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Revista de Antropología, Ciencias de la Comunicación y de la Información, Filosofía, Lingüística y Semiótica, Problemas del Desarrollo, la Ciencia y la Tecnología
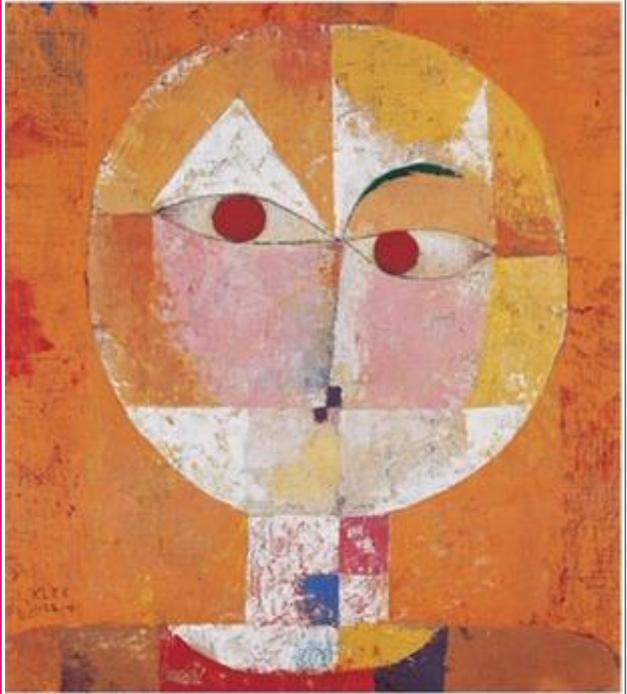
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Visual laboratories and fab lab in the university

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Abstract

The aim of the article is to analyze and adapt the advanced experience of developed countries in the field of engineering training via comparative qualitative research methods. As a result, the social effect of Fab lab is the promotion of the development of innovative products, the creation of new jobs, the improvement of the skills of young people, the arming of technology for people to independently solve their social problems. In conclusion, the organization Fab Lab on the basis of the university can be a platform for communication between investors and developers.

Keywords: Fab Lab, Visual, Laboratory, University, Modernization.

Laboratorios visuales y Fab Lab en la universidad

Resumen

El objetivo del artículo es analizar y adaptar la experiencia avanzada de los países desarrollados en el campo de la formación en ingeniería a través de métodos comparativos de investigación cualitativa. Como resultado, el efecto social de Fab lab es la promoción del desarrollo de productos innovadores, la creación de nuevos empleos, la mejora de las habilidades de los jóvenes, el armamento de la tecnología para que las personas resuelvan sus problemas sociales de manera independiente. En conclusión, la organización Fab Lab sobre la base de la universidad puede ser una plataforma para la comunicación entre inversores y desarrolladores.

Palabras clave: Fab Lab, Visual, Laboratorio, Universidad, Modernización.

1. INTRODUCTION

A society focused on the intensive use of modern information technologies, the emergence of new branches of science and production requires the training of specialists with new knowledge and skills that cannot only adapt to new conditions, but constantly, showing their own activity, improve their knowledge, develop their creative potential. A modern technical university must meet current trends, which is reflected in the need to provide students with not only modern knowledge, but also skills. Acquisition of skills is impossible without the use of modern equipment, which is the basis of modern production.

In this regard, the universities of developed countries a practical and scientifically oriented approach to the training of specialists is

used. It deals with the research nature of training, the development of students' creativity in the framework of scientific research through the active involvement of students in research activities in the form of implementation of group and individual research tasks; organization of student design bureaus; selection and encouragement of capable students, as well as the comprehensive involvement of students in innovation activities with the help of design-organized technologies, which allow recreating the holistic process of engineering work, applying and improving the knowledge and skills acquired in practice; promotes the development by students of the economic foundations of innovation and the foundations of industrial design, the inclusion of entrepreneurial ideas in the course content; learning to work effectively in a multi-professional team.

