

Innovative methods of popularizing technical education

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Abstract. There have been analyzed reasons of the loss of technical education's popularity. Also, the analysis of known educational and production methods, oriented at the innovative model of development of society, was performed. It is stated that the acquisition of 21st century's skills as a result of competition of technical education are natural for the DIY ideology, which was realized in the institutions like Fab Lab. The new educational strategy, based on project-based learning, is proposed to be implemented as a special laboratory with equipment, which would be a center of innovative development for students at the Technical University. Moreover, the list of projects planned for implementation, that includes not only projects, specific to a particular university, but also projects, demanded by society as a whole, is specified. It is worth to implement trendy projects in the laboratory, such as toy-like, ecological projects; projects of the energy dependence decrease or the energy efficiency increase, modern digital or innovative projects etc. The student should gain knowledge, skills and, possibly, equipment that are available for immediate usage on the labor market or for the realization of his own projects or the community's projects in everyday life after the realization of the particular project at the laboratory

1. Introduction

The majority of world's countries have faced the problem of lack of technical education's popularity, except the IT sphere. Popularity of technological technical education diminished in Ukraine although recently such tendencies contradict the labor market [1-4].

Stereotypes play an important role in choosing a future occupation. Among many stereotypes the following can be highlighted: it is difficult (to be competent in technology, to develop something new); hard (it is necessary to learn new abstract subjects with broad usage of means and methods of calculus); long (there is relatively long period of adaptation to specific production conditions, respectively, a badly-paid job); marginally profitable (the absence of "success's flashes" like quick enrichment against the background of low starting capital without taking into consideration expenditure on education, compared with designers, programmers, economists and other creative jobs).

The production equipment, which has been developing for a long time, is a product of many technological processes. Products [received with such equipment] exceed dramatically the similar ones, obtained by simpler means (for instance, the drilling machine provides the opportunity to make



holes with such well-regulated accuracy that is impossible for a hand drill). Results are replicated easily by the worker without university education, then labor costs can't be expensive. The equipment is highly productive that is why a relatively small number of professionals can satisfy the production's demand of the market.

The high technical level of equipment in the traditional educational system defines the necessity of learning of considerable amount of theoretical and methodical information for understanding the equipment's work. The necessity in development of new equipment appears relatively seldom in steady markets, so a demand for specialists/professionals of the level that allows to complete such a job is small compared with the volume of labor market. The collateral consequence/stereotype – technical specialties are considered uncreative.

There is a similar situation concerning social sciences but a relatively low cost for entering the labor market and promoted success stories conduce predominance of the inflow of social specialties' neophytes compared with the technical ones.

Thus, in terms of traditional educational system [of Ukraine], stereotypes, that lead to the lack of popularity of technical education, have certain basis. The aforementioned reasons lead to attenuation of historical impulse of desire to be educated in general and to technical education in particular. However, the sustainable development, which is based on high technologies and innovations, is impossible without people, who have been educated in the technical sciences.

All successful corporations demonstrate a need for innovations [5], the innovation policy is declared by the main paradigm of all successful countries and blocs, particularly the European Union [6], because the industrial development is unsustainable under conditions of limited resources [7].

2. Search

A number of approaches, concerning on overcome of the aforementioned or similar stereotypes, are known. This approaches have been started with pragmatic education and project's method, that are described in works of J. Dewey [8], W. H. Kilpatrick [9].

The most famous modern educational models and methods have a similar direction. They are suggested by economists and representatives of a number of other social sciences, for example Thom Markham [10], [11], the similar works in Ukraine are also known [12], [13].

An application of the similar methods in technical education for gaining skills of the 21st century [14] is known on example of the concept of fab lab [15], [16], proposed by MIT's professor Neil Gershenfeld. The fab lab concept also grew out of a popular class at MIT (MAS.863) named "How To Make (Almost) Anything". The fab lab also is known as a modern, well equipped, workspace for DIY (Do It Yourself). The concept of reforming of engineering education CDIO is proposed in MIT [17].

Providing of access to modern means of production, mainly on the CNC basis, and a kit of electronic components for providing a possibility to create one's own product of CNC is the main offer of Fab Lab.

Up to date the fab lab community is worldwide (Figure 1). Three fab labs are in Ukraine, all of them are in Kyiv.

The following projects of creation the manufacturing equipment can be taken as an example of DIY: a 3D printer or a milling. Numerous descriptions of realization individually, as a rule, of such projects in the DIY format are known (there are many examples on YouTube). Both people with special education and initiative autodidacts are authors of these descriptions. The possibility of realization of such projects appeared as a result of the progress in manufacturing of engines, systems of numerical data processing and CNC in particular. The globalization of markets, the possibility of direct cooperation between manufacturers and potential buyers, the development of common education and the broad usage of numerical devices in everyday life played an important role in providing of such a possibility.

