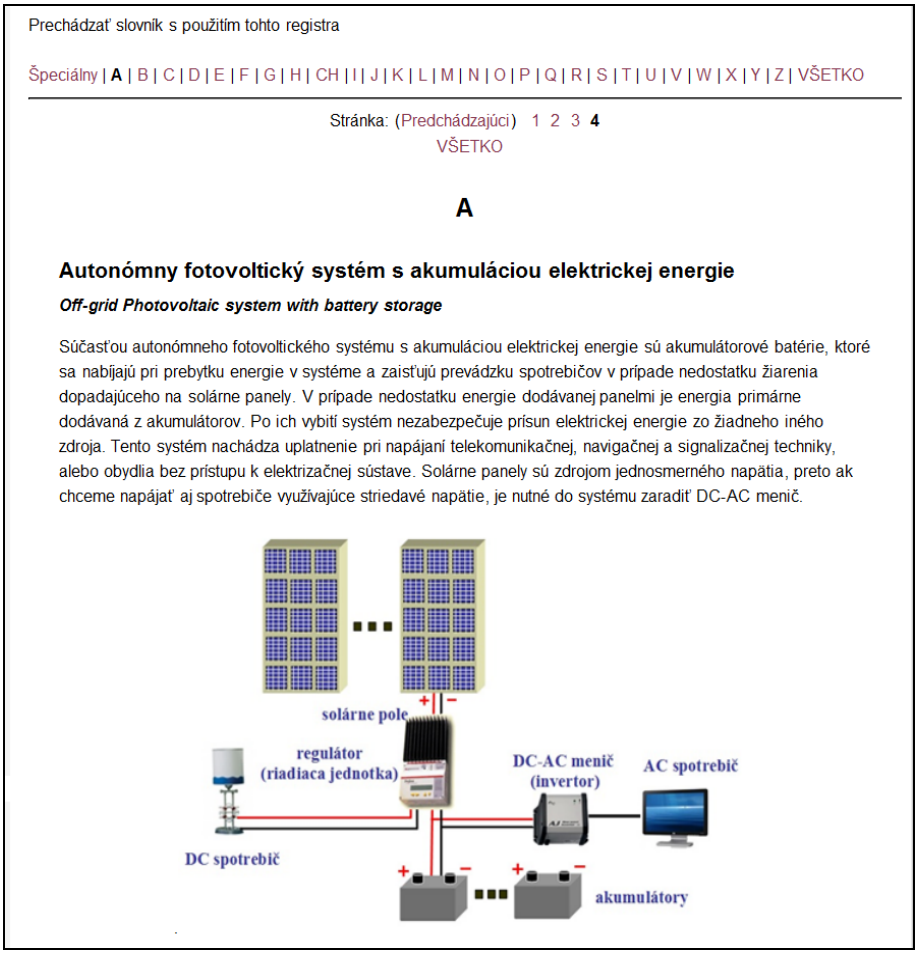

Fig. 2. The term – Off-grid system with battery storage
Source: own

Search engine allows finding words in alphabetical order or by their category. We have defined three basic categories only – Power plant, Power and Energy sources – Fuel. In order to acquire quick overview of available vocabulary, we created an alphabetical index of terms,

where each term is directly linked with the same term in the dictionary. To create a dictionary, we used information from many sources. The most we draw information from the Energy dictionary [2]. These sources are listed directly under each term (Fig. 4), as well as a summary list of references in the body of the chapter. As we continually update our vocabulary so we do with the list of references.

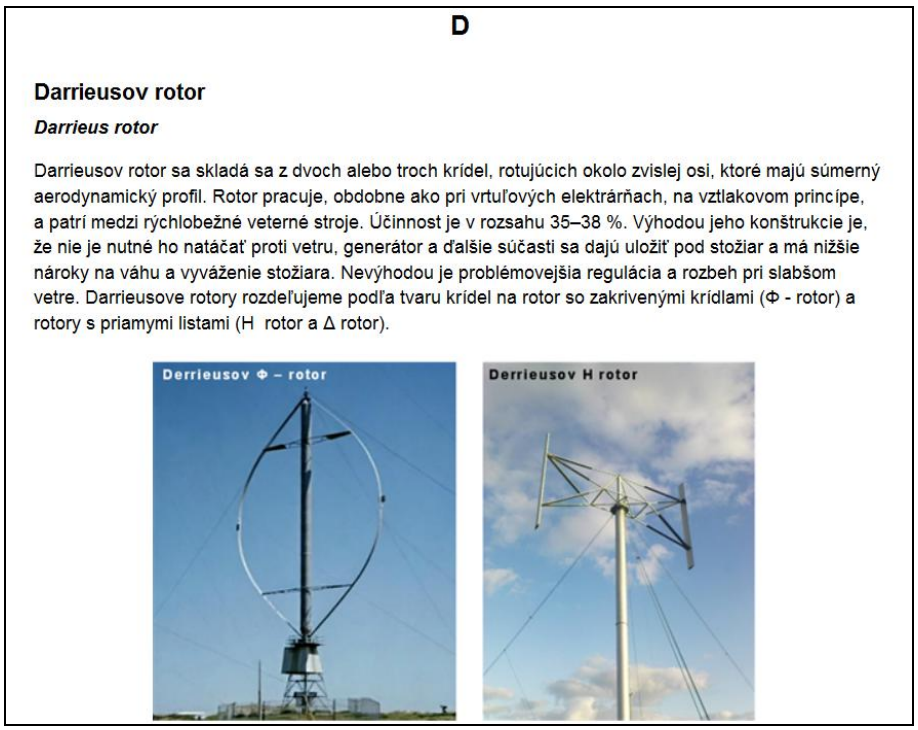

Fig. 3. The term Darrieus rotor
Source: own

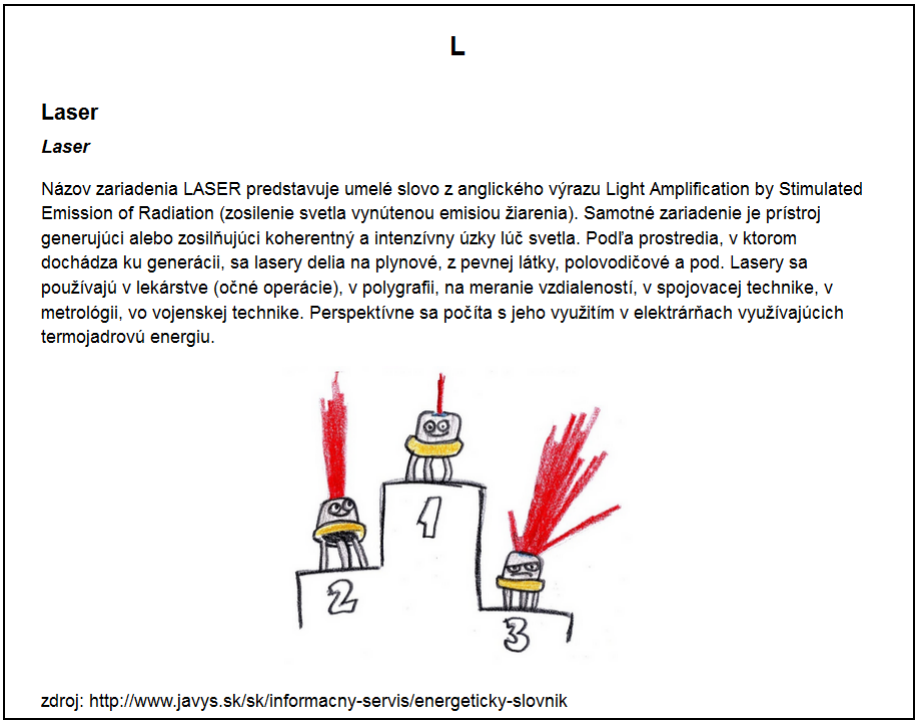

Fig. 4. The term Laser
Source: own

CONCLUSION

Electricity has an enormous impact on our lives. Without electricity life would be so much difficult and slow. People need to learn the value of electricity, learn how to generate it from renewable sources and learn how to store and save it.

In this paper we introduce our new e-learning project Power engineering dictionary including more than 820 terms enriched with pictures, graphs and illustrations, as one of the options to increase general public energy awareness. We assume that interactivity and colourful visual of the glossary is the most appealing for the younger generation. By the right selection of words in the dictionary we also tried to cover the needs of our bachelor students, who may use it as a supplement in the process of learning. The main advantages of our Power engineering dictionary are simplicity, lucidity, the big amount of words, English equivalent, useful illustrations and linked words. Power engineering dictionary is located on educational portal eLearn central open (this portal is designed for open educational activity aimed at popularization of science and technology). At the same time it allows you to use the vocabulary in all courses developed in this portal, because the dictionary is defined as a global dictionary for connected words in developed courses. The access to Power engineering dictionary is free at URL http://uef.fei.stuba.sk/moodleopen/course/view.php?id=117 for everyone who is interested in this topic. This dictionary is continuously completing and updating. We believe that it will be a useful source of information in the field of Power engineering for general public.

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DISTANCE LEARNING USING REMOTE ACCESS

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Abstract: *This paper describes the project of remote access to network devices both for educational and management purposes. The primary goal of this project is to help students with learning Computer Networks subject and similar ones. The mentioned devices can be linked into group according defined task. There can be several different groups of devices, whose total number is up to 32. Students can manipulate with these groups of devices without need of physical presence at laboratory. The whole set is based on appropriate hardware component and controlled by the created information system, which runs on Raspberry Pi. It composes of database server, web server, RADIUS server and application programmes.*

Keywords: networks, remote, access, teaching.

INTRODUCTION

The management of real network devices is invaluable experience not only for student. The problem is how reach them, as they are usually stored in laboratory with limited enter possibility. The project deals with issue of remote access and its goal is to find a complex solution for remote management of network devices. Its main intention is to support the Cisco Networking Academy (CNA) programme, but the created solution is general and can be used for any similar purpose, especially for the Computer Networks subject learning.

1. CURRENT STATUS

The issue of remote access has been already dealt at time of first mainframe computers. Nowadays, it is still growing trend in communication and information systems. Users should have opportunity to work remotely with network devices.

The CNA programme, but also Computer Networks and Computer Security subjects are partially based on practical tasks. There are three currently available CNA courses at University of Defence. The first, fundamental one is CNA Routing and Switching, the next is more complex program CCNA Security and third, the most demanding, is the CCNP (Cisco Certified Network Professional).

Students fulfil their practical tasks on real devices in labs. They use personal computers equipped with serial interface RS232 or USB port with serial adapter and local connection using rollover cable. There are problems with high lab utilization and bureaucratic burdens regarding lab access during evenings and especially on weekends.

Generally, laboratory exercises in CNA courses can be organized by one the following ways:

- Using simulation tool called Packet Tracer.
- On physical devices.

1.1 Packet Tracer

Packet Tracer allows creating of simulated network consisting of routers, switches, other devices and connection lines. Its usage is partially limited as it does not support all features which have physical devices, so it is not suitable for more challenging topics. In contrast to most real devices, Packet Tracer configuration can be also done using the graphical interface. Moreover, it allows the visualization of certain events (such as datagram or message transportation) and it also has interesting pedagogic features (adjustable time limits for task completion, automatic correctness evaluation, full student activity recording, etc.).

1.2 Physical devices

The role of physical devices is irreplaceable, because their operation is the only way how to get truly real skills. All currently used Cisco networking devices are equipped with console port (which is simplified version of the V.24/RS232 serial interface), the newer ones also use USB port. The network device is managed by the means of a terminal (which is usually software emulated - putty, HyperTerminal).

2. PROBLEM ANALYSIS

The whole project consists of several individual parts, which has to be solved. These parts are described below:

- It has to be ensured, that students can access a consoles of the groups of the devices from anywhere.
- The access to the groups has to be secure. The students should be authenticated and authorized. It is necessary to provide accessing based on date and time.
- Because the devices sometimes has to be switched of and then again switched on. It is important to ensure a remotely power supply control.
- Last part of the problem creates an implementation of an information system, which will be responsible for user management, reservation an access to the groups of the devices and power supply control.

Several unique devices have to be used to achieve intended goals. They are described later in this paper.

3. SOLUTION CONCEPT

Basic concept of the final solution is shown in the Fig. 1. Its primary element is console server Moxa NPort 6650-32, which is in details described below. The students use it to connect the consoles of network devices in desirable group. The Moxa authenticate and authorize the student against the RADIUS server which is runs under Raspberry Pi. If the student is evaluated as legitimate, the Moxa allows the connection to the groups of devices. If the student is rejected, the Moxa closes the connection. The web server runs on the same Raspberry Pi and under the web server the information system also runs. The student may use the information system for reserving an access to the groups of devices and for controlling power supply of the devices in the group. Individual network cables, power supply cords and some network protocols which have been used are illustrated in the figure.

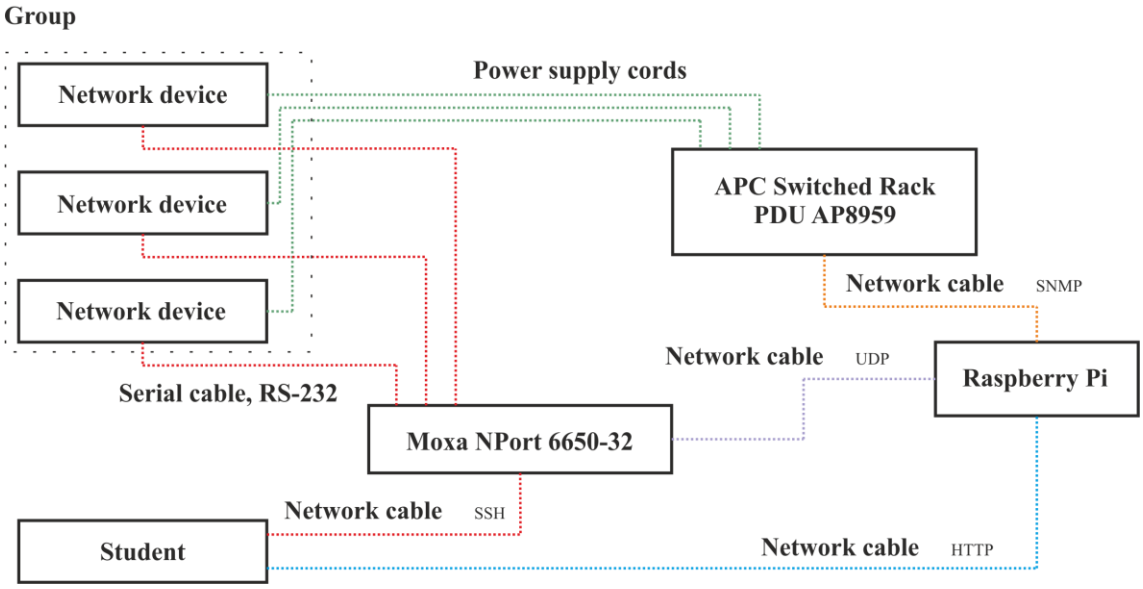

Fig. 1. Final solution concept
Source: own

There are about 60 devices in the laboratory available. This amount allows preparing several groups of identical or different tasks. Contrariwise, it brings some especially organizational problems.

It is supposed that the groups will be formed according real tasks, i.e. devices' appropriate interfaces will be connected using relevant cables. Reason is that several different kind of interfaces exist in router, especially serial ones (V.35, V.24, X.21 etc., moreover with male/female connectors) in addition to the Ethernet. If purely Ethernet was used, smarter solution could be used. It would be possible to connect permanently all interfaces of all devices to the larger dedicated switch and to implement particular links using virtual LANs.

3.1 Console server Moxa NPort 6650-32

Console server Moxa NPort 6610-32 is the device responsible for separation of local and global networks/wirings [1], it can be seen in the Fig. 2. It is also responsible for translation of TCP/IP ports to some of its serial RS-232 interfaces. It ensures the secure SSH connection to the devices behind it by collaborating with the RADIUS server.

Fig. 2. Moxa NPort 6650-32
Source: vendor

Console server Moxa NPort 6610-32 basic features:

- 32 serial ports.
- DES/3DES/AES for highly secure data transmissions.
- IPv6 support.
- Network protocols: ICMP, IP, TCP, UDP, DHCP, BOOTP, Telnet, DNS, SNMP V1/V2c/V3, HTTP, SMTP, ARP, PPPoE.
- Security protocols: DES, 3DES, AES, SSH, SSL
- Configuration options: serial, SSH, Telnet and Web consoles, Windows search utility.

Console server Moxa NPort 6610-32 operation modes:

- Standard: Real COM, TCP server, TCP client, UDP, pair connection, RFC2217, terminal, reverse telnet, Ethernet modem, printer server, PPP.
- Secure: Secure Real COM, secure TCP server, secure TCP client, secure pair connection, SSH, reverse SSH.

3.2 APC Switched Rack PDU AP8959

The APC Switched Rack PDU AP8959 is responsible for remotely power supply control. It communicates via version 3 SNMP protocol [2], [10]. It can be seeing in the Fig. 3.

Fig. 3. APC Switched Rack PDU AP8959
Source: vendor

Remote power supply control allows, in fact, switching attached device on and off. It is a way how to ensure (in conjunction with console server Moxa NPort 6610-32) password recovery.

The example how to recover router unknown password, is following:

- Remote access using Moxa NPort 6610-32 console server to the desired console port, i.e. to the connected device – by the same manner as if it was plugged in locally.
- Cycle router power off/on using the AP8959.
- Break router booting, jump to the ROM Monitor mode and boot sequence modification.

3.3 Servers

They are running run on the Raspberry Pi Model B (credit card size) [8], it can be seen in the Fig. 4. The Raspbian Linux distribution has been chosen as its operating system.

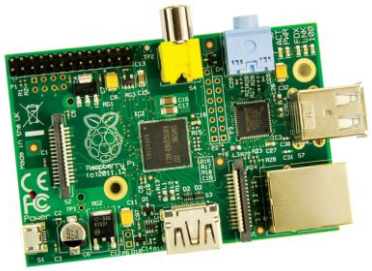

Fig. 4. Raspberry Pi Model B
Source: vendor

3.3.1 Web server

Apache2 has been chosen as the web server [5]. It has been configured to cooperate with the PHP and the MySQL. The MySQL has been extended by phpMyAdmin for better management of the database. The web server constitutes the basic of runtime environment for the information system.

3.3.2 RADIUS server

FreeRADIUS version 2.x has been implemented [3], [4]. It is responsible for handling requests from the console server Moxa NPort 6610-32. Main task of this server is to decide if users (students) can access the groups of network devices in the certain date and time. The RADIUS server has created inflicted the greatest problem in whole project. It does not have suitable tools for authorization of the users against the database. For this reason, it has been necessary to create more complex conditions for the authorization of users. This main problem has been solved by finding a new method for an executing the PHP scripts from the side of the RADIUS server.

4. INFORMATION SYSTEM

Two programming languages, PHP on a server-side and JS on a client-side have been used for creation of the information system [6]. On the client-side, also called a frontend, is used HTML5 as a mark-up language, HTML DOM and CSS3 as a styling language. The frontend use combination of AJAX and JSON for exchanging information with server [7]. On the server-side, also called a backend, MVC design pattern and dependency injection pattern are used for handling a database connection. It is works with a Sandbox file system. The information system use MySQL as a RDBMS with storage engine InnoDB. Next few subchapters describe individual modules of the Information system.

Proposed and implemented solution enables practical remote management of real network devices. Students can use genuine laboratory equipment in the time that they want; they are not limited by working hours or depended on supervisor presence. Experimental usage takes place now. It is a suggestion to constantly reserve a subset of network devices, especially the older ones, for remote laboratory purposes.

4.1 Users management module

4.1.1 User list

The user list is shown in the Fig. 5. This submodule is especially important for administrators. They can see users of the information system, stored in database. Count of the records in the list can be changed. Maximum count of the records per page has been set to 50. If the count of the records in the database is bigger than count of the records per page then paginator is displayed. It is possible change the page of the list and get other records. The user list includes a full text searching.

The records can be also sorted and ordered by clicking on header of corresponding column. Last column, called action, is used for two buttons. They are responsible for users editing and deleting.