2. MATERIALS AND METHODS

The current development trend is the Open Source model, which involves the use of innovative means of production and related products (PEARCE, 2014). New paradigms of the type are formed: Open Science, Open Lab, Open Software, Open Projects of Mechanisms. In addition, banks of ideas become popular tools, the essence of which is the accumulation of innovative proposals for a given topic (the vast majority of thematic banks are formed by manufacturing companies with completely proprietary approaches to development) or in the form of free collections on the subject. The development or idea is presented in its full form in open access;

everyone can join its modifications and improvements for free (DAVID, 2004; GIBB, 2014).

Most of the solutions received an incentive to develop after the creation and success of the first Fab Lab and the framework of the Gershenfeld course (2008), a significant part of the Fab Lab is organized at educational institutions. Today, considerable experience has been gained in implementing Fab Lab at universities and libraries at British Library Labs, Harvard Library Lab, North Carolina State University, Media Labs, Digital Social Science Labs, NYPL Labs, Media University of Texas International Librarianship, University of Texas International Public Library, University of Texas International Public Library, The European Labs and others (GUERRA AND DE GÓMEZ, 2016; MILARA ET AL., 2017). The main goal of Fab Lab is not production, but the provision of the possibility of self-production of things by people to stimulate their personal development in a certain technical sphere (production, bionics, ecology) and the formation of creative communities, which is realized by:

- Creating a common space in which users can work together in groups, interacting with the faculty of universities, representatives of scientific schools, business structures, etc.;

- Provision of innovative technical equipment and software and hardware: interactive boards, screens, plasma widescreen walls, equipment for 3D-modeling and the like;

- Implementation of technical support for lectures, educational activities, research and organization of experiments;

- Development of creative tools, software and interfaces based on the content and services of libraries, university curricula;

- Attracting the general public directly to work with digitization, classification, tagging, organizing and popularizing collections in the digital media environment, disseminating information about projects, etc.

The mandatory equipment of Fab Lab includes systems with numerical control, such as milling machines, laser and water cutters, 3D-printers. Today, significant statistical material has already been obtained, on the basis of which success factors have been identified that affect the performance of Fab Lab as a whole. These include clients/beneficiaries, access to finance, a competitive business environment and volunteers/employees. Unfortunately, these conclusions were made from the words of Fab Lab operators, but not their clients (GERSHENFELD, 2005). But it is clear that the success of Fab Lab is impossible without constant communication with partners, sponsors and promotional events (PAUCEANU AND DEMPERE, 2018).

An important place in the success of Fab Lab is the team, as well as the leader of this laboratory (KOHTALA, 2017), since it is the team that creates the face of the Fab Lab, forms its own identity,

promotes certain principles and values of production, positions itself in the market. At the same time, many researchers note the importance of introducing schoolchildren to the Fab Lab idea. For this, various seminars, excursions, master classes are held. Traditionally, Fab Lab is associated with 2D and 3D design, tools and machines, prototyping using CAD applications and programming. The greatest difficulties for high school students and students who were familiarized with the capabilities of Fab Lab were caused by prototyping using CAD applications and programming (**KOHTALA AND BOSQUÉ, 2014**).

The Fab Lab project has come a long way, and today this project can be a driver for the development of an engineering university, and it is important to analyze the possibility of implementing such a project for universities in developing countries. In this regard, the analysis of the best engineering education practices, which include, for example, visual laboratories, Fab Lab, is promising. The purpose of the article is to analyze and adapt the advanced experience of developed countries in the field of engineering training (FUJO & DIDA, 2019: MALIK ET AL, 2019).

3. RESULTS

Openness is the most important feature of Fab Lab; therefore, based on the Open Source model and joint development, the organization of production and laboratory complexes based on equipment and infrastructure of state educational and scientific

institutions is promising. At the same time, the Fab Lab project based on the university can be developed in the following directions:

- Organization of coworking space, providing for the purchase of new equipment;

- Organization of access of persons to the existing equipment in the laboratories of the university to perform their own tasks.

- Organization of virtual computing laboratories on the basis of the university.

Let us consider successively three directions of development of Fab Lab on the basis of the university.

The co-working space should be organized as a Makerspace laboratory working in two directions - educational and research. The laboratory can be a base for training, the performance of diploma and term papers, start-ups, approbation of visitors' own developments, as well as being available for creativity not only for students of this university, but also for all interested students of other universities, schoolchildren, young scientists, etc. Promising are workshops, workshops involving engineers, hackathons on creating electronics, cooperation with technology corporations, etc. The prospect of the development of the laboratory is to provide the reading room of the library for the needs of the users, equipping it with high-tech equipment and working 24 hours a day, 7 days a week.