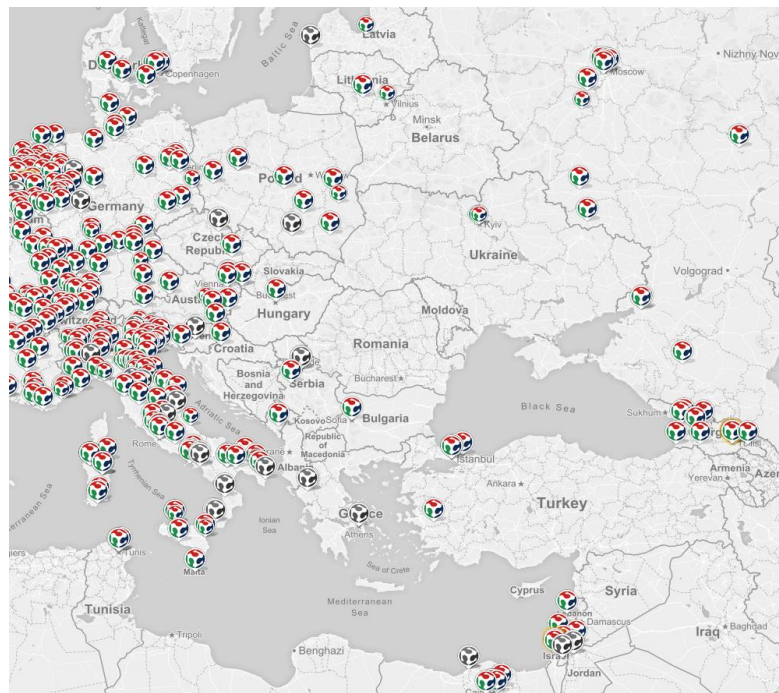


Figure 1. Up to day map of distribution of fab labs in Europe [17]

The framework CDIO provides students with an education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing — Operating (CDIO) real-world systems and products [17]. CDIO is mostly based on PBL [10]. 77 world's universities have joined the CDIO initiative as of today (no universities in Ukraine, Figure 2).



Figure 2. Part of the map of the current CDIO member schools [16]

The core of CDIO is CDIO Syllabus and CDIO Standards. CDIO Syllabus is a detailed list of competences, needed for today's engineer, opened to discussion and changes. These guiding principles (CDIO Standards) were developed in response to program leaders, alumni, and industry partners who wanted to know how they would recognize CDIO programs and their graduates.

The review and change of educational programs and work plans according to the changes of market's requests is basic in CDIO Standards. The realization of such a plan of the educational process can be imagined only in terms proposed by O. M. Telizhenko and others [14] in according to the Order of the Ministry of education of Ukraine "...about academic mobility of students..." [18], in terms of the existing [in Ukraine] educational system with a plan for 4+1(2) years.

3. Reflections and Suggestions

Based on the aforementioned, a hypothesis can be expressed: it is necessary to withdraw from attempts to cover the major part of the history of machinery's development and applied theoretical disciplines for popularization of the technical education, taking into consideration the vast amount of data about technical systems of the applied level and the high speed of their accumulation in the modern world.

The hypothesis about the new task of the technical education can be also articulated: the alumnus of the technical education's establishment should have [as an addition to the resume] a portfolio of executed projects. The educational establishment should provide a verification of such a portfolio (an access of interested people/employers to technical descriptions of resolutions and the corresponding theoretical part, necessary while clarifying of accepted technical solutions; a video depicting the process of devices' creation etc.).

Traditional university can be characterized as a set of the following functions: a knowledge base (a library, own collections, the knowledge and experience of teachers, a set of machinery and/or samples, details (a museum) etc.); a repeater, that is broadband and individual, of knowledge according to a schedule (classroom work of the teacher during lectures and other pursuits); a rating of a qualifying level (based on results of supervisory measures regarding the audit of learning); less often – an agent of licensing, that provides licenses for completing a particular kind of works. New knowledge, which can replenish the knowledge base, can also be created on the basis of the knowledge base in university's laboratories.

Conditions of the knowledge dissemination have completely changed during the last decades. The appearance of the broadband access to the Internet allows getting the access to knowledge from many sources in a different media appearance. There is a large number of courses in the free access developed in leading universities of the world. Search engines and specialized knowledge bases provide an opportunity to perform a research of the factual material easily. A certain obstacle is the modern model of copyright protection that is aimed at assistance of authors in gaining income in the result of spreading/realization of their works. Nevertheless, the value of traditional functions of the university as the base and repeater of knowledge has decreased.