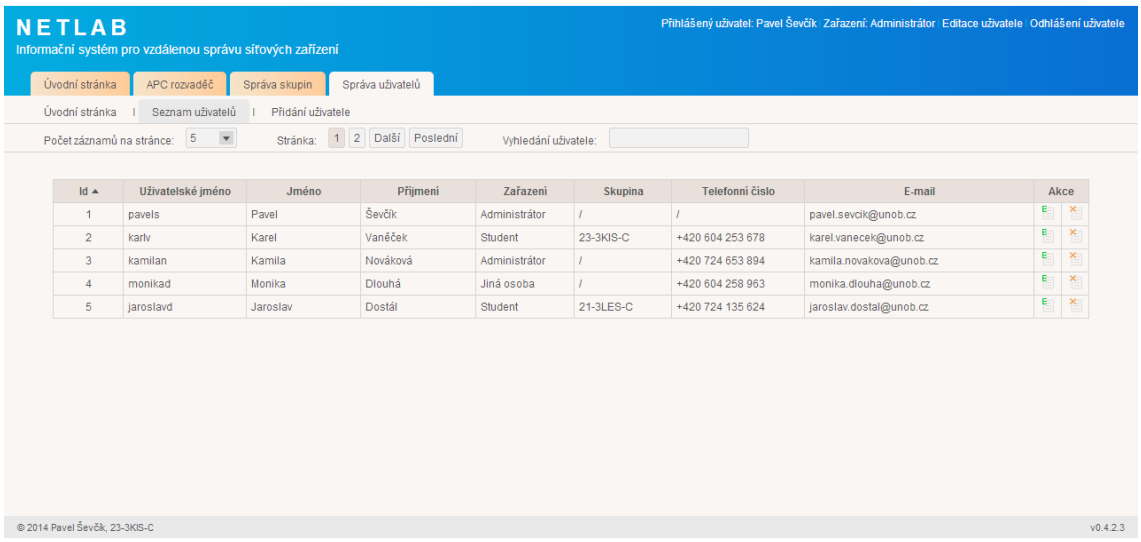

Fig. 5. User list
Source: own

4.1.2 User addition

The submodule is responsible for user addition. It is divided into two parts as it can be seen in the Fig. 6. The first part contains personal information about user, and the second part contains a permission settings. The correct filling of inputs is checked before form is sent. The uniqueness of a username is checked against the table of users in the database.

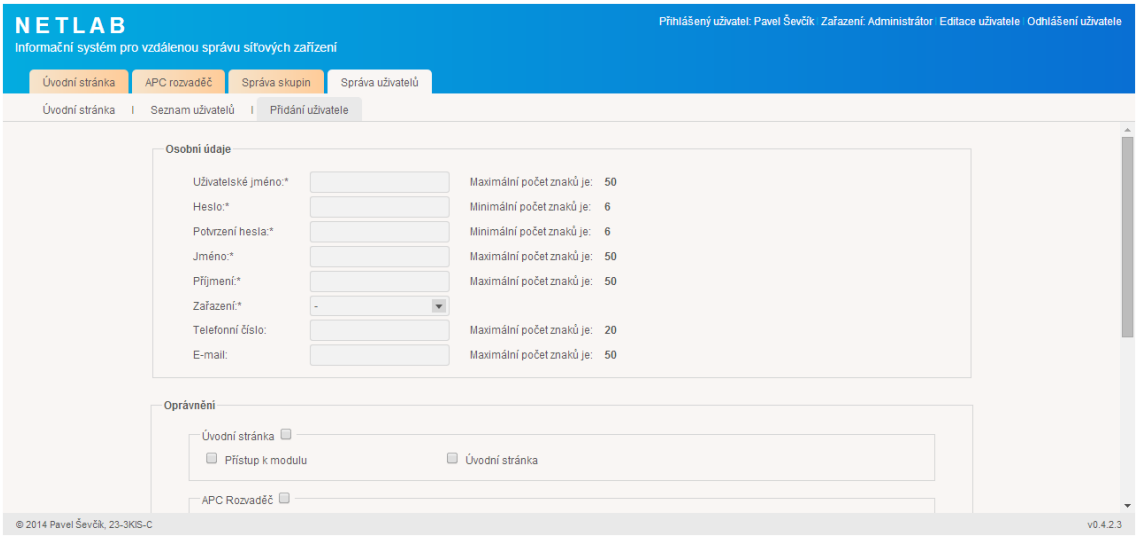

Fig. 6. User addition
Source: own

4.1.3 User editing

The submodule is responsible for user editing. It is the same like user addition, only with one difference. At beginning usernames are entered as the inputs data. The data belonging to the selected user are loaded from the database.

4.1.4 User deletion

User deletion is the part of user list module. Administrator can click on the button Delete in the last column, a popup window appears. After confirmation the user will be deleted.

4.2 Group management module

4.2.1 Group reservation

The submodule is primarily designed to users. It is divided into three boxes. There is a left box where users can choose the groups of devices. A calendar is located in the middle box. The users choose a date and then click on the selected day. The right box will display the table with time slots. The time slots are shown after one hour, all is shown on the Fig. 7. The users now can choose an hour of reservation. It has been used a several colours for marking the individual cells of times in the table. Brown colour is intended for marking of reservations the current user. Light orange colour is intended for marking of reservation the other users. Light grey colour is intended for marking of the time slots that are not currently reserved. It has been determined, that users can reserve the groups only for themselves and only for four hours per day. If the users click again on their reservations, the reservations will be cancelled. If the users click on the reservations of the other users, it will be shown a popup window with information about who have the time slots reserved. The administrator of the information system can cancel all of the reservations.

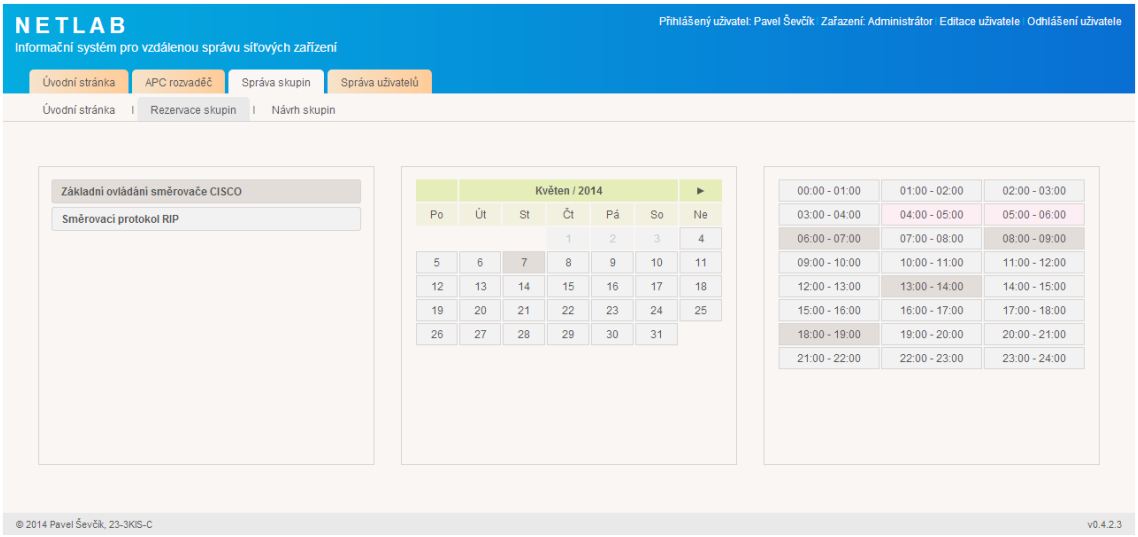

Fig. 7. Group reservation
Source: own

CONCLUSION

The intended tasks of this project have been fulfilled. It is possible to remotely and securely connect and manage the groups of the devices. Several supporting devices have been used; they are the Moxa NPort 6650-32, the APC Switched Rack PDU AP8959 and the Raspberry Pi as the server platform. Students are able to connect the groups of devices via SSH protocol with using PuTTY terminal emulator now [9], [11].

The created information system is quite complicated; it provides the mechanism for user administration, groups design and reservation of the access to the groups. That information system was implemented on very small computer which Raspberry Pi is.

It was necessary to pass several obstacles. First, the communication with devices like Moxa NPort 6610-32 console server and APC switched Rack PDU AP8959 appeared as nontrivial, especially because deficient description. Next, the security was taken into account. It asked deep understanding of several protocols and their implementations.

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BLENDED LEARNING IN PRACTICE

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Abstract: *The paper presents experiences of authors gained by blended learning at the Slovak Technical University in Bratislava. The attention is focused on the subject Electronic Devices offered for students of second year of bachelor studies at Faculty of Electrical Engineering and Information Technology. Authors see blended learning particularly effective, achievable by combination of personal involvement in teaching (e.g. lectures, exercises, seminars, workshops etc.), self-study and the e-learning support such as: electronically processed educational materials, e-modules, courses, interactive multimedia.*

Keywords: blended learning, e-learning, face-to-face, educational portal eLearn central.

INTRODUCTION

Blended learning is a combination of standard face-to-face teaching methods, and the popular e-learning education, utilized in order to exploit the positive aspects of both traditional and modern educational approaches [1]. It compensates some of the disadvantages of e-learning in order to fulfill the objectives of the educational process in everyday study [2]. Nowadays blended form of learning is widely used at various institutes. New communication possibilities of applications and the role of the tutor in the e-learning educational process enable students to virtually consult discussed topics. But in most cases even these funds can't replace a teacher who immediately answers questions, and can provide explanations by drawings discussions according to his/her own experiences [3]. E-learning can't replace the practical experience obtained experimentally, personal knowledge, neither practice. Students are also exposed to direct social connections with classmates, can review and discuss the topic from different angles, gaining experience in verbal communications [4]. All these factors contribute to the development of each individuals communication skills in society, thus the achievement for a better application in practice. This approach was originally designed for audiences who are not accustomed to use modern communication tools such as chat, forums, videos etc. Nowadays this approach is an ideal way of lifelong learning, but also appropriate for full-time students interested in gaining knowledge and skills in the most effective way [5].

We were inspired by advantages of this form of learning and used it as a standard educational process from the year 2005. The aim of this paper is to describe our long time experiences with blended learning gained by learning of subject Electronic devices.

1. SUBJECT ELECTRONIC DEVICES

Our students get in touch with the subject Electronic Devices in their second year of a bachelor study program Automobile Electronics at the Faculty of Electrical Engineering

and Information Technology, Slovak University of Technology in Bratislava. The study program Automobile Electronics was first introduced in summer term 2006/07.

Electronic Devices is a typical practical subject, mainly oriented on experiments. This subject deals with basics of physical principles, electrical properties, technology and constructional principles of passive and active electronic devices, the basic knowledge about electronic systems, circuit properties of passive and active devices, application of diodes, transistors, operational amplifiers, digital circuits and another semiconductor devices in different applications. This subject is presented as face-to-face lectures with traditional practical laboratory exercises and a complex e-learning support. There are also support materials in printed textbook forms Electronics devices and circuits [6] and Electronics devices – instructions for exercises and measurement protocol writing [7]. Practical laboratory exercises of this subject are enabling the verification of the students' knowledge, received by measuring physical dependences and properties of individual semiconductor devices and systems. Complex e-learning support consist of a standard interactive www course "Electronic Devices and Circuits" and an interactive www course "Electronic Devices" - interactive www guide for laboratory practice and exercises of the subject Electronic devices (Fig. 1).

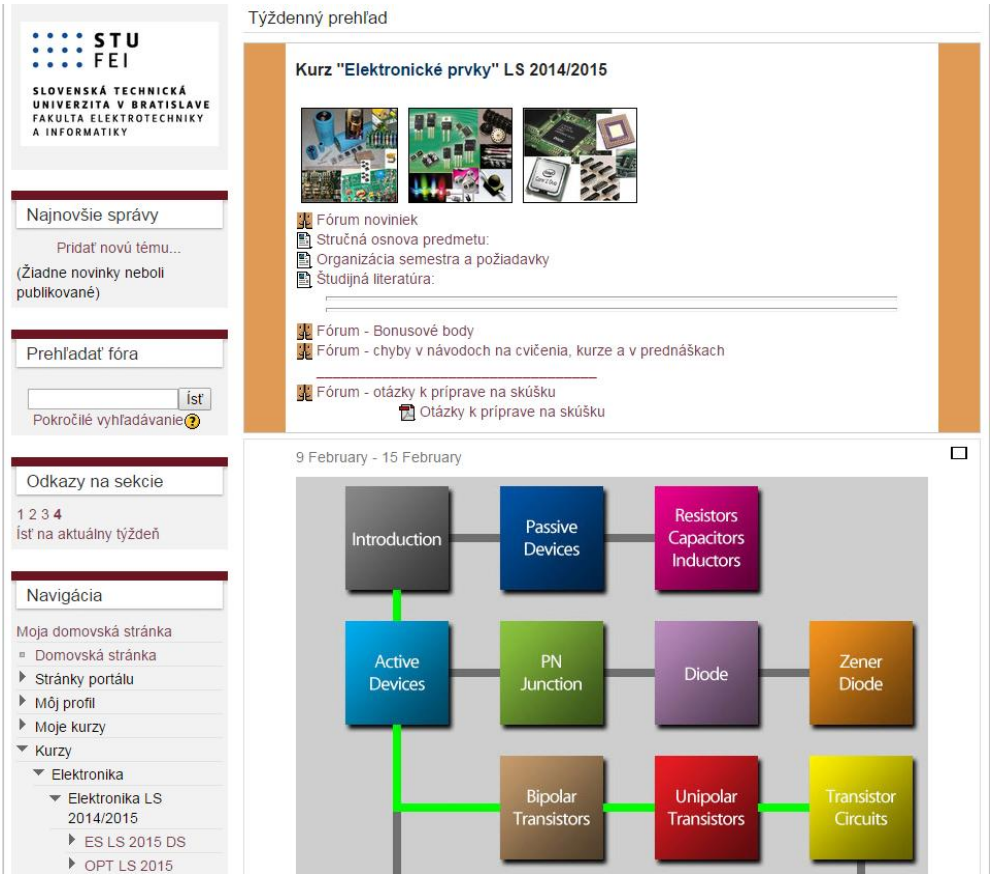

Fig. 1. The course Electronic Devices with interactive map of course
Source: own

The course "Electronic devices and circuits" [6] includes 10 lessons converted into SCORM packages (Electronic systems, devices and passive circuits; Semiconductors and pn junction of semiconductors; Semiconductor diodes and diode circuits; Bipolar junction transistor; Bipolar junction transistor dynamical parameters; Unipolar transistor; The bipolar junction transistor as an amplifier - the common-emitter; Further basic scheme with bipolar junction transistors; Operational amplifier; Digital circuits and systems), 30 interactive animations

(passive devices, passive filters, diodes and their usage in electronic circuits, as well as BT, HBT, JFET and IGBT transistors, real and ideal MOS structures, examples of planar technology produced diodes, bipolar junction transistor, digital circuits and gates), quizzes, glossary with more than 300 terms and with hypertext references. The course "Electronic Devices - interactive www guide for practice laboratory exercises of subject Electronic devices" (Fig. 1) has a weekly format divided into 12 weeks, as weeks on term and includes 32 interactive animations (Fig. 2) accessible on the educational portal "eLearn central" in the library of interactive animations: Course "Interactive flash animations" [8].

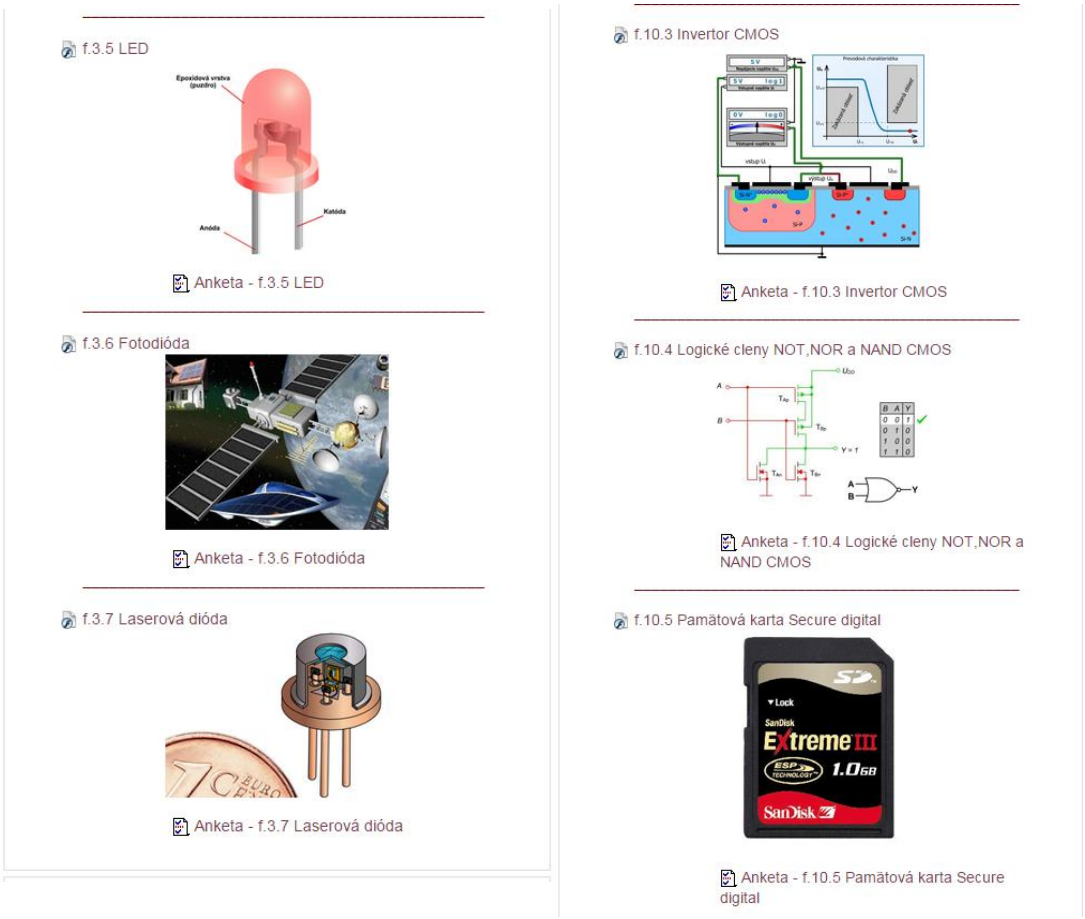

Fig. 2. The course Interactive flash animations
Source: own

The e-learning course "Electronic Devices" [9] starts with basic information about course content, followed by form of teaching, mode of completion, credits, regular and final assessment, course objectives, concise outline and course completion. Each part of this course includes presentations of lectures in pdf format, supposed to be free uploaded for students, information about the practical laboratory, exercises and course events, including illustration and motivation pictures. Ten parts of this course includes: pdf formatted, educational texts as guides for individual practical laboratory exercises with practical notes for measurements and equipment settings, self - tests assigned for students for home study and preparation for initial and final tests. The course includes also two forums - Forum of news and the forum "News in Electric Devices used in Automobile Electronics" [7]. The News forum is displayed on the top of the front page of the Moodle website. It is usually used as teacher information tool for students. The forum "News in Electric Devices used in Automobile Electronics" was mainly used as a motivation tool for the creation of new educational materials.

2. THE IMPACT OF BLENDED LEARNING

From the year 2006 we used blended learning in subject Electronic Devices (ED) as a standard educational process. Overall statistics of the gained grades were available in the AIS system only from 2008. All the gained scores are summarized in Tab. 1.

Tab. 1. Statistics of gained grades according to the number of students for each year from 2008

ED	2014	%	2013	%	2012	%	2011	%	2010	%	2009	%	2008	%	All	All %
All	31	100	22	100	18	100	20	100	34	100	44	100	57	100	226	100
A	8	25.8	1	4.6	3	16.7	4	20.0	6	17.7	8	18.2	12	21.1	42	18.6
B	6	19.5	2	9.1	4	22.2	5	25.0	9	26.5	10	22.7	10	17.5	46	20.4
C	4	12.9	10	45.5	7	38.9	5	25.0	5	14.7	8	18.2	7	12.3	46	20.4
D	6	19.4	7	31.8	3	16.7	3	15.0	6	17.7	10	22.7	13	22.8	48	21.2
E	4	12.9	2	9.1	1	5.6	2	10.0	7	20.6	5	11.4	6	10.5	27	11.9
FX	1	3.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	3.5	3	1.3
FN	2	6.5	0	0.0	0	0.0	1	5.0	1	2.9	3	6.8	7	12.3	14	6.2

The results are directly related to students interest in learning, unfortunately it does not show any trends related to the partial results (Tab. 1), which are greatly influenced by changes in the Slovak school system, such as the introduction of a compulsory ninth grade for primary school pupils. The number of students differs, like the quality of their education level.