Due to this, services related to 3D printing technology, using a 3D printer, a 3D scanner and a 3D writing pen in a stereolithographic fashion will appear among the new services. The organization of the Makerspace on the basis of the university aims to inform, actively promote and attract the general public of users to use the possibilities of the innovative printing method, as well as the introduction of 3D technology in the educational and scientific process of the university. It is possible to test a pilot project as a base for the Faculty of Natural Sciences, which specialists may be interested in the possibility of making unique 3D models (for example, specific chemical compounds, internal organs with certain pathologies, tissues and body parts, cells, bacteria, viruses, molecules, etc.

University digital laboratories can gain experience of cooperation with leading corporations, on the basis of which unique equipment, new software, digitization, etc. are being tested. Scalable, open, experimental - they are characterized as innovative projects, the idea of which is based on the cooperation and interaction of universities with the general public, social and communicative structures, educational institutions, research teams and schools, business circles, technical corporations. Being equipped with high-tech equipment and a variety of modern tools, such as 3D-printers, Raspberry Pi, Arduino, Lego, unmanned aerial vehicles, digital laboratories of universities, actually implement the concept of the 3rd place. In addition, in university Fab Labs, users get the opportunity to use innovative technological tools in the processes of educational, scientific and leisure activities.

They can participate in linguistic analysis, evaluation and annotation of digital objects, scientific classification of digital collection resources; create music, movies, edit photos and images, digitize various objects, acquire Web-design skills, 3-D printing, work with online services, work with technologies, start their own projects. For universities, the laboratory is an organizational resource that allows you to test innovative approaches to creating products, services, digital assets and tools for interacting with the audience of users; check the effectiveness of the introduced technologies; determine the prospects of innovative ideas before they become part of regular work processes, ongoing programs, projects. It is in digital laboratories that pilot projects begin and beta versions of the latest developments are tested, experiments are conducted to improve the efficiency of training, education, research, etc.

The special importance of digital laboratories lies in the fact that they can complement and preserve the digital assets of the university libraries, allowing users to experiment with the processes of collecting, processing, storing, synthesizing, auditing, availability of digital content. By promoting technical creativity, laboratories become an effective means of scientific communication, contribute to the realization of both individual creative potentials of individual users and scientific collective cooperation, influence the mobility of a modern student, scientist, provide an opportunity to quickly exchange ideas, get acquainted with the results of scientific research and introduce new ones.

It is expedient to create a Fab Lab in cooperation with a business incubator, which will make it possible not only to make a prototype, but also to consider the possibility of an appropriate startup. Thus, the Fab Lab on the basis of the university aims to create innovative open environments, digital production workshops, popularize research areas, innovative use of digital content of the cultural heritage, support educational activities, personal and collective projects of youth innovative entrepreneurship, promote ideas of technological progress.

To do this, you must perform administrative changes relating to access to the relevant equipment. At the same time, the list and description of the equipment that are located in laboratories are often available only within the department or a separate laboratory, therefore, it is not known to the general public. In addition, often there is a situation when access to equipment is complicated by the manifestation of the property position of a department, laboratory, and the like. Sometimes there is a situation when the equipment is idle without use for years, because the owners or managers do not have ideas on its use, and the access of other researchers is not regulated. At the same time, the concept of the possibility of free access to the equipment may be legally justified, since state educational institutions are financed from the state budget, and the results of their work within the limits of financing must be open.

However, it is likely that if new information or product is obtained from the use of equipment with full compensation for the

cost, a different procedure for determining the cost of use is possible. The university can be a platform for the publication of research materials, the formation of relevant directories. To implement such a laboratory in the university is necessary.

4. DISCUSSION

The process of intellectualization of the economy, which is becoming more widespread in the world, leads to an increase in the role of the higher education system. In fact, the level of its development and quality becomes one of the main factors determining the overall level of competitiveness of the country's economy. The knowledge and skills obtained in the course of training become the basis of the intellectual potential of the economy, the determining factor in the creation of innovations. It is university science in most highly developed countries that is the main part of the knowledge creation system. Thus, the main functions of the higher education system in the modern economy are the creation and transfer of knowledge.