In other words, the majority of people, acknowledged with the work on the Internet (this indicator is near 100% among young people nowadays), gain necessary information on request online free or for money. In our opinion, the key assertion is "on request". It is quite natural in terms of humans' fast accumulation of data, as the majority of other ways can provide irrelevant/outdated data.

In terms of fast exchange of data control means of qualifying level's rating reduced to struggle against the access to the Internet. Although in real conditions during the implementation of professional tasks such a challenge does not appear as a rule. The university creates the challenge for the preservation its traditional model of work. If student's profession does not foresee that he will work in a closed information space (without an access to knowledge) in the future, such a politics will be, at least, ineffective, at most – harmful. The harm is shown up in the creation of psychological block and/or lack of ability to find the relevant information quickly in a stressful situation.

Of course, there are professions that demand the availability of knowledge and skills "here and now" because it influences the reaction rate critically, and, consequently, the result. We assume that the majority of engineering professions are not referred to these ones.

Industry data creates more and more powerful tools for the extracting of knowledge, including unstructured data (knowledge bases, expert systems). Therefore, the functions of the fact search and generalization for the production of new knowledge, finally, answers to the questions, are now widely

automated. That is why, in our opinion, universities should change approaches to learning in accordance with the hypothesis 1.

Qualification level is assigned, based on points for the subject. The list of subjects and marks are given in the Appendix to the diploma. However, it is not always possible to restore the contents of acquired knowledge and their relevance to the requirements of /workplace/office by the name of the subject. The content of the discipline is not often shown by the university because it is intellectual property. At the same time, the content of the project performed by the student is the intellectual property of the author. Thus, access to the results of the project will not infringe the rights of ownership of the university, but allows to estimate easily his (student's) knowledge and skills. Evaluation of the worker/contractor for the portfolio is quite common among the employers/customers.

It is necessary to set up a task of completing the concrete project for a student for the increase of motivation of gaining knowledge that defines the modern technical education. The student should gain knowledge, skills and, possibly, equipment that are available for immediate usage on the labor market or for the realization of his own projects or the community's projects in everyday life after the realization of the particular project at the laboratory. The possibility of obtaining better results of working (the higher quality of results of the designed equipment's usage; development of equipment by correct design is cheaper etc.) can become a motivation to working in such groups, contrary to the unorganized self-realization of DIY projects.

Apart from the readiness to use modern methods of education, it is necessary to create the institutional system of innovative education's logistical support, for example, a laboratory for the popularization of the technical education. The inventory set of Fab Lab is a good model for such a providing. However, Fab Lab is oriented at the attraction of the broadest circle of citizens without any relation to the educational direction of the university or priorities of the development of the society. Providing of these specifics will not necessarily lead to lower prices of equipment or the ability of the laboratory. But not taking the specifics into consideration is able to lead to not providing the ability of realization of needed projects.

The list of projects, planned for realization, should be defined for identifying the list of equipment. Such a list ought to comprise not only projects, specific for the concrete university, but also innovative projects, which are in a high demand of the community or the society in general, taking the aim of increasing the popularity of the technical education into consideration. It is worth to implement trendy projects in the laboratory, such as toy-like, ecological projects; projects of the energy dependence decrease or the energy efficiency increase, modern digital or innovative projects etc. For example, in the IFSTUOG laboratory the following list of projects can be introduced: design CAD model of logo of team and print it on a 3D printer; assemblage of 3D printer from a DIY kit; operate with 3D scanner; storage with automated access control; modular-vendor machine; 3D scanner; 3D CNC; machine, adjusted to CNC; "Heat of solar" (collector, heat pump, heat accumulator, heated water/coolant with automated control); robot cleaner; automated pumping station; automated wellhead equipment; automated washing rig system with remote control. The list of equipment for realization of proposed projects should include (but not bounded): 3D printer, CNC milling machine; solder station; solder for PVC pipes; electrically operated components of pipelines (shut-off and control valves); electrical and electronic components, controllers, stepper and servo motors.

The proposal for the implementation of projects, proposed by potential employers or through own challenges/problems of potential students, the availability of infrastructure for the projects, the availability of supplies, spare parts, contacts with suppliers, the executed projects (portfolio) is the basis for the interest in technical education. The modern university has to perform a sort of business incubator and "first job" for its graduates. This exactly is able to return the popularity of high technical education.

Thus, ways of increasing the popularity of technical education as a result of the innovative teaching methods' review and the analysis of causes why technical education lost its popularity have been proposed.

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