However as in other technical subjects, we struggle with the motivation. This is probably specific because all students meet with physics of semiconductors for the first time. Additionally, students coming from secondary grammar schools usually have no practical experiences with electronic measurements and devices. Other part of students in general with very good study results has no experiences, no skills with practical measurements, and for them the subject Electronic Devices can be source of frustration, but on the other hand they are excellent in theoretical calculations. The opposite is also true, thus some of these students are good in practical experimental works but have difficulties with numerical seminars. This is related to students from technical high schools or radio amateurs, who usually undervalue the careful exam preparation. One way, we tried to reduce students knowledge differences, was to motivate them by using the e-learning support to raise the education efficiency.

After course completion we regularly do research in the form of discussions, about the students' opinion on blended learning and how it affected their study. Students have always reported, that they enjoyed and found really effective this way of education and will prefer the blended learning format in the future. As main factors affecting the effectiveness of blended learning education students listed several benefits. Most of them addressed a continuous and unlimited access to educational materials via the Web, giving them flexibility, freedom, and convenience when working part time online from home. By this solution they have the opportunity to comprehensively prepare for lessons, seminars, exams or tests. Students observed an increased success as compared with other subjects without e-learning support. In this solution our students can participate more in various class discussions since they can choose the environment - online or face-to-face - in which they feel more comfortable. Receiving more frequent feedback, from their teachers is now provided.

Blended e-learning gives advantages not only for students but also for teachers. Linking multiple teaching methods allows teachers to achieve the course goals and objectives thereby increasing the educational process efficiency. Teachers can easily update educational

materials and important information during the semester, thereby being certain that all students, have access to the necessary data. Another interesting property is that the educators may guide the student directly to specific parts of the curriculum, or to incorporate new types of interactive and independent learning activities, that were not possible in traditional courses for e.g. bonus forums. Integration of these "home" activities allows teachers to more effective utilize the traditional class time. Teaching with blended learning transforms the teacher-student relationship to be more centered on the students learning process. The main benefit is a well organized information exchange; everything is given in clear format, supporting the idea of the students' clear overview of the subject achievable goals and aims.

As an example of motivational tools and methods in the course we provide information about bonus forums [7]. From our personal contact on lectures and on practical laboratory works, it is clear that our students have continuous interest in the automobile world. This fact inspired us to create a new "bonus forum" topic in the News Forum: "News in Electric Devices used in Automobile Electronics". Students now can find and add in this forum any interesting information covering the area of "automobile world" focused on application of electronic devices. If their information enriches the content of our course, they can obtain up to 5 bonus points. The statistics from summer term 2007/2008 shows the impact of students joining this forum (Fig. 3). In summer term of 2007/2008 56 students were registered in the subject "Electronic Devices". 48 of them had successfully finished (Fig. 3a). Only these students, had also contributed in this new forum. On the other hand, students who have failed (have not appeared at the final exam), were not interested in the discussed problematic (Fig. 3b).

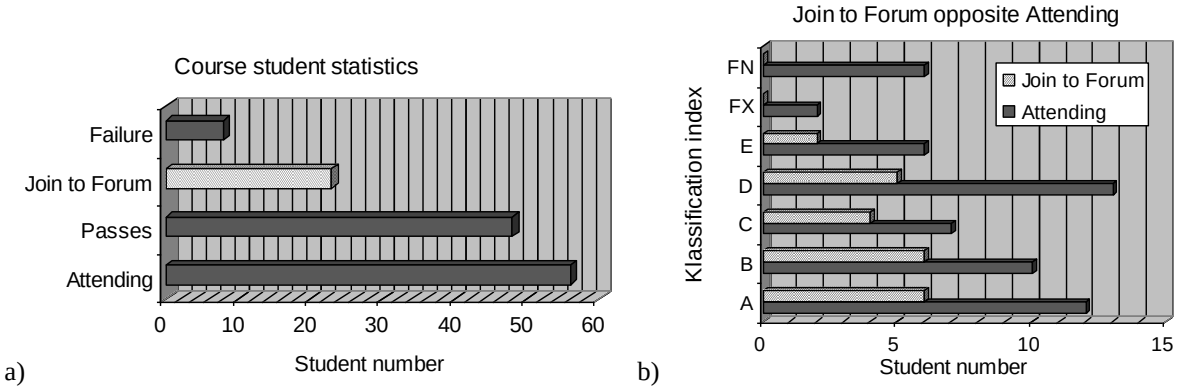

Fig. 3. a) Course student statistic of results and activity and b) Statistics of course results
Source: own

Indirect influence, meaning if this activity helped to better understand the studied topic, is hard to tell, because exactly in this course students are also influenced by several other factors – topics are very close to automobile industry, excellent background on practical lessons and complete e-learning support in very high quality. As a result of this, high percentage (21.1 % – Tab. 1 – year 2008) of students finished the course with top classification grade A. Students have prepared the study material and provided to their study colleagues, featuring high level of interestingness and actuality. The most interesting materials were in short time available to all students interested in news from the automobile world related to electronic devices.

CONCLUSION

E-learning has become one of the most popular and progressive forms of education and easiest way for accessing a huge amount of information. This approach moves us further to

better understand individual processes, but unfortunately nothing can replace the contact with reality, meaning, to solve tasks arising in practical design and implementation. Practical experimental work in laboratories and theoretical seminars are important components of the general education process in order to be able to obtain practical knowledge on the subject.

We have been using e-learning as support in the standard educational process since 2005, as for example for the subject Electronic Device. Based on our many years of experience we consider blended learning as an extremely effective solution for high quality learning. The combination of personal involvement in teaching, self-study and the e-learning support closely link all the advantages of both approaches, thus face-to-face, as well as e-learning solutions. It clearly increases the preparedness of students, reduces the frustration caused by the lack of practical experience as well as gaps in physics and mathematics knowledge. Feedback from students is clearly positive. They highly value transparency and the continuing availability of all educational materials. This way of teaching, us – teachers, provides a superior comfort, without which today we can't imagine the learning process.

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E-LEARNING SUPPORT FOR PRACTICAL EXCERCISES OF SPECIAL MEASURING TASKS

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Abstract: *E-learning courses improve the quality of knowledge if used with classical way of teaching or they are used as the one of the teaching methods. At our institute e-learning course Electrical measurements for bachelor study course was created as a possibility for students for better understanding of what they are learning at practical exercises. The e-learning version of the course was built in the learning management system Moodle. Interactive software applications were created in LabVIEW environment. Simulations of common measuring devices or of some measuring principles can be downloaded. Special application was designed for the areas dealing with power and its measurement and for measuring the additional errors. Students can become familiar with the measurement in 3D graph, corresponding graphs including time behavior, measured values, etc.*

Keywords: e-learning, Moodle, LabVIEW, simulations of instruments, power measurement, additional error, form factor.

INTRODUCTION

In the information society there is big need for excellent education which has also an enormous influence on the position of people chances to gain a good and interesting job. From this point of view it is necessary to take into account rapidly changing role of education and teaching tools at universities. Modern information technology has opened up many new possibilities in learning. E-learning has become one of the most popular and progressive forms of education and easiest way for accessing a huge amount of information. E-learning as educational method is motivational, effective, and practical and allows learning more information in shorter period and in an enjoyable way [1].

Our department of Institute of Electrical Engineering deals with area of measurement, especially with measurement of electrical quantities. The essence of teaching measurement is to lead students to understand selected electro-technical principles and their impact on the technical application. From our experience there are some topics difficult for understanding for most of students. In this paper two of such topics are discussed: additional waveform error measurement and power measurements. E.g. power measurement is a complicated task, mainly if taking in account expansive economical semiconductor elements. It is important to know how to measure various types of power and how to use different gauges and measuring equipment correctly.

It is a common problem of university departments that they teach similar topics in more different subjects and for several study programs. That is the reason why we decided to build

one common source of information. It has form of e-learning course created in learning management system Moodle. It is described in the final part of this paper and its purpose is to cover a whole group of subject using modern software teaching tools.

1. HISTORY AND TOOLS

Our Department of Electrical Engineering provides education in the field of electrical measurements for all study programs at the Faculty of Electrical Engineering and Information Technology in Bratislava. The most of these courses are taught in the second and third years of bachelor study and the practical exercises in them are realized in laboratories. For some of the subjects the e-learning courses are used for some years. Historically e-learning tool were engaged for distance learning, however, it proved to be useful for present study too. We recognized two basic problems of providing information for distance learning using information technologies. One thing is to find the software aids for publishing of the content and another is to choose appropriate supporting tools. Under supporting tools we understand all the sources for creation of animations, simulations, explanation calculations etc. It could mean probably some of applications the students are dealing with during practical exercises.

In the first step we used MS Excel sheets for calculation of semiconductor characteristics or transient phenomena simulation. For our technical purposes or generally in academic practice seems more advantageous to use Matlab. If deeper programming features are required in measurement experiments environments as LabWindows and LabVIEW are profitable. Actually LabVIEW is mostly used at our department and many simulations were created by teachers and students for distance learning activities.

For publishing of technical content special sections of institute web page were established. However for comprehensive e-learning course special web tools exist. Moodle learning management system [2] is used at our university for this intention. It allows integrating courses into university e-learning structure. In addition it includes support for mutual communication between teacher and student. The feedback could be achieved by different tests, questionnaires or inquiries.

2. DIFFICULTIES IN THEORETICAL BACKGROUND OF SELECTED TOPICS

The years of teaching experience reflected that there are more problematic parts. For example students can understand basic calculations of measurement errors, while they hardly conceive additional error sources and relation between waveform form factor and error in cheap conventional multimeters. The other difficulty stays in understanding of power measurement in AC circuits especially if a semiconductor element disturbs sinusoidal waveform shape. Both topics will be explained below.

2.1 Form Factor and Waveform Errors

When providing the measurement various types of error can occur. One of them, additional errors, belongs to systematic ones. They arise due to non-compliance with the reference conditions laid down by the device manufacturer. External condition includes temperature, pressure, humidity, position or it may include external magnetic field, etc. The manufacturer

guarantees the limit of error (guarantee error) also for frequency range or the shape of input waveform. If the device is used out of these reference conditions the additional error occurs.
The shape of waveform could really influence measurement accuracy. In this sense, if we measure the RMS (Root Mean Squared) values of voltage *U* or current *I* it is important to know how the value is evaluated inside the device. Alternating quantities may be measured using rectifier bridge and measuring system for DC value like a permanent magnet moving coil instrument. This arrangement could provide precise RMS value for sinusoidal waveforms, as we know the relation between the rectified average value and the RMS value. This factor, known as the form factor *FF* has a value of 1.1107 for the sinusoidal waveform. Since the rectifier type moving coil meter is meant to measure only the RMS value of sinusoidal waveforms, the meter is calibrated to read 1.11 times the average value rather than the mean value of the rectified waveform. However, this is not valid for other waveform shapes. Generally it is valid

$$U = \sqrt{\frac{1}{T}\int_0^T u^2(t)dt} \qquad U_{av} = \frac{1}{T}\int_0^T |u(t)|dt \qquad FF = \frac{U}{U_{av}}$$

Hence, the form factor for e.g. triangular waveform is 1.155. When the effective value of non-sinusoidal waveforms is measured, an additional error appears

$$\delta_t = \frac{1.11 \cdot U_{av} - U}{U} \cdot 100 = \left(\frac{1.11}{FF} - 1\right) \cdot 100 \quad [\%]$$

The error for the triangular waveform is -3.81 %, for the square waveform 11 %.

2.2 Power measurements

Common power meters or AC wattmeters measure active power *P* [W]. For understanding of behaviour of AC circuits following terms describing energy flow in a system are defined: real or active power *P* [W]; reactive power *Q* [VAr]; complex power **S**[VA] and apparent power $S = |\mathbf{S}|$[VA] that is the magnitude of the complex power. All the powers could be expressed from the instantaneous power delivered to a load $p(t) = u(t).i(t)$, where *u*(*t*) and *i*(*t*) are the time varying voltage and current waveforms [3]. Then, the active power consumed on a load is defined as the mean value of the instantaneous power $P = \frac{1}{T}\int_0^T u(t)\, i(t)dt.$

In the case of a perfectly sinusoidal waveform it holds $S^2 = P^2 + Q^2$. The mathematical relationship among them can be also represented by vectors or using complex numbers $S = P + jQ$. Apparent power $S = U.I$ is the product of RMS values of voltage and current. It represents the total capacity that must be available from power supply to the load – even though only a part of this is useful power. In case of harmonic supply $S = P + jQ = UI(\cos\varphi + j\sin\varphi)$ here the active power is $P = UI\cos\varphi$ and the reactive power is $Q = UI\sin\varphi$. The cosine of the phase angle φ between the voltage and the current is called power factor $\lambda = \cos\varphi = \frac{P}{S}$.

When the current is non-sinusoidal the influence of harmonics has to be considered. The powers *P* and *Q* are put together by harmonics of the same order of both voltage and current $P = \sum_{k=0}^{\infty} U_k I_k \cos\varphi_k$ [W], $Q = \sum_{k=1}^{\infty} U_k I_k \sin\varphi_k$ [VAr]. Apparent power is then $S = U.I = \sqrt{\sum_{k=0}^{\infty} U_k^2}\sqrt{\sum_{k=0}^{\infty} I_k^2}$ [VA]. In case of non-sinusoidal signals there is inequality $S^2 \geq P^2 + Q^2$ valid and the influence of so called distortion power $D = \sqrt{S^2 - P^2 - Q^2}$ occurs. It consists of unequal harmonics of voltage and current

$$D = \sqrt{\sum_{j\neq k}^{\infty}\left[U_k^2 I_j^2 + U_j^2 I_k^2 - 2U_k I_k U_j I_j \cos\left(\varphi_k - \varphi_j\right)\right]}\ [\mathrm{VA}].$$

The function representation of mentioned powers is shown by 3D graph in Fig. 2 on the right.

3. DEVELOPED APPLICATIONS

Several animations have been developed especially in program LabVIEW (from National Instruments) [4] simulating measuring devices and principles. The application could be downloaded and installed on the own PC by several simple steps. Simulations could be inserted into Moodle course and help students to get prepared for incoming topic or to understand measuring devices and related complicated processes or technologies.

3.1 Waveform error

During practical exercises several measuring devices are available based on principle with rectifier described above. For some of them a simulation of their behaviour was created. The developed application can simulate M1T 242 digital multimeter (Fig. 1 - left), the analogue moving coil meter with rectifier (Fig. 1 - right), moving coil meter or precise digital multimeter GDM-8145. Each meter is located on a separate tab, where you can select the parameters of the simulated signal. Signal is graphically illustrated too. For the case of M1T 242 multimeter depicted in Fig. 1 (left) it can be seen that for a square signal with amplitude of 10 V (RMS is also U = 10 V) the displayed value 11.11 V is loaded by expected error of 11 %.

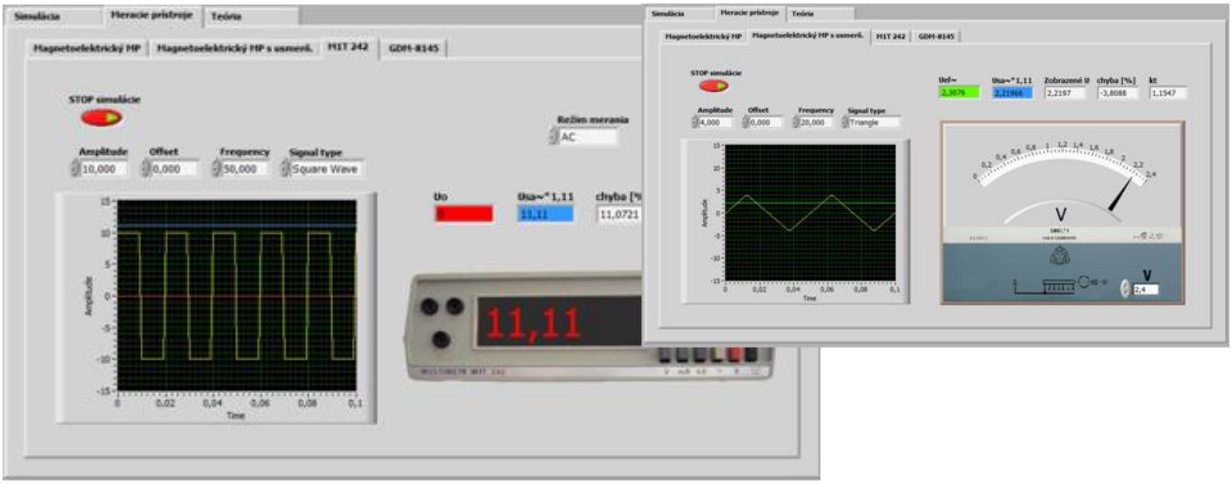

Fig. 1. Designed simulation application – tab with digital multimeter M1T 242 (left) and moving coil meter with rectifier (right)
Source: own

3.2 Power measurement application

Power quality measurements and current harmonics are two common sets of measurements made on the input section of a power supply to analyze the effects of the power supply on the power line [7]. Power quality refers to a power supply's ability to function properly with the electric power that is supplied to it. These measurements help to understand the effects of distortions caused by nonlinear loads, including the power supply itself. The measurements

include RMS voltage and current, true and apparent power, crest factor, line frequency, and power factor.

Professional applications like [7] are quite expensive and require complex establishment. Program developed at our department uses cheaper DAQ measuring card and can run also in simulation mode. Both voltage and current waveforms, from which the power is calculated, could be measured, simulated or loaded from a text file. Their waveform examples are depicted on the left in Fig. 2. From simulated or in another way acquired samples the parameters of voltage and current (e.g. mean value, RMS value, offset, form factor…) are calculated. There is a possibility to choose the representation of the power either as the instantaneous power time waveform or in 3D graph of phasors [6].

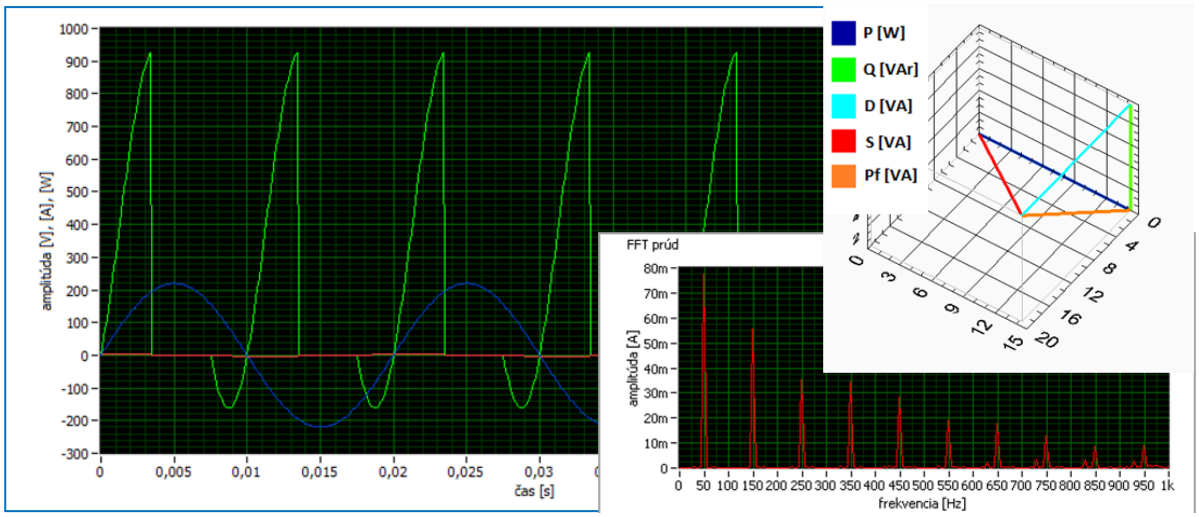

Fig. 2. Graphs generated by designed power application – waveforms of voltage (blue) current (red) and instantaneous power (green); FFT spectra of current; 3D graph representing power relations.
Source: own

4. E-LEARNING COURSES

At our institute, topics related to electrical measurement are common in several subjects. So we created one new e-learning course “Electrical Measurements” which covers overlapping themes. In this course, students are introduced to different methods for measuring of electrical quantities and methods of measuring error evaluation. During practical exercises different instruments and methods are used.