An innovative economy requires, on the one hand, active processes of creating and introducing scientific developments into production, simplifying the scheme of their transformation into innovative competitive products, and on the other hand, highly developed human capital capable of providing them with modern demanded labor market and innovation processes and competencies

which cannot be formed exclusively by the efforts of universities through the use of traditional learning technologies.

At the same time, the potential of the Fab lab lies in the field of a completely new market segment. This is not a prototyping center (gave the order - received a model), this is not a shared-use center (where you have to pay for equipment rental). At the same time, this is not an innovation consulting firm (set the task - received development) and not an educational institution in its pure form. The scope of the Fab lab lies between these segments. And its peculiarity is the ability to be flexible at the disposal of resources, to find a compromise with customers, to look for alternative ways of interaction with developers, but at the same time not be afraid to take on complex non-trivial tasks and solve them.

Fab lab teaches the skills needed to develop and produce new products (from 3D modeling and graphics, electronics and programming to project management), but unlike classical educational institutions, theory training takes place when the need arises. Of course, Fab lab conducts both short-term (up to a week) and long-term (up to six months) training programs in which university lecturers, engineers and specialists from major laboratories in the world give lectures. But most of the training takes place in the process of working on their own project; laboratory staff, other visitors and experts of the international network act as consultants.

Lab a community of developers with a wide range of professional skills is formed. It is this community of creative and able-bodied people - the main resource of the laboratory. Having formed such a resource, Fab lab invests it in the development of commercial products, the implementation of technically complex, non-trivial orders, and innovative consulting.

The main achievement and priority of the Fab lab is to overcome the psychological barrier of young people from this is impossible. To solve this problem, I need to buy a machine for several million dollars, and six years to study in a technical university to I will do it myself at Fab lab using milling machine, or handsaw and insulating tape. The social effect of Fab lab is the promotion of the development of innovative products, the creation of new jobs, the improvement of the skills of young people, the arming of technology for people to independently solve their social problems.

5. CONCLUSIONS

The main goal of Fab Lab is not production, but the provision of the possibility of self-production of things by people to stimulate their personal development in a certain technical sphere (production, bionics, ecology) and the formation of creative communities, which is realized by:

- Creating a common space in which users can work together in groups, interacting with the faculty of universities, representatives of scientific schools, business structures, etc.;

- Provision of innovative technical equipment and software and hardware: interactive boards, screens, plasma widescreen walls, equipment for 3D-modeling and the like;

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- Development of creative tools, software and interfaces based on the content and services of libraries, university curricula;

- Attracting the general public directly to work with digitization, classification, tagging, organizing and popularizing collections in the digital media environment, disseminating information about projects, etc.

Compulsory equipment includes systems with numerical programmed control, such as milling machines, laser and water cutters, 3D printers. Fab lab teaches the skills needed to develop and produce new products (from 3D modeling and graphics, electronics and programming to project management), but unlike classical educational institutions, theory training takes place when the need arises. As a result of such communication and constant interaction in each successful Fab lab, a community of developers with a wide range of

professional skills is formed. It is this community of creative and able-bodied people - the main resource of the laboratory. Having formed such a resource, Fab lab invests it in the development of commercial products, the implementation of technically complex, non-trivial orders, and innovative consulting.

The social effect of Fab lab is the promotion of the development of innovative products, the creation of new jobs, the improvement of the skills of young people, the arming of technology for people to independently solve their social problems. Modernization of the university can be carried out in the following areas: the organization of the co-working space, providing for the purchase of new equipment; organization of access of persons to the existing equipment in the laboratories of the university to perform their own tasks, as well as the organization of virtual computing laboratories on the basis of the university.

The process of creating Fab Lab and visual laboratories on the basis of the university is considered. It has been established that the organization Fab Lab on the basis of the university can be a platform for communication between investors and developers. It seems expedient to create a Fab Lab in cooperation with a business incubator, which will make it possible not only to make a prototype, but also to consider the possibility of an appropriate startup. This approach is consistent with the best international practices for ensuring the creative development of the individual in terms of technical creativity, ensuring

the innovative development of the settlement, region, country and world.

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