Fig. 3. View of the course – Introduction page (left); Addition errors (middle); Measurement of single-phase power (right).
Source: own

The e-learning version of bachelor study course was built in the learning management system Moodle. The current version is Moodle 2.6. The course is accessible from the educational e-learning portal of the Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava on the following link *http://learn.elf.stuba.sk/moodle*. In Fig. 3 there is shown a screen segment of the Moodle. The course includes animation (simulation) for the following topics: Errors of measurement and measuring devices, Additional errors, Resistance measurement, Measurement of single-phase power, Analogue oscilloscope and Spectrum analyzer. However, only two of them are selected for presentation in the figure. Applications designed in LabVIEW mentioned above form parts of published content. Applications could run on local PC after downloading. The requirement is corresponding LabVIEW or LabVIEW Run-Time Engine installed on that PC.

CONCLUSION

Special e-learning course and resources presented in the paper are used for education process in subjects related to measurement. It supports practical exercises in full-time and distance study programs. Our goal was to offer the possibility for students to improve knowledge about additional waveform errors and power components for non sinusoidal signals via the course.

The advantage of LabVIEW applications is availability of simulation. After downloading from Moodle and installation of LabVIEW RunTime Engine the program could run at personal PCs of students. The application was just integrated into teaching process and we hope, that it will improve motivate the students and to rise their sympathy to given topic. It could be simply verified in the future e.g. by survey in Moodle.

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E-LEARNING AS TOOL OF SECURITY MANAGEMENT PREPARATION

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Abstract: *Area of the security of information requires technical and legislative-procedural knowledge. Preparation of experts for this area brings many problems relating to fragmentation of information, holding of information and the re-fragmentation of information. The person, that is responsible for the preparation of the security personnel must very carefully distinguished within the preparation of study materials for students fact, what resources and what information will be accessed to students This task is based on the decision of the teacher.*

Keywords: security, education, e-learning, information.

INTRODUCTION

In case of the preparation of the security expert's organisation has to take in mind the need of periodical preparation. Information protection within the Czech Republic means application regulation from nearly 30 documents which contain 800 pages. Due to enormous quantity of pages it is very effective use various tools and combines them to each other during the process of the preparation. Lessons in a classroom involve lectures, presentations, practical demonstrations, discussions, working with the students. Training outside the classroom usually includes a separate study from textbooks and made notes. This part of the training can be supplemented with an interactive or repeat study new knowledge using the learning management system (LMS).

1. TWO WAYS OF PREPARATION

Education of the security experts which protect all kinds of information must be established on the requirement from Czech laws and other standards from appropriate institutions like National Security Authority or the Office for Personal Data Protection. Organization itself has choice how to ensure education of the security experts. The organization can establish own education centre and system of education, in this case will be everything under the organization control. Organization itself knows their specific conditions and can have influence on it.

The other choice of the education of the security experts is outsourcing of the education. There are a lot of firms that provide special training for different organization for payment. The training will not be so specific on the environment because the "outsourcing" organization doesn´t know all details and consequences. The advantage of outsourcing is that it can be cheap. Organization immediately knows the price and can predict budget from long term point of view. There is no need to invest money for special preparation of teachers or invest money for updating study material etc. Which price will be really paid? Are there

any criteria what are more effective? Are there any criteria of quality of the training? Are there any threats with the organisation from outside? Organization itself has global responsibility for protection of information. Protection must be controlled by trained and educated personnel.

2. PREPARATION OF THE SECURITY PERSONNEL

It is necessary to ensure the quality of the education system for the preparation of personnel in this very specific and technically challenging area. The system must be realigned due to the access to information and especially classified information. Preparation of experts for this area brings various problems relating to fragmentation of information, holding of information and the re-fragmentation of information.

Students are introduced with unclassified information in the first phase. They have to understand all rules and associations and relations. With the basic understanding they can continue with study with classified information as the second step. The final step is situation that they have to recognize with whom and about what, they can talk about some topics with protection of information. We can talk about intentional fragmentation of information, because the system is intentionally set up. The organization provides access to information in parts, depending on the requirements for their protection:

- Some information is expressed as publicly available-legal standards.
- Some information is available and available to specific group of people belonging to a single group – can be identified only for business use, for the purposes of the profession (for official use only). They have access only to the organization where employees are.
- Some information is only available to a limited number of persons – mainly due to the fact that the requirement of a legal norm has been established for their protection, for example classified information, special considerations, etc.

3. LMS IS EFFECTIVE TOOLS FOR PREPARATION

Security experts have to use all available tools for their preparation. It is not sufficient to spend time only with teacher in the classroom and watch numbers of presentations and listen hours of lectures. Some Czech law defines examination of special professional competence. There is very strong importance to self-study permanently. For comprehensive teaching is very efficient to involve all the available types of training and resources. It is very useful to take advantage of the e-learning opportunities. LMS offers options for training students from anywhere, but only for available general information. Extension of publicly available unclassified information is the initial phase.

Lessons in a classroom involve lectures, presentations, practical demonstrations, discussions, working with the students. This is passive participation for students. The IT brings new possibilities how to make the education process more effective. There is movement from the passive mode to the active mode of the education. With usage of IT we can make students much more independent on the place, time and way of study. It is appropriate to use the LMS. We have to be aware with handling of information; LMS can be used without any obstacle only for the unclassified part of education. In this part they can meet with the public information.

For the creation of LMS course organization needs IT specialist and an expert on the specific security issue will participate on the preparation of the e-learning education. IT specialist will ensure the implementation of an LMS into the information system of the organisation. IT specialist must perform the initial training of the guarantor (teacher) of security education. Consequently the teacher will be responsible for the formation of the course with using LMS. Both experts together must help to students to exceed their concerns about the use of LMS.

Subsequently, the exposure is made with teaching of classified information. This procedure will help fix the issues with the already studied non-classified then using and pointing out the context of how to work with classified information. We have to be very careful with using information systems. In this case we would need information system with certificate of National Security Authority about handling of classified information within these systems. Access to these systems will be restricted and we nearly lose all advantages of LMS. Students have to stay within the classrooms with teachers. During the preparation of the security personnel for the information protection, organization can keep track of possible deviations from the normal curriculum process:

- The teaching material is classified – information is provided on a particular place and in a particular time, information is provided by the teacher.
- Students are restricted in the formation of their comments regarding the presented issues-information protection requirements define the conditions allowing the record to the media and that it is very limited.
- Teachers are limited in the formation of didactic aid - obstruction in record creation and the place of processing are laid down in legislative terms.

The exchange of information between teacher and a student is limited due to place and time. Organization has to always apply the principle that the member providing the information must be certain, that provides general information. In case of ensuring of the secure communication link it can be more detailed in the description of the problem. Consultation of classified information after completion of education is limited, because it is limited to the place.

4. USE OF THE LMS

Due to the fact that majority of the documents are not classified, organization can decide to use LMS for education, the situation is much more comfortable for students. All passive hours when a student has to listen and make notes are supplemented by hours when teacher expect right answer from student. There are several possibilities which come from usage of the LMS. The success depends on the teacher's strategy. If the e-learning course is complex with all available information, on-line tests and main ideas from the main topics it seems to that mission of the teacher should be successful.

All presented information from lectures and presentation should be stored within the course. The reason why is very simple. Some students prefer personal contact with teacher and make only some notes from teacher speech during lectures. But after the presentation student can find important information and he or she request a dialog with teacher for better understating. E-learning doesn't mean only copying all documents, presentations or lectures on the webpage.

University of Defence creates every year special course for security personnel. For this reason is used the LMS Moodle. It is open source. It is requested that various courses should have similar frame. Whole documentation must be approved by National Security authority. Typical course for security experts consists of:

- 4 topics:
  - Legislative,
  - Security management,
  - Administrative security,
  - Cryptography.

These topics are focused on specific issues, the topic is introduced, explained by the presentation and lecture if the teacher. Students can find main points students can find the main points from the topic within the e-learning course. This practise was chosen due to the knowledge, that students read only presentation and nothing more. For the self-study students can find in the same place:

- Glossary, because all experts need to speak the same way with the same words.
- All valid law, students can find immediately all valid norms and regulations.
- Study material for examination of special professional competence, this document helps to students with the final phase for preparation to final exam. They know what is requested.

To help students with study teachers created 3 on-line tests that are divided according to their difficulty, from beginner to expert. Students have immediately results. They know which topic is still a problem for them.

The course seems to be complex, but it is important to have feedback. Students can express their opinion. Their proposals are anonymous. This possibility is not used to much.

We are optimistic due to the relevant statistics, which means:

- 9 one week courses
- 62 students
- 55 men
- 7 women
- 42 secondary school graduates
- 7 university graduates.

Nearly 50 % used e-learning course according invitation letter before the course start. All of them used e-learning course during course. The teacher has all results in tome and can change the centre of gravity to the rights direction. All students passed successfully the examination of special professional competence.

What is very useful for students? They recognize different access to the education. All of them prefer education in different forms. They really enjoy the variability of preparation. Every student likes his own way how to learn the topic. Students need to have all documents for following study and they also need a tool for their self-testing. It is opportunity for the teacher to help students by concentrating all available sources in one place in various formats. Some people still prefer paper document but majority of young generation prefer electronic format, they can read on their tablets or notebooks. This form gives them the opportunity to study anywhere or they can download all documents and books to tablet or notebook, pick up with themselves and study anywhere.

E-learnig should be very effective tool due to the interactivity form. The interactive phase begins when the teacher creates tests on the specific topic. Students can test their knowledge about the topic. They can have results immediately. It is better if the teacher creates the test without the possibility of simple key for right answer. On-line test is challenge for students. Test doesn´t know the "face" of the student. The test counts right answers and mistakes. Every teacher has to find his way to creates interesting test. It is necessary to create interesting course that consists various forms. The way of multiple choice test, is not way ahead because students will learn to eliminate mistakes, they compare only if the answer is correct. The test should have questions where students have to express his knowledge about the topic. It is very important to make test which ask students for active access and not only elimination of mistakes.

Students have everything what they need in case of the preparation for the protection of unclassified information. All information is from open sources. Students know what it is requested on them, they have all sources from which they have to learn and they have tool how to check their readiness on the topics. What they miss is personal contact with teachers. The usage of the LMS is very convenient for both sides. Students can use it for his preparation and teacher can use it as a tool how to improve the education process and check knowledge of students. LMS can provide us a lot of interesting data. Teachers can make statistics, they can find weak point of the topic and they can move their interest into difficult topics. The education is more complex.

All security personnel have to pass an exam of special professional competence. It means they have to get over enormous number of pages with various conditions for protection of information. They have to attend course and they have to pass final exam. This exam contains knowledge from unclassified documents and classified documents. All mentioned information above describes preparation of students with unclassified information. There is no restriction for handling with them. But in case of the education with study material which is classified all interested people has to take in mind that conditions must change immediately. Classified information can be stored only in classified area within storage units. Organization has to have systems of administrative security. Access to the information has only people with security clearance. Classified information can be stored, displayed, changed only on the information systems that have certificate from the National Security Authority.

CONCLUSION

Preparation of security experts is very complicated because the protection of information is the question which is characterized as very complex and strategic. Threats can have devastating effects on firms, organizations etc. Students of courses as future professionals on information protection must be ready to get over their duties. Education has to be organized in all available forms. The system of training should be focused on the average of a group of students because the aim of the education is to prepare the student for highly skilled job. It needs to convey the information during preparation, and in such a way to understand the need for fragmentation of information provided to him. It is important that student understood fragmentation of information. It is also important that information is memorized. The aim of the teacher is fulfilled if the student understood correctly and adequately. Security experts should be able to handle with all kinds of information in various conditions.

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This article will be focused on the realization of the e-learning education for the security experts at the University of Defence in Brno.

COMPUTER MODELLING AND SIMULATION OF POWER MOSFET PROPERTIES IN INTERACTIVE E-LEARNING COURSE

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Abstract: *The paper presents an interactive course named Power MOSFET. The course was primarily prepared for daily students but we found it very helpful also for distance learning. The course is divided into several parts providing a wide range of information. The basic theory of power electronic devices is completed by practical results obtained from measurements and 3-D TCAD simulations. The aim of the course is to assure the rise of education efficiency and to reduce knowledge differences of students on several seminars. The results from simulations allow a deep insight into the internal behaviour of devices. Therefore the course was enriched by input files for simulators that students can use for their projects. This course is located on the educational portal for students called "eLearn central".*

Keywords: power MOSFET, 3-D TCAD simulations, e-learning.

INTRODUCTION

Power semiconductor devices are recognized as key components of all power electronic systems [1]. For the design of innovative products in the microelectronic industry, especially in the area of power electronics, the availability of the most recent design knowledge is mandatory [2]. It is also very important to have laboratory experimentation to reinforce the theoretical knowledge taught during the classroom lecture. However, it is really difficult for any university or academic institution to have all types of practical setups in large numbers and continuously updating them with the development in the field of power electronics. Therefore, one of the best ways to tackle this problem is to use computer modelling and simulation. Numerical modelling and simulation are very effective educational tools for a better understanding of the electrical characteristics of analyzed semiconductor devices. Simultaneous use of process and device simulation allows the deep understanding of the physical operation behaviour of a wide variety of semiconductor devices. A very important issue where simulations can help is to identify and explain parasitic effects [3, 4, 5]. The main advantage of modelling and simulations is the ability to visualize the internal electro-physical properties of the analyzed structures. As the old proverb says "better to see something once than hear about it hundred times". Therefore we found that modelling and simulations are very popular among students because they allow very easy and more illustrative explanation of the internal behaviour of electronic devices.

The scope of this paper is to present a new Power Electronics e-learning course named Power MOSFET prepared and located on portal "eLearn central". The course combines theoretical basics with corresponding results from TCAD simulations and is also implemented in blended study of bachelor and master programs at our faculty.

1. TEACHING vs. LEARNING ORIENTED EDUCATION

In the field of power electronics, the explosive development of the last decades has dramatically changed device fabrication and design procedures, with strong implications for educational practices. The traditional approach to education consists in acquiring knowledge by the students. The assessment of educator is in testing whether the students could reproduce the acquired knowledge [6]. The changed demands from industry ask for more emphasis on the skills and deep understanding than on knowledge. Therefore, the main goal of education has to be in the development of student skills. This means that the teacher is a coach in the process of the student knowledge development [6]. This is a difficult task, especially in the field of power electronics, specifically in the area of power electronics components design. Although some students have some access to technological equipment in laboratories and during some exercises they have the opportunity to try technological steps like etching, lithography and to prepare some parts of electronic devices, they are missing an overall view on technology and importance of each step for the final device performance and its characteristics. Brilliant solution besides real experiments is TCAD system that becomes a central part of the design process, covering almost all design phases.

1.1 Simulation in education

TCAD systems opened a new way of educating students and enabled more illustrative explanation of abstract notions such as current, voltage, charges and specially the phenomena during technological processes. Many students who are faced with the principles of power electronics have problems in understanding and dealing with the high complexity of these systems [7]. On the other hand, large amount of important information and time limits of each lecture force the educator to use modern display and presentation techniques. One of the solutions for the teacher is the use of dynamic animations that leads to eye-catching lectures with high concentration of provided information but often with disappointing learning yield. Students may become de-motivated and feel themselves unsuited for the subject because they think it is too difficult for them [6]. Especially in the field of electronic devices design, a change in the style of educating is needed. Besides forcing the students to learn long and not trivial relations for calculating many effects connected with technological processes (diffusion, implantation) or device performance it is better to use simulating tools and to explain important relations and phenomena on pre-prepared examples. The students can try to change parameters and examine their influence. A significant advantage of modelling and simulations is the ability to work with parts of the structure or to prepare the structures by steps and examine the impact of each added part or step (mostly of high temp processes) on the whole structure.

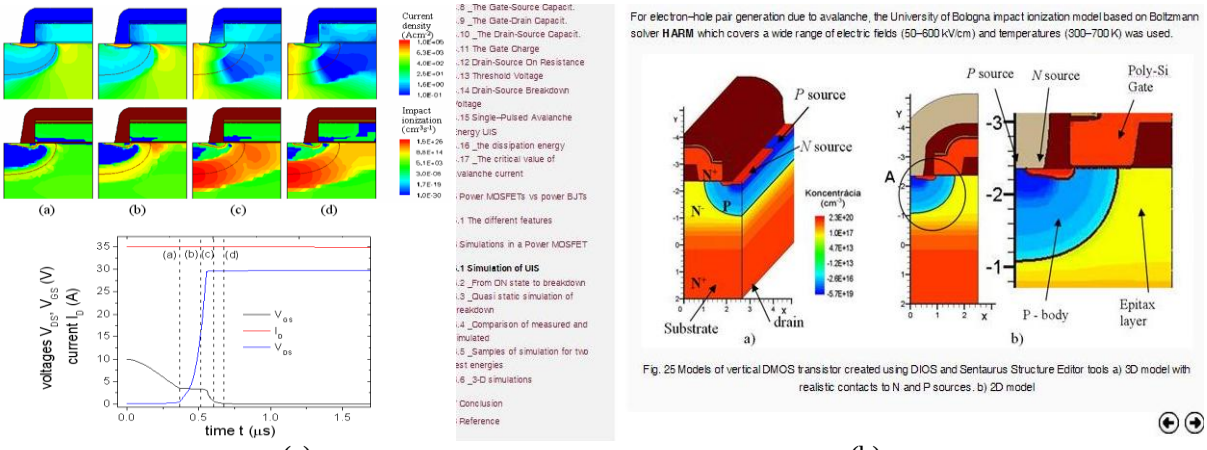
2. POWER MOSFET COURSE

E-learning course Power MOSFET is located on e-learning portal “eLearn central” and is intended for master and PhD students and also for the interested community. However, the aim of the course is to presents detailed info about the topic of power MOSFETs, though some basic relations and behaviours are explained in detail. The course assumes basic knowledge of electronics and circuits and therefore we can say that this course is an upgrade of the basic electronic devices course. This allowed us to focus more on some specific areas connected with Power MOSFET operation in detail, e.g. turning on/off process, inductive load switching, and second breakdown and still maintain the compactness of the course. The

(a) (b)

Fig. 1. (a) Visitor´s view of the Introduction section of the Power MOSFET course. (b) Sections from course "From D-MOSFET to Trench Gate architecture" and "Applications". Source: own

course is divided into eight sections – Introduction, history, basic concepts, basic characteristics, simulations… Each section consists of educational materials (texts, figures, equations) arranged in the form of slides. The students can easily browse through the course using the next/previous buttons or the navigation panel on the left side of the screen (Fig. 1a). It is very important to keep slides compact to maintain attention of students. Too long texts discourage students from reading them, and this can also suppress the main aim of the course – to obtain basic information quickly. Therefore each page of the course is not longer than two regular screens. The educational texts are, if it is possible, written in the form of bullet points supported by figures or graphs (Fig. 1b). Some phenomena are explained using flash animations. More detailed operation can be explained using the attached simulation package with a more realistic MOS structure (Fig. 2a). However, to use this package the user must be logged to one of our servers and have an account with access rights to the simulating tools. This restriction was done due to the limited amount of licenses for students and employees in our institute and to control unauthorized use of our TCAD tools.



(a) (b)

Fig. 2. (a) Simulated internal behaviour of DMOS transistor during self clamped inductive load switching. (b) Section from course showing models and their descriptions. Source: own

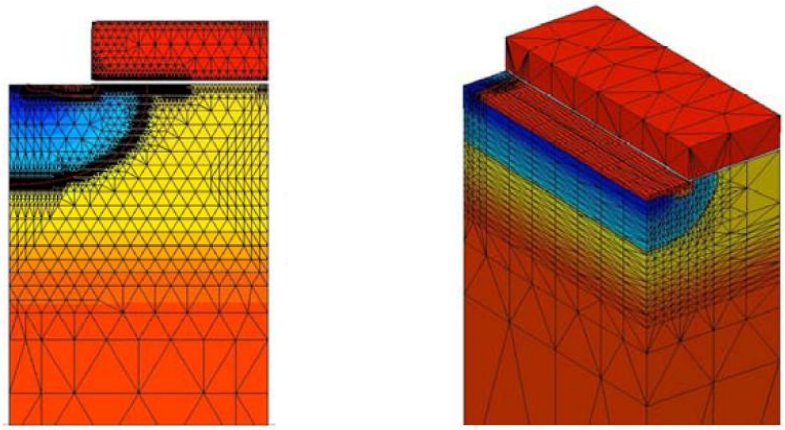


Fig. 3. 2D and 3D models of power MOSFETs used for simulations.
Source: own

All electro-physical and thermal simulations were performed by Synopsys TCAD simulating system. The prepared application library with illustrative device models of structures is very helpful also for students working on bachelor, diploma or doctoral projects and significantly helps them to create their own input files.

3. EXAMPLE OF POWER DMOS SIMULATIONS

An N-channel vertical double diffused MOSFET was used for simulations in the presented course (Fig. 3). The 3-D and 2-D models of the structure were created using the Sentaurus structure editor and Dios tools [8, 9].

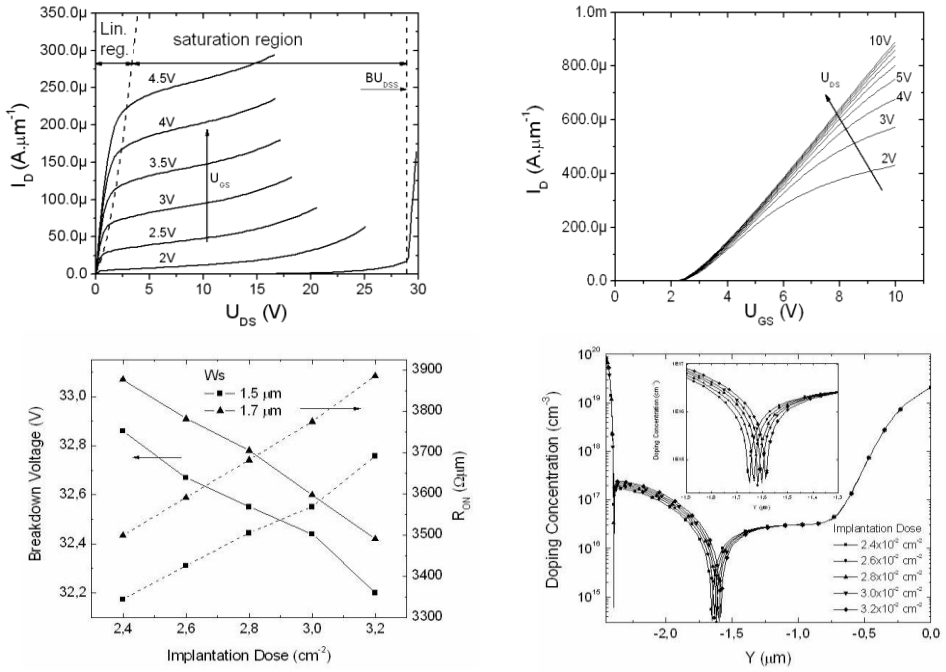


Fig. 4. Simulated output and transfer characteristics (top) and the impact of implantation dose on the doping profiles and ON resistance R_{ON} and breakdown voltage V_{BR}.
Source: own

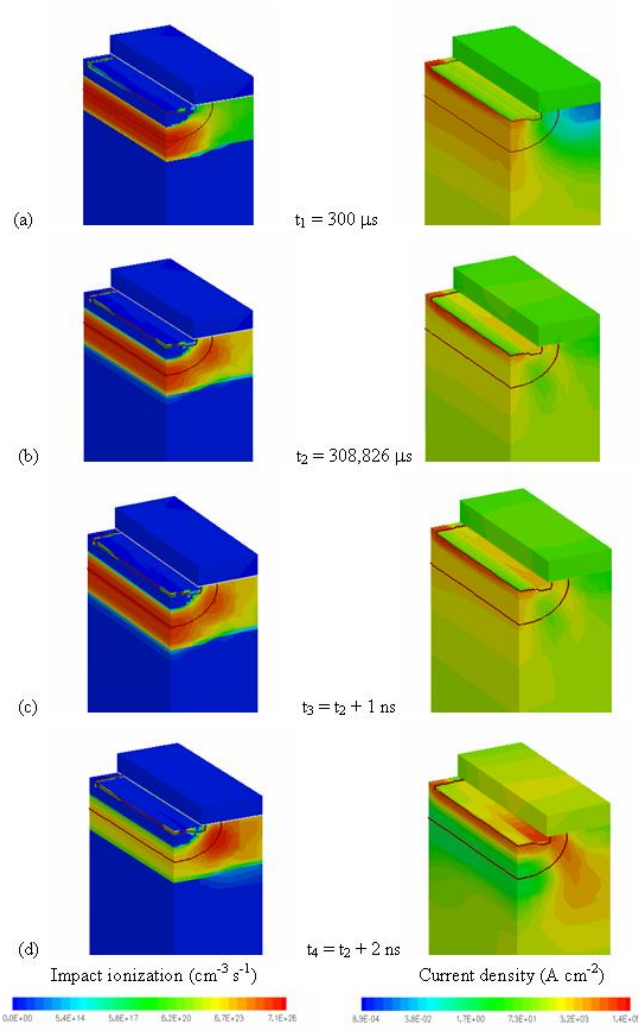


Fig. 5. Simulation of UIS in 3-D model of power MOSFET. Current density and impact ionization during test for I_{AS} = 46 A.
Source: own

D-MOSFET was used because of its structure simplicity. Models are very simple to prepare and simulations exhibit good convergence for meshes with around 6000 points and have only low hardware requirements. This is necessary because we cannot expect that all students have the possibility to do simulations on high-end computers. From the time consumption point of view the results from provided examples have to be obtained in a few minutes so that they can be used for seminars. In Fig. 4 simulated output and transfer characteristics are shown of the designed transistor model. One can see that the threshold and breakdown voltages are V_{TH} ~ 1.8 V, V_{BR} ~ 30 V. The values were chosen with respect to mobility and impact ionization models with best convergence results. Using simulations and these premade models the students can easily do their own "examinations" of the transistor behaviour and performance, e.g., the impact of acceptor impurities in the P-well on the on state resistance and breakdown voltage. These are 2-D quasistatic simulations done using the drift-diffusion mode and to obtain the results takes less than one minute for R_{ON} and five minutes for V_{BR}. The whole project can be pursued during two classroom lectures (1.5 hour). This course is often used for lectures and seminars for the subject named CAD of electronic devices. More information can be found in [10].

A more complicated situation is in the case of electro thermal and 3-D simulations. These simulations require excellent hardware equipment and usually take more than an hour to be done. Therefore they are not suitable for standard seminars. However, they are crucial for deep understanding of power devices behaviour. In Fig. 5 results are shown from simulation of UIS. UIS (Unclamped Inductive Switching) is a common test used to determine the maximum energy that a device can withstand without destruction or permanent change of parameters. During this process high current densities and electric fields occur in the volume of the device causing significant heating. Destruction of the device is caused by activation of a parasitic bipolar transistor. Using simulations one can show the exact position of this parasitic BJT as well as describe the turning on process that is only a few ns long. Results correctness and their attraction for students can be increased by comparison of the measured values and transients with simulations.

CONCLUSION

One of the effective ways of quality assurance in microelectronics education is application of high quality e-learning. E-learning has a huge potential as a motivational and effective tool for acquiring knowledge in an enjoyable way. In the presented course – Power MOSFET – we used our experience from previous e-learning courses and combined it with our experience in the area of TCAD simulations. This course is focused on the effectiveness of microelectronics education supported by 3-D / 2-D numerical modelling and simulations. TCAD device simulations provide a very effective educational tool for better understanding of the electrical characteristics of the analyzed semiconductor devices. The results help to better explain and/or understand the operational principles of the main and most widely used semiconductor structures and devices in microelectronics and electronics .

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EDUCATIONAL SOFTWARE IN INTEGRATED COGNITIVE FIELDS

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Abstract: *We define an opened educational space, as a context of scientific content, witch can be associated with different approaches, at several disciplines. The opened educational space is used as an integrative and unifier auxiliary teaching, for various disciplines in the curriculum and it allows increasing and accelerating the formation of transversal skills. The opened educational space is a digital auxiliary teaching, with educational valences specific of learning programs. It implements in different and unitary teaching scenarios, the elements of scientific content specific to a discipline, in a real situational context, intuitive, common to several disciplines. This manner of design outlines the characteristics of a transdisciplinary educational software. The teaching scenario for the learning program, afferent to each discipline, allows to the student to approach scientific context of the lesson in an interdisciplinary context, without affecting the rigor and consistency of approach monodisciplinary. In this way, it creates a scientific context, witch allows students to explore and discover new elements of scientific content in an interdisciplinary context, logical and intuitive. The student is placed in the centre of the cognitive context. The manner of approach maintains and supplies its interest to the approached scientific content. In this way, it outlines skills that enable the student to adapt to the dynamics and complexity of reality, in the diversity of contexts in which the reality is manifested.*

Keywords: educational software; integrated cognitive field; opened educational space; teacher visibility; discovery learning.

INTRODUCTION

One of the weaknesses of learning programs is the elimination of the "natural" presence of teacher, its competences being transferred a scenario elements. Returning the presence of teacher image in the training process centre should be a concern of the educational software designer. Open educational space is the most appropriate framework for expression both the student as well as for the teacher, which is not, substituted some elements of teaching scenario, but is permanently present and sometimes visible. This paper presents the manner in which the teacher appears in a real context and presents scientific content, constantly argued for the real visual support of the learning space. The presence of teacher in the opened educational space is not dominant. It presents the essential elements of content and establishes the learning tasks. As well, is detailed the way in which the student explores the educational space and learns by discovering. This manner of designing the training process allows the teacher a concentration of resources in the direction of raising the formation, internal and external components of the involved skills. It is noticed a sensitive and visible nearness by the resource-based learning paradigm, through the integrating and unifying character of their exploitation.

1. DISCIPLINARY AND INTERDISCIPLINARY APPROACH

Cucoş C. [1] comprises in a comprehensive and accurate formulation, the essence of interdisciplinarity as "a form of cooperation between different disciplines concerning a complex issue which cannot be surprised only by a convergence and a prudent combination of a several points of view".

We cannot overlook, at the same time, the mobilizing argument offered by Alfred North Whitehead in Process and Reality Essay in Cosmology [6] "to eradicate fatal lack of connection between disciplines which kills the vitality of our modern curriculum. There is a single object of study for education and that is life in all its manifestations", argument sustained by the statement of J. Moffett "The strongest argument for interdisciplinarity is the very fact that life is not divided into disciplines".

In order to define interdisciplinary approaches, even in higher education, it is important to understand the concept and origins of the concept of "discipline". In the academia, and not only, the disciplines are constituted, by segmenting the areas of knowledge, as content entities, convenient in terms of scientific and educational purposes, but which are artificial in essence, in the context of the reality it represents.

A consensus of unity and balance between disciplines is vital and this can be realized than through a common integration in the context of the real world.

Văideanu G. [5] says that "interdisciplinarity involves a certain degree of integration between different domains of knowledge and different approaches, as well as use of a common language, allowing conceptual and methodological exchanges". Integrated cognitive fields are the context of scientific content in which interdisciplinarity can manifest as open educational space, with strong integrative, unifying and accelerating development of soft skill.

Interdisciplinary approach of the training process experiences a paradigm shift at the level of teaching, learning, assessment. Research can encourage the integration between the different academic structures, separated and apparently isolated, through the unification of disciplines. This allows students to correlate the specific contents of several disciplines. The current cognitive challenges, cultural and social, enable to making the educationally synthesis integrated and viable. In current academic approaches, the research-education correlation, must respond to these challenges, in spite of traditional implementation barriers.

The limit of interdisciplinary approach to content is motivated by positive and negative aspects, seen by some as advantageous for education, but difficult to be applied; traditional training of teachers, occupying teaching positions, teaching performance in conditions of excluding the narrow specialization, which generates performance, etc.

In the way of a the synergistic approach lie the communication deficiencies between different academic entities, traditional independent approach of knowledge areas in the training process, but the occurrence of research opportunities in critical emerging areas, make more and more sense but need to enhance interdisciplinary approach in academic environment. Inevitably, this is the direction of development for academic research, determined by the business environment who constantly goes to niche areas and which imposes financially resource, main resource of development. Educational characteristics of interdisciplinary

curriculum are explored in a comprehensive collection of papers, due to the prestigious researchers [7].

2. TEACHER VISIBILITY IN OPENED EDUCATIONAL SPACES

Opened educational space, such as auxiliary didactic, confers interdisciplinary meanings of learning programs, through an alternative implementation.

In a distinct and unitary teaching scenario, with elements of scientific content specific to more disciplines; a real situational context is intuitive and integrator. The design manner of teaching strategy emphasizes the characteristics of transdisciplinary educational software and allow the formation of transversal skills.

D. Crutzen [2] highlights as a main point in the development of strategy for the European educational system, the citizenship education, intercultural education and education for diversity. The trends seem "to promote education for diversity in the perspective of building a European citizenship capable of valuing the cultural identity and diversity of Europe." In education, this construction is based on the concept of transversal or transferable competences. Transversal competences are the way to integrate basic skills pursued by every discipline, such as, the cultural descentration, relativisation of view points, the uncertainties management etc. The main difficulty in achieving these desideratum resides in the fact that at the level of each discipline, these views are addressed in a general manner and an intradisciplinary nuance. From this perspective, the training of transversal competences must aim equally entire school population and all disciplines of study.

The complexity of everyday reality applies equally to youth and adults. The rate of change and response modalities of the school, through all its components, to the training needs, raises more questions than give answers. This situation needs to be expressed in terms of transversal competences and training priorities.

Consequently, is necessary teaching aids and educational software, to facilitate this process. The scenario of the teaching learning programs, must to realize a balance between mono and transdisciplinary approach, to allow students to assimilate scientific context of the lesson in an interdisciplinary context, without affecting the right and consistency of a monodiciplinary approach. This creates a learning space circumscribing reality, which stimulates the student to explore and to discover elements of scientific content, in a logical and intuitive way.

„In classical manner, the student is obligated, at the stage of new knowledge communication, to undergo the cognitive processes by memory, understanding and application. The memorizing as a process creates cognitive discomfort, either because of volume or difficulty of content, either cognitive instinct by preservation of the student. A apparent intuitive approach, based on a multimodal, sensorial perception produce an inversion in Bloom's taxonomy of cognitive processes. In an integrated cognitive space, emphasis fall initially on the understanding and application, memory appearing as a optional and involuntary process, that which creates a cognitive comfort. In reality, through a rigorous design of educational activities, it returns gradually to the natural sequence of cognitive processes, in a context of cognitive comfort, enthusiasm and volunteer mobilization.”[3].

The student is placed in the centre of cognitive context, perceives, correlates and integrates primary information learning from an intuitive environment of knowledge. Gradually he undergoes learning situations in which he places himself in the context of classical learning, determined by dedicated didactical resources of the learning process which gives rigor and accuracy.

Scientific content, specific of the various disciplines are transmitted alternately and correlated in a interdisciplinary teaching scenarios, with transdisciplinary connotations. It forms skills, which allow the student to adapt to the dynamics and complexity of reality, the diversity of contexts in which reality manifests.

In contrast with the presentation of contents, specific to the conventional educational software, which borrow the presentation features to scientific content specific of the manual (text, images, audio and video), in a apparent static and limited context, an integrated cognitive space, presentations will be made by imagining virtual learning spaces as a real space. From this cognitive reality the teacher must not be missing, the central element of the training process.

One of the weaknesses of learning programs is the elimination of the physical presence of the teacher, its competences being transferred to the elements of scenario. Returning to the presence of teacher image in the centre of educational process should be a concern to the designer of educational software. Opened educational space is a framework most suitable to expression for both student and teacher, who is no longer replaced from some elements of teaching scenario, but is always visible and sometimes even present.

In an opened educational space, the teacher can appear in a real context (film), during which he present the elements of scientific content, sustained by the context in which it appears.

The content elements presented to be made available to the student in the classic format (PDF File). Professor virtual presence is mandatory to grab attention, when presenting the course objectives, or derivatives skills, at the time of feed-back, formative assessment, hands on exercises and systematic presentation of knowledge.

CONCLUSION

At each occurrence, after carrying out the didactical tasks, teacher distances himself discreetly, without causing essential changes in the course of learning situation, in which it was involved. Further, the student will access the critical points of cognitive field and learning by discovery. The teacher will intervene, according to the scenario, whenever it is needed. In this manner the training process design, allows the teacher a concentration of resources in the direction of accentuating internal and external training components of the competences concerned.

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USE OF SIMULATION IN COOPERATION TRAINING OF CRITICAL INFRASTRUCTURE ENTITIES

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Abstract: *The article defines entry requirements for using methods and tools of PC modelling and simulation used in environmental development of joint training of crisis management liaisons and critical infrastructure entities in emergency management. A questionnaire-based research into the critical energetic infrastructure entities has revealed that no simulators have been used for crisis management training. The proposed training environment based on simulation is to a great extent universal. Blackout and black start were selected as exercise scenario themes for discussions with appointed representatives of critical infrastructure entities, as these phenomena present the highest level of risk for society, infrastructure, property and environment. The characteristics of modern simulation systems were analyzed in order to assess their suitability for training. Emphasis was placed on constructive simulation. Generally speaking, a training environment built on simulation and supportive tools for preparation, execution and evaluation of training should serve for improving and verification of crisis preparedness of the critical energetic infrastructure entities.*

Key words: simulation, cooperation exercise, black out, black start, critical infrastructure entity, energetics.

INTRODUCTION

Impacts of incidents of anthropogenic and natural origin prove dependence of modern society on infrastructure. Due to negative impacts of these threats to state security, population, property and the environment, governments seek to implement and develop preventive and remedial measures in order to increase resilience and safety and reduce vulnerability. The sectors of critical infrastructure with direct impact on the functioning of equipment and systems essential for the sustainable development of the country in the event of disruptions and have cascade effect were identified in order to support this effort.

Public authorities and critical infrastructure entities should be prepared for conjoint and coordinated crisis management through organizational, methodological and material-technical measures. An integral part of emergency preparedness is education, training and communication. Lack of practice and effective communication among the participants makes even carefully crafted crisis documentation useless.

1. CURRENT SITUATION ANALYSIS

1.1 Critical infrastructure protection and interdependencies within critical infrastructure

Critical infrastructure protection system has its origin in the United States of America. The National Infrastructure Protection Plan (NIPP) [1] contains 18 sectors of critical infrastructure and key resources. The concept of critical infrastructure and key resources includes all assets, which are so vital for any country, that their destruction or degradation would have a debilitating effect on the essential functions of government, national security, national economy and public health [2]. This issue was subsequently adopted by developed European countries (Germany, United Kingdom) and the European Union by means of The Green Paper on a European Programme for Critical Infrastructure Protection [3].

The Czech system of critical infrastructure protection is based on the European program and was implemented by means of the Emergency Act [4]. Critical infrastructure of the Czech Republic includes production and non-production systems and services, whose malfunction would have a serious impact on state security, economy, public administration and provision of basic life needs based on the Resolution of the Committee for Civil Emergency Planning no. 277 of 12. 6. 2007 [5]. Critical infrastructure entities, which are operated by a government department, are appointed by government pursuant to the Emergency Act [4] § 9 Article 3 (d) of, as amended. Private entities are determined by a general measure issued by the competent ministry. National critical infrastructure is divided into nine sectors. One of the sectors is energetics, which includes the supply of electricity, natural gas, oil and oil products [6]. Private entities of critical infrastructure energetic sector are appointed by the Ministry of Industry and Trade of the Czech Republic. The entities of energetic critical infrastructure are mainly owned by legal entities with a business licence.

The first step towards effective critical infrastructure protection is risk assessment, which involves analysis of environment and its soft spots, risk assessment and implementation of procedures for hazard mitigation. An inherent characteristics of electric infrastructure protection refers to interruption or unavailability of power supply, a risk management issue. Most research to quantify and assess risks within the electricity infrastructure, taking into account the existence of technical and non-technical threats, is currently under progress. It is impossible to achieve energetic sustainability, economic or social development if the operation of its infrastructure network are at risk or vulnerable [7].

The reason for increased protection of critical energetic infrastructure is its interconnectedness and complexity. Disruption of a single critical infrastructure sector because of a terrorist attack, natural disaster or man-made damage, is likely to have cascading effects on other sectors [8]. Disruption spreading is known as interdependence. Critical infrastructure entities are dependent in various ways, dependence may thus refer to merely one-way dependence or interdependence (bilateral interaction) [9]. Interdependencies vary widely and each has its own characteristics and effects on infrastructure agents [10]. The four main types of dependencies are: physical, cyber, geographic, and logical.

Interdependent infrastructures also display a wide range of spatial, temporal, operational and organizational characteristics, which can affect their ability to adapt to changing system conditions. Finally, interdependencies and the resultant infrastructure topologies can create

subtle interactions and feedback mechanisms that often lead to unintended behaviour and consequences during disruptions [10].

The scheme in Fig. 1 depicts the relationship between the energy sector and other sectors. It shows the crucial importance of critical energetic infrastructure for the state and the need for its increased protection and resilience. Efficient response and coordination of integrated rescue system requires that the responsible public authorities understand the interdependence of the mechanisms and instruments.

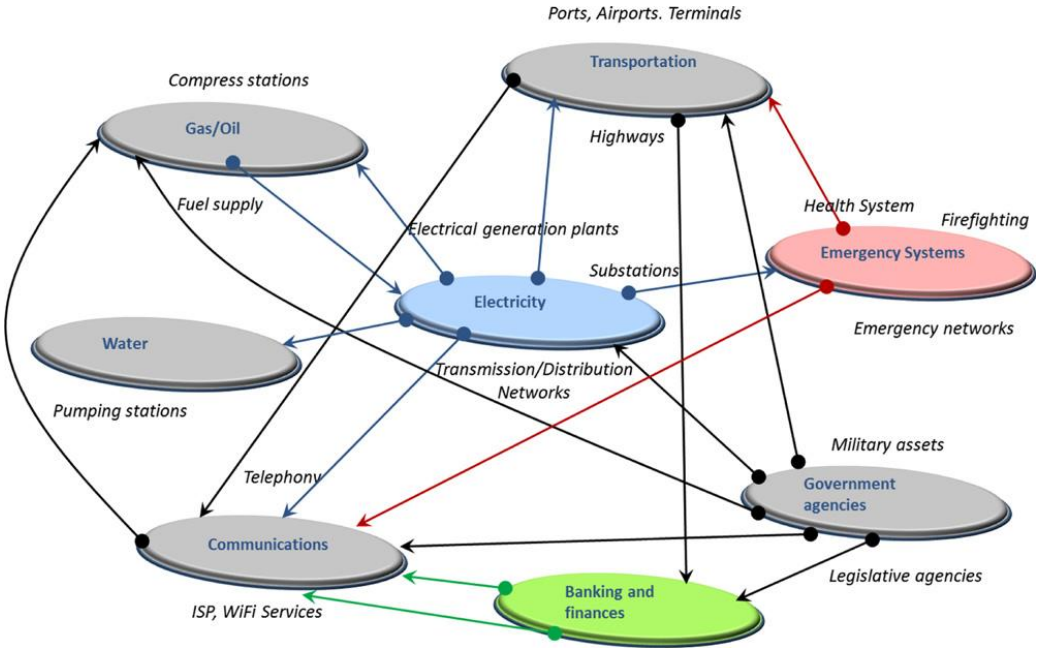

Fig. 1. Example of interdependence between energy systems and other entities of critical infrastructure
Source: own

1.2 Crisis preparedness exercise

The documents governing the conditions of critical infrastructure and key resources issued by USA [1] deal with staff training, including exercises. The Crisis Act operative in the Czech Republic deals with verification of preparedness for emergency situations by means of exercises, but it applies only to the units of the integrated rescue system and public administration under the Act on Integrated Rescue System No. 239/2000 Coll. [12]. Critical infrastructure entities are not obliged to test their crisis preparedness plans by means of exercises, although exercise is the most appropriate method of emergency preparedness verification and also an effective tool for acquiring skills and abilities for crisis situation management [13].

Well-qualified personnel, who is continuously being educated and trained in security procedures is essential for ensuring emergency preparedness. Professional emergency preparedness is implemented in different ways, depending on the function performed. Real units training is very costly, especially large-scale cooperation exercises, which makes the use of appropriate simulation tools very favourable.

Training models and simulators must be adapted to the objectives of preparation and training as well as the characteristics and extent of trained situations. Exercises are divided according to preparation and training objectives into following categories:

- drill exercises
- cooperation exercises
- testing exercises
- experimental exercises.

Crisis preparedness exercise can be implemented at the central, departmental, regional, and municipal level and at the level of response units. Exercises are organized as a single-level or multilevel, or as staff or exercise with participation of executive authorities.

An analysis into the possibilities of using modelling and simulation in preparation and training of personnel and emergency management authorities shows that there are virtually no rules for creating and use of training models. Educational and training models and simulators can improve education, preparation and training, making it more intensive and effective, and thus can help in increasing preparedness and improving skills of personnel and emergency management authorities.

1.3 Modelling and simulation in critical infrastructure

The modelling techniques for critical infrastructure protection used by various methodologies are applied to critical infrastructure protection by means of simulation paradigms and decision-making procedures: multi-agent systems, system dynamics, rating matrices, relational data-bases and the network theory. Those modelling techniques are also combined with supplementary computational methods and techniques: continuous time-step simulation (CS), discrete time-step simulation (DS), Monte Carlo simulation (MC), decision trees (DT), geographic information systems (GIS), risk management techniques (RISK) and event monitoring or real time record (RTR) as a support for decision-making [7].

Types of applications for modelling and simulation using synthetic environments

The suitability of a particular simulator used in preparation for resolving most commonly occurring emergencies can be assessed primarily based on the following characteristics:

1. existence of entities and models intervening at an emergency event
2. ability to create an emergency event
3. possibility to affect emergency event in the simulator with use of forces and resources deployed for its disposal or mitigating its consequences
4. ability of exercise director team to respond to the emerging situations.

The first three points are determined by direct simulation system capabilities. These can be narrowly focused on tackling certain emergency event types with highly sophisticated degree of reality, or greatly simplified, allowing almost any event simulation. It is advisable to design the simulation system so as it includes both variants to the maximum possible extent.

These, to certain extent universal, properties are met when using constructive simulation systems, which also meet openness requirement.

Simulated entities are controlled by the simulated operator in constructive simulation. Constructive simulation is thus a kind of simulation, in which a model includes everything

that is essential for replacing the original in the course of simulation, even a model including humans. The person is thus represented by a submodel in constructive simulation.

2. METHODS USED

In the initial project phase, a systematic requirements analysis was carried out, so-called "requirements engineering [14]". Stakeholders from the national critical energetic infrastructure were selected and addressed; relevant ministries, designated bodies of critical energetic infrastructure and emergency management authorities. The stakeholders were individually interviewed regarding activities, cooperation and collaboration among the crisis management agents and critical energetic infrastructure in the exercises focused on the analysis of their impact on the environment. The interviews were carried out with use of questionnaires. Twelve national critical energetic infrastructure entities from the field of electricity and central heating supply were selected. One entity refused cooperation. Due to the small number of entities, the so-called exhaustive investigation [15] was opted for.

The survey results show that critical energetic infrastructure entities implement exercises beyond the scope of legislation. The exercises either have a particular character of one-level in-house training, or they are realized in cooperation with municipal authorities and the IRS units. No simulation tools are used in preparing or running the exercises. Simulators are used only exceptionally, mostly for risk analysis and analysis of the extreme events impact spreading, as a means to support crisis and emergency planning and decision-making.

Based on requirements engineering, following requirements have emerged:

1. on exercise themes – black out, black start
2. on exercise participants – regional emergency committees and emergency committees of municipalities with extended competence
3. the critical energetic infrastructure entity – key objects affected by power failure
4. type of exercise – cooperation staff exercises.

Furthermore, it was revealed that provinces and municipalities have not defined minimum requirements on electricity supply for maintaining the functionality of key facilities and equipment within their territory during black start emergency.

3. MODELS FOR THE COOPERATION SIMULATION EXERCISE

3.1 Environment

An integral part of the simulation is a model of the region of interest, in which the simulated events take place. The environment model includes the terrain model and a model of weather and natural or anthropogenic phenomena that take place within the area. Simulation places certain requirements on the terrain regarding data organization (format) and the data characteristics. The model development requires considering interdependence and dependence of the models and the possibilities of using the environment model by other models (e.g. navigation in the terrain, affecting the functionality of the simulated entities models, phenomena spreading, interactions, etc.). Structured data must be used, with a minimum of mistakes and providing accurate data quickly and reliably.

3.2 Entities

Without the models of vehicles and persons moving in a simulator environment and performing activities the same way as in the real world, any simulator, no matter how good, is only a means for landscape visualization. It is necessary to invigorate the environment with entities (models) of people, animals, vehicles, machinery, equipment and other items used in usual human activity.

For the training needs of municipal/regional crisis staffs and entities of critical infrastructure, the training units will mainly consist of the Fire Rescue Service, Police, Health Rescue Service, Voluntary Fire Brigades, Administration of State Material Reserves, municipal police, humanitarian organizations, organizations providing help upon request, etc.

All of the listed organizations possess a variety of technology and equipment. The material including its operators will be represented by individual entities and tasks, which will simulate the units' activities so as they correspond to reality to the maximum possible extent, in terms of content, technical aspects and time.

Created entities will perform independent activities, which will be assigned to them by means of predefined tasks. The tasks can also be performed in groups.

The tasks models will have to be properly parameterized and set for the selected entities and units. Activities will emerge from the actual training requirements. When choosing a constructive simulation system, it will be necessary to ensure its openness for further additions and modification. It is necessary to take into account that new requirements for models and tasks or their modification, extension or parameterization change will appear depending on new possibilities. Some of the units will perform tasks without any requirements on material, equipment and special requirements, others will require material support, a specific place or their performance will be affected by the surrounding environment.

When using simulation for training in a larger area with plenty of simulated agents, it is possible to introduce some degree of aggregation in order to simplify the simulator operation and reduce its load. The "entity" will thus represent a certain number of elementary entities (e.g. an aggregated "30 people" entity will represent the location and status of 30 people).

Functional (complex) entities present a special entity type. They contain process models of specialized equipment (e.g. substation), i.e. input and output parameters and the process of their transformation over time using other means is defined.

3.3 Emergencies and environmental effects

Emergencies and crisis situations are accompanied by domino effects and synergistic effects. Models of emergencies and related phenomena form an integral part of the synthetic environment created by the simulator. Some of these activities can be realized in exercise rally, however, it is more suitable to create tools allowing dynamic simulation of the phenomena.

The complex links between individual simulated elements need to be included in the simulated environment, i.e. cohesion of terrain, weather, entities and the links to their

surroundings. This consistency makes the simulator a training tool and differentiates it from common computer games. Changes in the simulated environment usually take place dynamically, independently of the user's will, and are controlled by complex internal algorithms, which imitate corresponding states in the real world, e.g. speed of movement.

Based on requirements engineering and planned project outcomes, an implementation of the basic module on blackout and black start will be carried out.

Other events and phenomena that may affect the critical energetic infrastructure may be controlled by the team of exercise director (e.g. rime, fire, flood, terrorist attack). The method of problem initiation is a short-time event, with the same or very similar effect. Especially crucial is mastering cascading phenomena, which present a complicating factor from the point of view of emergency response training.

3.3.1 Blackout model

The blackout model is characterized by its:

- structure
- structure objects (entities) behaviour
- procedures for invoking emergency and its gradual elimination.

In order to allow training of certain specialists in addressing issues related to elimination of blackout consequences, it is necessary to create the structure of the system (transmission network, distribution network, substations, transformers), which is affected by the blackout.

The model structure will reflect the current state of the electricity network in the Czech Republic. In terms of designing constructive simulation software, it is advisable that the above-mentioned elements of the model structure have a character of so called "entities", which can be matched with a defined behaviour.

Parameters and behaviour of the objects (entities) in the blackout model

The blackout model structure includes the elements of transmission and distribution systems, substations and transformers. The target group, which is likely to use the model, will address issues related to the detection of sites of disruption power line overloading.

The most important behaviour feature in the model will be the possibility of defining the site of line disruption (alone or due to electrical column destruction) and the effect of this disruption on electricity distribution (which elements of the transmission and distribution system will be put out of order due to this phenomenon).

The transmission and distribution system substations will be characterized in terms of identifying the model especially by its field position and power distribution orientation. The model will therefore have to include a graph of local electrical energy distribution elements.

The transmission and distribution system transformers can be considered point objects, which "only" change their physical element features (electric energy), i.e. the voltage of electricity transmitted into given direction. It would therefore be advisable for the blackout model that the entity is characterized by its location in the terrain.

From the point of view of the system behaviour as a whole, the transformer operability (functionality) is crucial. It is important that the model allows changing its status (operable-inoperable) and showing which of the system components (transmission and distribution) will be affected by the change of its status.

The blackout and black start model must ultimately allow displaying the following states and phenomena in the simulation system:

- identifying the component of the transmission and distribution system (section of power lines, column, substation, transformer) that is out of order
- an area affected by this phenomenon (interruption of power distribution)
- areas where electricity supply is being renewed in accordance with the requirements of crisis management authorities.

When the administration mode is activated, the simulator must allow putting the objects (line sections, columns, substations and transformers) into following states:

- out of order
- operational.

This function of the model is important in terms of the possibility of creating emergency states, which are defined by an exercise scenario created for training of a specific target group of trainees.

In the model implementation it is particularly important to consider possible domino effects, which are important for given training purposes (cooperation among the entities of critical energetic infrastructure and IRS and state administration).

3.4 Other elements of the training environment

The above-specified simulator, which will provide the trainees with a virtual world in which the trained event will take place, presents only one part of a complex training environment, the scheme of which is shown in Fig. 2. Another crucial feature is an exercise evaluation tool. The tool records the course of the simulated events and trainees‘ activities and based on the critical factors it provides quite objective view of managing the trained situation by the trainees.

Among the critical factors, as the most important criterion in assessing the situation and deciding on individual measures to tackle events or situations, are:

- threat or harm to public health
- individual deaths
- mass deaths
- threat / damage to elements of critical infrastructure
- destruction / malfunction of critical infrastructure elements
- threat / damage to property
- destruction of property
- threat / harm to the environment.

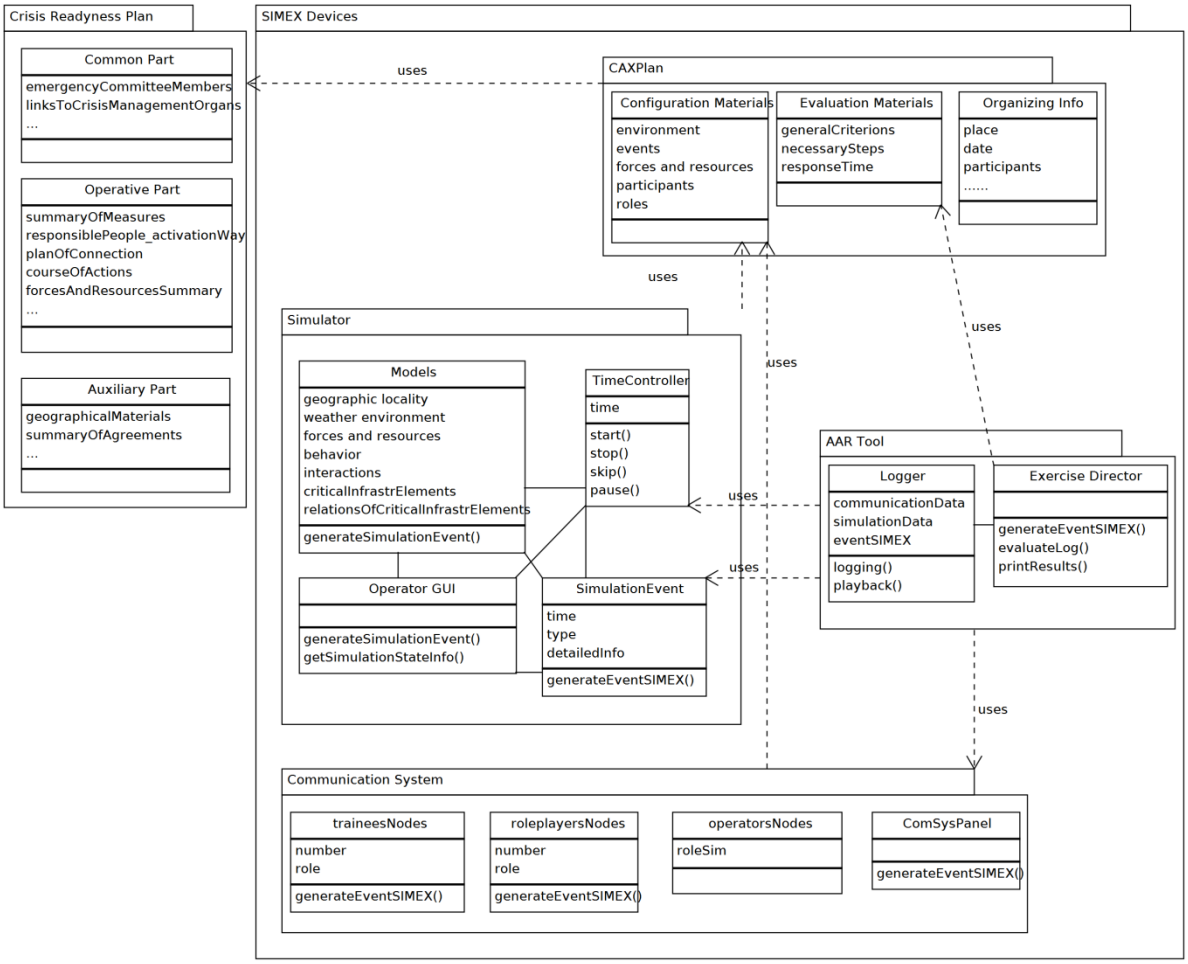

Fig. 2. Diagram of the suggested training environment
Source: own

CONCLUSION

The analysis into the current state proved that the critical energetic infrastructure is the key sector of the whole critical infrastructure. Its disruption presents a significant threat due to its interrelationships with other infrastructure sectors. For this reason, it is necessary to be well-prepared for the threat of electricity supply interruption. The best form of crisis management authorities training are exercises, which can benefit from the use of constructive simulation.

The analysis into the requirements of critical energetic infrastructure entities has revealed that no simulators are currently used in exercise preparation and realization. According to the respondents, the weakest link in emergency preparedness is preparedness for dealing with black start after a sudden black out. They perceive the need to ensure mutual communication and information exchange among emergency management authorities, electricity supplier, dispatching and affected parties. This survey served as the basis for selecting the stakeholders who should take part in the cooperation exercise.

General models and conditions for black out/black start simulation were defined. Further research will be oriented to two directions; the first is designing a simulator, the second is creating a schedule and a plan for conducting an exercise, which will then serve for testing the designed simulator. The exercise plan will include defining specific exercise director team members, the exercise objectives, the time for conducting the exercise and exercise phases.

The simulator will be tested during a staff training of a regional crisis management staff. Presently, discussions regarding realization of exercise in cooperation with the South Bohemian Region and the E.O.N. Distribuce, a.s. company are taking place.

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PROFESSIONALS CALL FOR IMPROVING FOREIGN LANGUAGES COMPETENCE

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Abstract: *Students should master to express their opinion using both proper linguistic means and terminology. The aim of module based teaching consists in encouraging linguistic and professional competence covering topics in forestry, woodworking, furniture, landscape engineering, arboriculture, etc. The interactive Forestry/Wood focused CD offers introductory texts and lists of vocabulary presented by a native speaker; after that the vocabulary is practised and revised using multipurpose exercises focused on critical points in English grammar patterns. Further topics as well as students presentations can be gradually added, therefore learning-teaching aid can be easily extended and modified. It can be used both during classes and as an e-learning support.*

Keywords: training module, terminology, multi-purpose exercises.

INTRODUCTION

Module-based learning and teaching are efficient tools in improving professional and foreign language competence. Specialized terminology has to be carefully selected so that topics can be arranged from general to highly specialized. Current undergraduates do not come from secondary schools specialized in the field they study at university. Graduates from secondary grammar schools are better at mathematics, chemistry, physics and foreign languages and they somehow benefit from it in the first year of their study; therefore requirements for general English language knowledge and skills are easy to pass, grammar structures and vocabulary are usually not a problem to revise; in addition, many students select the English language as one of school leaving examination subjects. On the contrary, students coming from some secondary technical schools prefer selecting mathematics; they consider passing the school leaving exam in math easier comparing to the English language. They can speak, however they sometimes use intuition instead of logical approach. Sentences mostly contain right words arranged in "exotic" order, particularly sentences such as "Who calls you every morning X Who do you call every morning?" Nevertheless, finally they are able to manage grammatically correct sentences. Having passed the exam in general English, they continue studying specialized terminology focused on the Forestry, Woodworking, Arboriculture, Landscape engineering, Furniture and Design.

1. WHICH OF TEACHING METHODS CAN FIT BETTER?

Long-standing pedagogical and methodological experience has been reviewed and final decision was: we need general language skill knowledge B2 before teaching terminology. Long-term practice in teaching a foreign language has been considered and determined that an ordinary grammar-focused method is more efficient comparing to methods used in foreign textbooks; grammar-focused method is less time-consuming, it is based on logical steps,

grammar patterns and models are easily remembered, practised and prioritized by technicians in general. Czech and Slovak Bachelor undergraduate students have grammatical awareness; therefore, using the principles of contrastive linguistics, a foreign language is easier to learn. As students know grammatical terminology and categories, they are able to make a correct hierarchy of grammatical structures, they can discover their consistency and can establish additional grammatical syntax; this method has to be consistently complemented with listening comprehension, reading comprehension and writing. In this step, modern textbooks coming from native speakers can be used depending on the teaching and working time available. See e.g. [1], [2], [4].

2. SECONDARY GRAMMAR VERSUS SECONDARY TECHNICAL SCHOOL

Twenty-eight topics-modules are divided into texts specialized in Forestry and Woodworking because students are expected to manage basic terminology in these two specializations.

Students coming from secondary technical schools (forestry, woodworking, furniture, horticulture, etc.) have a big advantage comparing to those coming from secondary grammar schools; they have professional knowledge and skills in particular fields. They are sometimes confused with a new vocabulary; however, having remembered a few key words, they are able to understand correctly material presented in English. They studied the problems from technological point of view at the secondary technical school and now they are quicker in the uptake when studying the topic, which is quite unknown for the others. Students from technical-oriented secondary schools really benefit from their professional knowledge; in case they are familiar with the topic, i.e., "game management", "logging", "clearcutting", "MDF boards", "chain saw", "assemble techniques", "wood defects", "fasteners", etc., many of them are able to present fundamental data, technologies and crucial information in English.

2.1 What helps students?

Students have to participate in various practical exercises, exhibitions, workshops during their study. At the same time they are expected to follow the study requirements, study materials for their lessons, etc. The project Akademie can somehow help students who miss some lectures, selected a combined study program or would like to learn some specialized topics and vocabulary by themselves. Topics are prepared so that students are able to work independently; they need just a quality specialized dictionary. Unfortunately, they prefer dictionaries available on the Internet despite the fact the expressions there do not provide the information about the field of study they belong to or no translation is offered at all. Referring to the fact that study curricula overlap, interdisciplinary topics are selected: 28 topics are presented on the English language focused CD. Individual modules use the same template and are arranged as follows: introductory text, vocabulary with no Czech equivalents, and exercises with keys. The introductory texts as well as vocabulary are presented by a native speaker. New study modules are currently used in regular classes, however, keys and solutions are not available for students because they would prefer using keys instead of creative approaches.

2.2 Questions are the critical point

The most critical point is not a specialized vocabulary itself; questions seems to be the most complicated issue; in particular these are exercises such as: form questions – the underlined

expressions or phrases are the answers. Students often hesitate, they are not sure, confuse the word order, the difference between "WHAT" and "HOW" causes troubles, "subject question" specification becomes a really hard nut to crack; indirect questions and passive voice are further critical structures in general.

Personal questions usually arise very naturally during the course of a lesson and we can practise expressions such as: would, could, may, shall..., etc., e.g., "Shall I switch on the light? I can´t see the letters. May I use your dictionary?, Could you sit, please?, Is warning written with capital W?", or so called Wh-word questions, containing expressions such as:

WHEN: When will the next course start?
WHO: Who has left?
WHICH: Which of these two brushes is softer?
WHOSE: Whose saw is it?

The purpose of comprehensive questions is to clarify doubtful points and establish that the material under consideration has been thoroughly understood, These are questions, such as: Why are 3 knives missing?, How should the surface be sanded? There are a lot of question signals containing WH-words in sentence patterns.

Grammar questions deal with particular lexical items and are rather restricted in number. We can practise questions, e.g., "What is the opposite of ´thin´?, How do you spell ´tyre´ in British and American English?, Is ´practice´ a noun or verb?, How can I pronounce ´either´?"

General questions help to expend the scope of vocabulary items included in the discussed material, in particular questions close to the students´ own experience; therefore the teacher can allow students rather more freedom in forming questions. The teacher may model the general procedure for comprehensive questions and the cues may be both a single word or phrase selected from the text or the material studied before. Questions may vary, e.g., What is the difference between "coniferous" and "broadleaved species"?, What is a final shape of a knot if we cut a branch perpendicular to its axis?, Look at this table, how many right angles can you see?, etc. Regardless the subject, i.e., woodworking, mathematics, etc., students should be taught skills how to raise different types of questions that guide, lead or inquire. Questions testing mathematics require higher-order thinking, social studies oriented questions involve recall of facts.

2.3 What is practised in modules?

Every module comprises the introductory, text, list of vocabulary and various types of exercises such as: answer the questions, form questions – underlined expressions are answers, mark sentences True – False, match opposites, which expressions do not belong to the group, form adjectives, nouns, verbs, match expressions (use drawing), fill in the blanks, what do the definitions stand for, form logical groups, etc. At least five types of exercises are included in every module, e.g.

Module LACQUER
Find expressions, which are related logically; number in groups varies:
contain, thinner, susceptible, water-resistant, spray, water-repelling, sensitive, solvent, drawback, odour, hydrophobic, smell, strong, positive, weak, composition, compound, brush, ingredient.

Solution:
Water-resistant, hydrophobic, water-repelling
Susceptible, sensitive
Odour, smell
Brush, spray
Thinner, solvent
Strong, weak
Drawback, positive
Contain, composition, compound, ingredient.

Module PARTICLE BOARD
Form nouns:

STRONG	
RESISTANT	
HARMLESS	
IRRITATE	
STIFF	
RECOGNIZABLE	

Solution:

STRONG	STRENGTH
RESISTANT	RESISTANCE
HARMLESS	HARM
IRRITATE	IRRITATION
STIFF	STIFFNESS
RECOGNIZABLE	RECOGNITION

Module MATERIALS USED FOR CONSTRUCTION PURPOSES EXCEPT WOOD
Match definitions and expressions given below:

- …made from clay moulded into oblong blocks and fired in a kiln or baked in the sun
- …a white, metallic chemical element that is extremely ductile and malleable, capable of a high polish; the best metal conductor of heat and electricity; it is a precious metal, it is used in manufacture of coins, jewellery, alloys; a salt of it is used in photography, etc.
- … to wear away gradually, as by rusting or by action of chemicals
- … hard, compact material formed when a mixture of cement, sand, gravel and water dries
- … a trough or channel along or under the eaves of a roof, to carry off rain water
- … loose, gritty particles of disintegrated rock, varying in size, usually deposited along the shores of bodies of water, in river beds or in deserts

(gutter, silver, sand, concrete, brick, corrode).

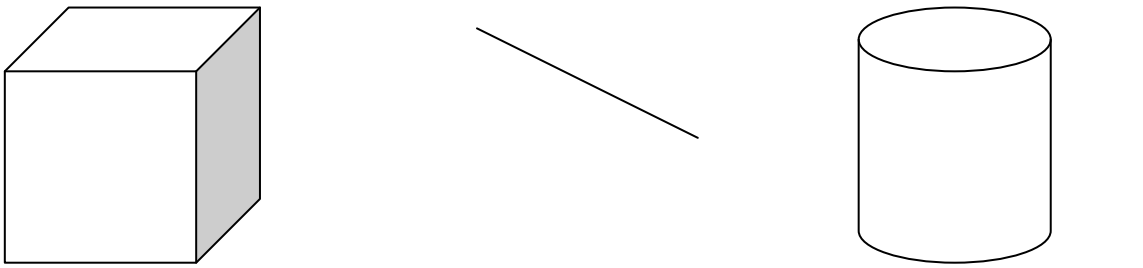
Solution:
brick
silver
corrode
concrete
gutter
sand.

Module FURNITURE

Match expressions and drawings (there are more expressions)

(cone, tapering, arrow, straight line, curved line, volume, triangle, rectangle, vertical, sphere)

1



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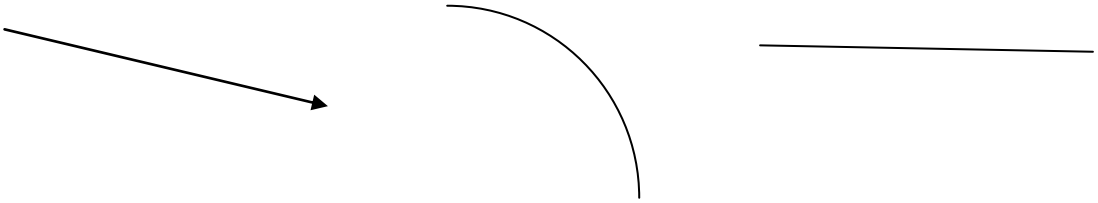

Solution:

1a: cube, volume
1b: straight line
1c: cylinder, volume
2a: arrow
2b: curved line
2c: horizontal line

Module URBAN FORESTRY

Form questions. Underlined expressions are answers.

Transplanting season

Trees and shrubs are moved with the greatest success in the late winter or early spring, after threats of frozen ground and frost but before enlargement of buds or renewed growth. Newly planted trees require special attention during the first two seasons. A saucer-shaped catch basin around the base of the tree aids in collecting and distributing water to the tree roots. Mulching aids in moisture retention around newly planted trees and helps to moderate soil temperature and control weeds.

Solution:

1 When are trees and shrubs moved successfully?
2 When do newly planted trees require special attention?
3 How does a catch basin look?
4 What is distributed to the roots?
5 What helps in moisture retention?
6 What does mulching help to moderate?

Module ECOLOGY

Which of the expressions cannot belong to the group?

1 Particle, particulate, dust, micrometer
2 Photosynthesis, CO_2, copper, water
3 Combustion, zinc, fossil fuels, sulphur dioxide

4 Incomplete combustion, spore, petrol, hydrocarbon pollutants
5 Water, high velocity, transport medium, nutrients.

Solution:
1 Particle, particulate, dust, **micrometer**
2 Photosynthesis, CO_2, **copper**, water
3 Combustion**, zinc**, fossil fuels, sulphur dioxide
4 Incomplete combustion, **spore**, petrol, hydrocarbon pollutants
5 Water, **high velocity**, transport medium, nutrients.

Module SEED COLLECTION
Match expressions (each can be used only once):
Permanent, tray, pruning, paper, hand, collection, scythes, bags, shears, marker, seed, wooden.

Solution:
1. Permanent marker
2. Seed collection
3. Pruning shears
4. Hand scythes
5. Paper bags
6. Wooden tray

3. DISCUSSION

The interactive CD is a good support not only for regular full-time students but also for combined-study program students and self-study activities (academic staff, PhD students); it can be used as an e-learning support as well. The aim is to reinforce the language competence, enhance students´ chances to work both for foreign and domestic companies. The goal is to read, reproduce and present technical issues and research results, give oral presentations at foreign conferences, feel language safe at internships, improve skills and start publishing in foreign journals.

CONCLUSION

Learning-teaching process has to keep the pace with increasing volume of knowledge regardless the time available for studying. Students differ in abilities to learn foreign languages; therefore, individual approach and relevant teaching supports are required and are highly appreciated by students, in particular those being engaged in combined study programs. This interactive Forestry/Wood CD resulted from shared effort of teachers, technicians and IT staff. Another big advantage consists in the fact that further topics including exercises, lists of specialized vocabularies, presentations prepared by students, etc., can easily be added. This type of CD can efficiently be used for e-learning purposes; it is easily handled, vocabularies as well as texts are presented by a native speaker and solutions for different exercises are offered.

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INDIVIDUALIZED ON-LINE EDUCATION IN STEM

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Abstract: *This note focuses on the culture of individual communication within the massified Education process, and the prospective role of new technologies there. Based on the authors experience in the area of STEM Education, new horizons and possibilities are questioned.*

Keywords: asynchronous communication, flipped classrooms, MOOC, EduArt.

INTRODUCTION

Over centuries, the development of teaching and learning swapped repeatedly, roughly speaking, between two main phases: *"Teaching Facts"* and *"Engaging the Intellect"*. Both can be done in a useful and practical way, or the opposite. But in recent decades the tendency to teaching facts was perhaps stronger than ever before. Moreover, there were many other risk factors appearing: too much specialization, fit for purpose training, unrealistic expectation from new web based technologies, etc. At the same time we are facing heavy decline of interest in the Science, Technology, Engineering, and Mathematics education, the so called *"STEM"*. Actually, a good illustration and essence of the problems can be seen in the current role and the position of Mathematics within STEM.

This paper displays the authors personal views and experience from the Masaryk University, the ongoing project "A Brisk Guide to Mathematics", and recent usage of the newly developed EduArt technology. On the way, we shall pay attention to the potential of the new technologies including rich media, on-line learning, and further web based communication techniques in general.

1. WHY NEW TECHNOLOGIES

1.1 The impact of personal typologies

All experienced teachers are aware of the fact that the perception and thinking schemes of individual students are as diverse as their behaviour and attitudes. The author devoted attention to this phenomenon in [3]. In particular, it is clear that classical face to face lecturing in big classes cannot address all the students in a fully satisfactory way because there is no universal best approach for all of them.

This phenomenon was not well visible in small groups of well-motivated students, living together in the colleges with their teachers. Nowadays, the massified Education is mostly flourishing at the universities, but the current generation of students is ready to live in a quite virtual world in the internet and so we should be able to substitute the lacking direct communication by its virtual forms.

This is the great potential of new technologies, but we must not focus on capturing and archiving classical lectures without changing their form or, even worth, on replacing them by simpleminded drill e-learning environments. Instead, we should build platforms where all the relevant types of (mainly asynchronous) communication can happen. Moreover, the chosen tools and channels should support both the quest for real understanding – let us call this the *"engaging the intellect phase",* and the obligatory *"teaching facts phase",* and they should support them in a way allowing the students to choose the ordering of these two phases. This is extremely important in view of the personal typology differences among the students, see again [3] for more details.

The architecture of our platforms should also take into account the quickly growing differences between the generations. Recently, studies pointing out some of the most obvious worries were published. For example the results of the survey *Meet Generation Z: Forget Everything You Learned About Millennials*[1] says that the current (American) teenagers are, unlike their teachers: they are multitasking across 5 screens; keeping attention for less than 8 seconds only; they collaborate better, but more than 10 % of them suffer hyperactivity and further neurological deviations; they live in virtual realities.

1.2 The real performance of colleges

Reading recent studies on the real performance of universities/colleges is even much more pessimistic. For example, there are two recent books by the sociologists Richard Arum and Josipa Roksa, [1], [2]. The first one deals with more than 2300 bachelor students in 24 schools of different character. With a bit of exaggeration, the students learned a lot of bad habits while their critical thinking and readiness to work got too often even worse. In the second book, they extend the study to the general changes in the social behaviour in the last 40 years. Among others, they conclude that both students and teachers are more and more obsessed by quick appreciation and success in the community, while the importance of more conservative and long lasting values and goals is wading out.

Obviously, this discussion applies to the Czech Higher Education as well. Most of the universities have been undergoing serious debates leading to reforms of the curriculums and the new technologies have played often an important role there. Unfortunately, the author is not aware of any example of best practice where this would represent a global change of the paradigm replacing and essentially extending the approaches and tools in the everyday teaching praxis.

1.3 The potential role of asynchronous communication

As we are witnessing across social networks, the individualized communication can be restored easily with properly chosen technologies even in extremely big communities. Most of such communication is asynchronous, but with quite short intervals between the interactions.

Thus, we do not want to focus on simple capturing of standard lectures and making them available on demand, or on straightforward drilling tools for memorising facts. Instead, the materials displayed should rather initiate discussion among the peers, perhaps monitored and further expanded by the teachers. This could promote the engaging intellect phase of the

[1] Survey released by Sparks & Honey in April 2014, cf. http://www.sparksandhoney.com/work-index/

process and it should also support the appearance of individual leaders emerging within the community, which seems to be the most efficient improvement of quality by itself. At the same time, the students could possibly feel more like in a private and individualized environment, similar to the most classical colleges with small groups of students living together.

2. THE MOOC PLATFORMS

2.1 Three main types of activities

The universities understand that their basic roles are quickly expanding together with the expansion of the numbers of their students. They should feel responsible also for the motivation of the talented youth, as well as for the lifelong learning of the graduates. Therefore, we must not understand the new platforms like the MOOC's as mere extensions or complements of the regular lectures at the universities. The typical MOOC courses are not having the character of full basic university courses either. Although they could complement and partially replace them, actually there should be more goals there:

- General motivation and exposition of hardly accessible news/knowledge in a way addressing wide population. In particular, the talented youth and bright potential students should be exposed to appealing lectures and presentations addressed to them.
- The more and more interdisciplinary character of most important inventions call for extension of regular courses and seminars by blocks of specialized and still accessible lectures/presentations.
- The public loves the messages on newest achievements in Science and Technology, Medicine etc. Why not to have a new channel with non-traditional forms of public lectures of the best experts available. This would also greatly impact the interest of the talented youth in careers in innovative research and development and it would serve also as a great lifelong education possibility.

All the three points match perfectly the needs in the STEM Education. The reason is that exactly the STEM area suffers most by the changes of attitudes of the new generations and a MOOC-like platform covering the three points above could be of great help in learning how to understand written texts or told explanations – two abilities which are less and less developed among the fresh enrolled students at universities. With a bit of exaggeration, the young generation is overwhelmed with fast and shallow information represented in the form of sequences of very short pieces of texts, animations or videos. Thus we should like to prepare materials and communication channels which would force them to stop and think, to try to explain things to peers, to think critically of what they read/hear. This is clearly just the opposite of e-learning systems focused on drill and teaching facts.

Another set of questions reads: Do we want to support and to push forward the average ones, the best ones, or the laziest and weakest ones? Does the technology strengthen the 'teaching facts' or the 'engaging intellect' parts? Does it help to balance them right for the different types of personalities? The answers are obvious – we always want to cover all the options.

2.2 The platform maintenance

As stressed above, the MOOC like platform we are talking about should allow asynchronous peer to peer communication, which makes the participation of the students and teachers individualized and quite symmetric in the sense that the students have got approach to the same technologies as the teachers and the platform supports peer to peer communication.

The author has been using the recently developed purely software based solution EduArt by PolyMedia Technologies. This is meant to capture any kind of presentations based on explicit material displayed on the computer screen, and standard audio/video recording of the person in question. We are getting a very lean solution, were the captured presentations are kept at a server in a completely open html5 format and thus, they are easily streamed to any mobile or computer platform. Moreover, the screen shots are kept in their original resolution, the data flow is very low, the capture client is downloaded for free, and there is nearly no maintenance of the server part of the system too. The server content management can be integrated into any standard e-learning or general information system.

The latter properties represent exactly the requirements considered as reasonable. The community using the system should be on one hand without any special maintenance needs, but at the same time everybody should be able to actively contribute to the entire process.

In particular:

- *the right technology should allow for 'live' appearance of teachers/speakers combined with classical slides displaying the topic to be discussed – this very much imitates the standard way of consulting in someone's office;*
- *the technology should invoke symmetric discussion the same way in any kind of groups (as opposed to one-way exposition of the material by the teachers);*
- *the technology should allow the teacher (or anybody in the group) to create the messages/lectures easily, in order to keep the feeling of rather real time discussion than an anonymous performance brought to perfection*.

3. HOW DOES THE BRISK GUIDE TO MATHEMATICS WORK

3.1 The concept

Mathematics is a quite specific part of the STEM. Unfortunately, Mathematics often is not presented as the common language supporting the 'engaging intellect' part of the learning process. Instead it is either a collection of recipes to be learned by heart, or even worth, a series of abstract nonsense games with letters with very limited understanding of its use.

The author's own experience from teaching Mathematics for big classes of Informatics students says, that the mere existence of simple videos from lectures leads them to the belief that they are able to browse through the materials short before the exams like they watch the sitcoms. Thus, we have planned to include the following parts in our teaching process:

1) a flipped-classroom approach based on up to date prepared presentations amending the practical aspects of the lectures, available to the students short before the main lectures;

2) standard lectures (in the rather classical big lecture hall standard, complemented with usual tutorials in smaller groups) showing the practical use of the mathematical tools again, but focusing on rather intuitive explanation of the methods and procedures (including many proofs);
3) practical seminars devoted to the numerical and computational aspects (computer based activity in small groups with a tutor – attended only by some students);
4) individual problem solving and discussion (perhaps in small groups, invoking mutual discussion between students).

We try rather to focus on the 'right things' and to present them as useful tools and we hope that the best students will come to understanding of the tiny details too, while the average students will at least remember the usefulness of Mathematics. Another point is touching topics in a simple way first and 'coming back' with new understanding later again.

This has been also projected into the unconventional textbook called *Rough Guide to Mathematics*, cf. [4]. In order to push the readers to choose their own paths through the Mathematics landscape, we have designed a two-column format splitting the practical and theoretical parts of the exposition and also allowing various parts of the text to appear with very diverse complexity of exposition. We hope this will convince the readers that no one is expected to read simply through everything in any given order and they could explore their own thrilling and adventurous discovering of Mathematics by themselves.

3.2 The results and further plans

After years of experimenting, the courses have stabilised and we got the graduates of all four semesters of Mathematics for several years already. The responses are diverse, quite as expected. Clearly this new model of structuring and presenting Mathematics is more often welcome by the very good students. We have not got a detailed statistics, but the general university questionnaires reflecting the opinions and feelings of students suggest that at least those in the 1st quartile by their results of study find the model often good. Also their skills seem to be very good, while the average students (or those less motivated ones) have not got worse. This was exactly the main goal of the project – to serve the best 10 % students best, while not doing any harm to the average.

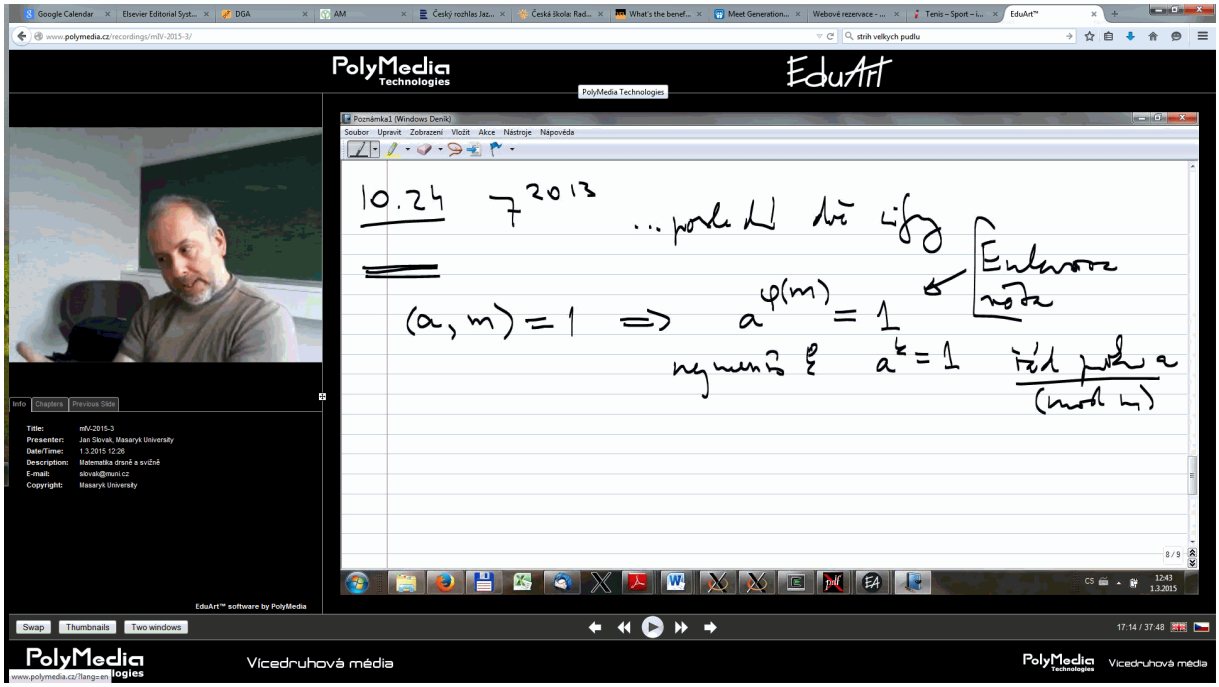

Fig. 1. Screenshot from streamed "practical presentation" by the author from March 1, 2015, (in Czech) preceding the lecture on the same topic in the week after
Source: www.polymedia.cz/recordings/mIV-2015-3

In general, it seems that the existence of the practical presentations (closely related to the main lectures and tutorials in both topics and time) is most appreciated by nearly all students. As expected by the psychology theory, some of them come back to the practical parts after they have seen the theoretical lectures; others enjoy the practical presentations before the lectures already. There is a small group of students having also the numerical seminars mentioned in point (3) – this proved to be a great idea and this is exactly the part which could be offered as complementary course in a MOOC like format to everybody.

Unfortunately we have not managed to initiate the fourth part from the list above to our satisfaction – the discussion and problem solution in small groups. This is another activity which could be perhaps managed via a platform mentioned in 2.1 above.

CONCLUSION

We have advocated main features of a platform which would allow the universities and the wide regional or international communities around them to enjoy active learning, to support and motivate the growth of talents, and to blend the lifelong education with public interest.

So far, there is no working platform satisfying all the requirements listed above in the Czech Republic.

Recently, a group of colleagues from several Czech universities, together with foreign partners, started to work on a project aiming at such a goal and we believe to have first results ready for tests and wide discussions by 2016.

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MOOCS – SELECTED SOCIAL AND EDUCATIONAL ASPECTS

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Abstract: *The authors explore a trend in modern education referred to as the Massive Open Online Course (MOOC), analyze the main types of MOOCs as well as current projects involving MOOC, and examine the ways in which they are used to ensure openness in education. In addition, the authors discuss opportunities for developing a MOOC using LCMS and WIKI technologies, which allows for organising and performing students' dynamic and open research activities, and describe one such actual application of the technologies. The paper also looks at main MOOC projects – international as well as national, and describes their concept, structure, principles, important characteristics and methodology of design. Furthermore, results are presented of research into students' opinions concerning the development of distance courses and in particular MOOCs, conducted at Polish and Ukrainian universities – the University of Silesia in Katowice and in the Borys Grinchenko Kyiv University. Moreover, the paper discusses general and specific principles of an effective MOOC and sets out general as well specific comments.*

Keywords: E-learning methodology, Massive Open Online Course (MOOC), cMOOC, xMOOC, Wiki technology, modern education, international and national conditions for MOOC.

INTRODUCTION

The current education system is undergoing a global change because it should fully develop individuals, prepare future professionals to live in an open information space, to form their 21st century skills, to ensure their continuous lifelong learning in informal form. There is a need for interaction between different social, economic and technological developments in the field of education in a global context, which specially develops technologies, tools and means of open education.

1. OPEN COURSES AS A PHENOMENA OF A DIGITAL SOCIETY – CATEGORIES AND DEFINITIONS

Open education plays an important role in ensuring equal access to education for everyone and in overcoming difficulties arising from the ever-changing circumstances in education, including:

1. Globalization and the increasing internationalization in higher education.
2. Increasing demand for access to higher education.
3. The changing demographics of students, increased number of adult students.
4. Wide access to modern technology and communication.
5. The need to change the prices, affordability and economic models for higher education.

The Model of Online University is one of the most promising projects to meet the objectives of higher education. Competition between universities, with increasing differentiated and innovative use of information and communication technologies, stimulates the emergence of various forms of open learning. In this model, students learn independently, mainly on free open courses.

Open courses - an open content where the term "open" is used in the context of freedom of intellectual property and allows reuse of content.

Open learning - an open practice which is regarded as a transparent activity. The difference between openness of practice and openness of content is important. Creating content takes time, effort, resources and opens numerous discussions about intellectual property rights.

The new paradigm of open education opens up opportunities for the exchange of ideas and cooperation between institutions, teachers and students locally and worldwide, and for strengthening cooperation between students and teachers. The notion of open education is related to new technologies and tools, described as a *Model of Online University* (*TEL-Map*) [1]: an open platform, open evaluation, open education, open schedule, open source, etc.

Open learning: teachers, experts and students, through various activities, generate ideas and share them in the learning process, communicate and collaborate in solving specific practice-oriented tasks. It provides students with the possibility of independent self-study based on personal needs and interests.

Joint assessment conducted by teachers and other students in the learning process, i.e. students' evaluating each other or in a group of "certification", in the request for the openness of clear criteria for evaluation of all activities.

The open platform supports a dynamic and interactive community of open education, creating and providing intuitive operation and a stable user interface for teachers and students. Computer software is based on the principle of an information cloud, and the use of open standards facilitates the exchange of data for different platforms and services.

Open education provides opportunities for the emergence of innovation in higher education that not only supports institutions in preserving the fundamental values of education, but also changes the focus from traditional teaching to learning that is based on student-centered approach and a different role of the teacher (the translator of knowledge to facilitator).

For those studying at university this model is provided by the MOOC (massive open online course) - an innovative form of education [2]. In these courses a large number of members can participate, can have free access to all training materials via the Internet. The initial goal of MOOC – "open" education and provision of free access to higher education for a large number of students from different countries. Unlike traditional online university courses, MOOCs have two key features:

1. **Open access –** anyone can become a member to attend a free online course.
2. **Scale – at present,** an infinite number of students can participate.

The article aims to examine massive open online courses, analyse major MOOC projects, ways of running MOOCs using Wiki-technology as well as analyzing a selected social and educational aspects.

2. ANALYSIS OF CURRENT RESEARCH. NATIONAL AND INTERNATIONAL EXPERIENCE

MOOCs are two different educational areas: connectivist MOOCs (cMOOC), based on connectivist technology, more focused on teachers and scientists; and MOOCs based on the content (xMOOC), based on behavioral approach.

cMOOCs devote more attention to the organization of joint training and allow to go beyond the traditional audience. This approach includes J. Siemens, C. Down, John Groom and other courses. In Ukraine, this trend has evolved from efforts of researchers B. Kuharenko, K. Bugaichuk.

The connectivist principles include:

- a variety of approaches;
- presentation of learning as a process of forming networks and decision-making;
- teaching and learning takes place all the time - it is always a process, not a state;
- key skill today - the ability to see and understand relationships between meanings of fields of knowledge, concepts and ideas;
- knowledge can exist outside the human in a network;
- technologies help us in training.

The xMOOC educational model is essentially an extension of pedagogical models used in higher education, and involves the use of video presentations, questionnaires and tests, etc. A typical example of this trend is a MOOC project called Coursera [3] and Udacity [4]. They provide a unique approach that allows students to find alternative "routes" in education.

The cMOOC open space for the introduction of non-traditional forms of education based on the needs of students, allowing students to learn from each other [5]. Online communities solve all problems by creating networks that disseminate knowledge. For example, institutions such as MIT and the University of Edinburgh use MOOCs as an experimental company that allows you to take part in the development of new models of education, experience and the support of other agencies.

Many countries are introducing MOOCs in their different institutions, foundations, societies, as well as with government support. Main MOOC projects include:
edX (https://www.edX.org/) – a non-profit MOOC project, created by MIT and Harvard University. Currently, the project includes a large number of courses, including chemistry, computer science, electronics, medicine and others. Students who achieve significant success in the subjects can pay a small fee and receive a certificate confirming the course.
Coursera (https://www.coursera.org/) – this is a commercial company. Coursera offers courses in computer science, mathematics, business, humanities, medicine, and engineering. Some universities provide a Certificate of Completion for a small fee, there are also additional courses and evaluation of teachers.
UDACITY (https://www.udacity.com/) – commercial project founded by Sebastian Trunov, David Stavens and Mike Sokolsky, offering courses in computer science, mathematics, science, and business programming. After completing the course, students receive a certificate of completion.
Udemy (https://www.udemy.com/) – project, established in 2010. Udemy offers more than 5,000 courses, 1,500 of which are not free.

P2Pu project (https://p2pu.org/en/) was launched in 2009. Process improvement and quality improvement courses are based on feedback from students and teachers.
Khan Academy (https://www.khanacademy.org/) – online learning platform, which was founded in 2008 by Salman Khan. The organization offers several thousand video lectures on various subjects, they add various tasks, assessment of which is carried out regularly.

While edX only offers courses from Harvard and the Massachusetts Institute of Technology, Coursera gives access to a platform that can be used by any university, and Udacity has its own schedule. Other projects of open education, such as Udemy, P2Pu and Khan Academy have been around for a long time and provide opportunities to anyone learning outside the traditional framework of universities [5].

For example, the Ministry of Education of Korea is also considering providing credit for these online courses, after assessing their credibility. In the second half of the year, the South Korean government will be launching massive open online courses, with lectures by well-known scholars available online, free of charge, to everyone. On Feb. 3, the Ministry of Education decided that it would make available a few dozen lectures online later this year on a trial basis and increase the number to more than 500 by 2018. These massive open online courses (MOOC) - courses available online that have no limits on enrollment and are open to everyone – include functionality for questions and debates. This sets the courses apart from the around 9,600 lectures that 183 universities in South Korea have made available so far, which take the format of non-interactive videos. Coursera, which was launched by professors at Stanford University in Apr. 2012, features 839 lectures (including three by KAIST, a South Korean university), which are being used by 10 million people. The Ministry is also considering whether to eventually provide academic credits and diplomas after assessing the credibility of the course [6]**.**

The most famous Ukrainian MOOC project is Prometheus (http://prometheus.org.ua), operating on platform edX. Trainees browsing video lectures (5-7 min.), the best teachers of the leading universities of Ukraine, will discuss with other students and teachers in the forum, check their knowledge through a variety of interactive tasks, successfully performed tasks of the course will receive a certificate [7].

Young Science Foundation (Poland) proposes an initiative to create a Polish distance learning platform offering different types of activities - both universal, open formula MOOC floor, as well as specialized courses dedicated to specific stakeholders. As international experience shows, for such an initiative to succeed it is necessary to broaden cooperation between academic institutions, researchers, companies and NGOs. "Poland MOOC platform" will be an effective tool only when it becomes a national project, bringing together different communities and having a wide range of high quality, attractive rates for different social groups [8]

In the Porto Declaration on European MOOCs [9] we can read: "*Europe must seize this moment to grab the opportunities offered by MOOCs.* MOOCS have continued to attract considerable media coverage as governments and universities respond to the open and online education movement. MOOCs are at this moment seen as a disruptive force and an important driver for change—for both better and worse. The growth of MOOCs has helped to make institutions, governments and societies at large more aware of the possibilities of open and online education. *Opportunities*: It is important to note that MOOCs remain relatively poorly defined and they should not all be assumed to confer similar benefits. Nevertheless, we

believe the open and online learning movement has great potential to educate the many in a flexible way that meets the needs of today's learners for an increasingly complex world. We must embrace opportunities to open up education in a manner consistent with European values of equity, inclusion and social justice, and to increase life-long learning and social mobility." [9]

Furthermore, the authors of these important documents stressed the *Risk* and threats posed by MOOC movement, arguing in particular: "However, we must also recognize the risks that come with the advent of MOOCs. Current evidence suggests that MOOCs do not reach those that most need access to higher education. The majority of participants who join MOOCs are already well-educated and live in developed countries. Moreover, they already have the digital and language skills needed to successfully complete MOOCs. The threats that MOOCs pose to the traditional educational system need further analysis and public debate. One threat, for example, is that only universities with celebrity academics and the financial means can develop MOOCs and offer them for free to a massive audience. Some consider this approach nothing more than a self-serving marketing exercise by a few universities with the effect of promoting the dominance of Western knowledge, a new kind of imperialism." [9]

2.1 Some results of own research

Creating tools that allow the teacher and eventually most students to understand and optimize the teaching and learning process is a difficult task. Today we offer only elements of future educational systems analytics. For example, a teacher can examine student activity journals in virtual learning environments to see how much time a given student spends studying and mastering specific material. Students, on the other hand, have access to different variants of guidelines and recommendation systems that model systems of proximal development. For example, students can use of YouTube for regular reviews of video lectures, websites can be configured to automatically compile lists of videos in related subjects.

Many higher education students are interested in MOOCs. Research conducted by staff at Duke University show that students choose MOOC for several reasons [10]:

- To support lifelong learning or gain an understanding of the subject matter, with no particular expectations for completion or achievement
- For fun, entertainment, social experience and intellectual stimulation
- Convenience, often in conjunction with barriers to traditional education options
- To experience or explore online education.

Research and survey on MOOCs was conducted among students at the Borys Grinchenko Kyiv University as well as the University of Silesia (Tab. 1, 2). The outcomes of surveys are very similar. The opinion of students about more important results of a remote learning course, in particular MOOC, as far as BGKU students are concerned, are as follows:
1) comprehensive knowledge of the chosen topic,
2) practical skills in a range of issues,
3) satisfaction of participating in the course.

In the case of US students, the opinion is the same, however, the US students rated Satisfaction of participating in the course as the most important result. Student survey results show that the theoretical material in this course is best presented as video lessons, "wiki materials" and useful links. Assessment can be carried out occur in the form of tests and

formed evaluation tools. It was found that the result of instruction using training materials for MOOC is knowledge and e-portfolio with the appropriate resources:

Options and variant of answers	BGKU	US
Theoretical materials as text	26 %	88 %
Opening theoretical material that can be filled together (wiki)	41 %	25 %
Video	74 %	75 %
Presentations	53 %	88 %
Mind map	35 %	38 %
Links to helpful resources	56 %	50 %
Forums	29 %	25 %
Discussion of issues	47 %	50 %
Practical tasks	50 %	13 %
Keeping e-portfolio for reflection of their own learning	44 %	38 %
Blogging	9 %	13 %
Forms for self-assessment	47 %	25 %
Testing	79 %	25 %
Project methodology	29 %	50 %
Group work	18 %	13 %
Other	0 %	14 %

Tab. 1. Elements of study mentioned by students, considered appropriate for the use of MOOC
Source: Own research

Options and variants of answers	BGKU	US
Comprehensive knowledge of the chosen topic	88 %	63 %
Practical skills in a range of issues	47 %	63 %
Satisfaction of participating in the course	47 %	75 %
Certificate	26 %	38 %
E-portfolio of materials and achievements for further use	44 %	38 %

Tab. 2. What should be the result of a remote learning course, in particular MOOC
Source: Own research

That is why, in response to the needs of students who are about to enter the profession, an open training module was established called "I – in the information environment of the University." As a platform for its location the Wiki Portal of Borys Grinchenko Kyiv University (http://wiki.kubg/edu.ua) was chosen. The Wiki portal created as a platform is intended for educational technology oriented on active students and faculty activities, all members of the educational process. Wiki technology can allow users, without any effort, to publish a variety of educational web resources, share ideas, re-use web resources based on contributions of many participants.

Students of the University of Silesia have considerable experience in the field of participation in distance learning courses, available on the faculties' DL platform (http://el.us.edu.pl) as well as on the project platforms for example on UPGOW project platform (http://el.us.edu.pl/upgow). Of course they were able to conduct discussion on the DL courses inside as well as outside of the profile of the university, faculties in the social media, were

able to use of digital sources at the CINIBA (www.ciniba.edu.pl), Silesian Digital Library (http://www.sbc.org.pl). This support, according to the students, is very useful and important.

CONCLUSION

During the period of active development and implementation in all spheres of information and communication technologies, particularly in education, there exists a large number of scenarios of effective educational process not only in universities, but also beyond [16], [17]. Education openness and accessibility are being used in massive open online courses and are leading to the acquisition of new free comprehensive knowledge in a usable form. MOOC tasks:

- development of a large number of electronic educational resources using transfer of university courses to a MOOC format;
- improvement of the methods of mass distance learning and virtual learning environment based on large data analytics;
- involvement in the creation of open courses employers interested in talented students;
- worldwide cooperation with universities and educational organizations.

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