

STUDENTSKI PODUZETNIČKO-TEHNOLOŠKI INKUBATOR U BJELOVARU

STUDENT ENTREPRENEURIAL-TECHNOLOGICAL INCUBATOR IN BJELOVAR

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Pregledni rad

Sažetak: *Prema Statutu Visoke tehničke škole u Bjelovaru [1], jedna od djelatnosti ustanove je promicanje novih tehnologija, inovacija i poduzetništva. S ciljem poticanja razvoja poduzetničkih vještina i inovativnosti studenata, Visoka tehnička škola u Bjelovaru osnovala je Studentski poduzetničko-tehnološki inkubator Bjelovar (u nastavku: Studentski inkubator).*

Ključne riječi: *elektrostrojarski laboratorij, studentski inkubator, poduzetništvo, nove tehnologije*

Review article

Abstract: *According to the Statute of the Technical College in Bjelovar [1], one of the institution's activities is to promote new technologies, innovations and entrepreneurship. With the aim to foster development of entrepreneurial skills and innovativeness of students, Technical College in Bjelovar has founded the Student Entrepreneurial-technological Incubator Bjelovar (hereinafter: student incubator).*

Key words: *Electro-mechanical laboratory, student incubator, entrepreneurship, new technologies*

1. INTRODUCTION

For the purpose of encouraging the entrepreneurial skills and innovativeness in students, on February 9, 2010 the Management Board of the Technical College in Bjelovar passed the Decision on Launching Projects and the Establishment of the Student Entrepreneurial-Technological Incubator at the Technical College in Bjelovar. The realization was initiated based on an agreement between Technical College in Bjelovar and the Local Development Agency Poslovni Park Bjelovar d.o.o.

The purpose of the project is the preparation of students for working in entrepreneurial environment and providing conditions for the development of projects based on knowledge and contemporary technologies, connecting with the economy, development of technological projects based on the needs of industry and the production and entrepreneurial sector in Bjelovar and its region. The idea related to the development of entrepreneurial skills in the technical area was also recognized by the Ministry of Economy, Labour and Entrepreneurship. Technical College had applied for the call for proposals "Education for Entrepreneurship 2010" and proposed the project of establishing the Student Incubator. The Ministry accepted it and co-financed the procurement of equipment and basic means.

The justifiability of the project and investment into the further development of the student incubator was also acknowledged in the Strategy of the Economic Development of the Town of Bjelovar 2011-2015, where the development of the incubator is recognized as one of

the measures for developing and upgrading the conditions for entrepreneurship development [2].

Upon meeting basic requirements, Technical College has continued to encourage students' innovativeness and has invested additional means into equipment. In 2012 the Ministry of Entrepreneurship and Crafts co-financed further development of incubator activities: incubator rooms was equipped with equipment and devices necessary for project realization of training companies, several process-production projects related to material testing and measurement were initiated, three business plans for the implementation of new technologies in the economy were made, and Student Incubator accessed the Student Entrepreneurship Incubator Network.

Students' interest, more intensive presence at entrepreneurs' and innovators' meetings fostered the need for further development of material and spatial conditions for the development of innovative entrepreneurship. In September 2013 the Town of Bjelovar, Technical College in Bjelovar and the Local Development Agency initiated the establishment of the Technological Park Bjelovar, the purpose of which is to provide the conditions for the development of entrepreneurship in the technical and technological environment.

2. STUDENT INCUBATOR ACTIVITIES WITHIN THE ELECTRO-MECHANICAL LABORATORY

Increased competition on the market allows for customers to have specific requests towards the producer

[3]. Student incubator was developed as a system of training companies that operate with the support of the electro-mechanical laboratory. Their task is to develop flexible technical and technological products that meet market demands by a higher level of machine automation, modular machine concepts and additional contents, such as robotized flexible assembly and production systems, CAD/CAM systems without which a more complex machine processing is today hard to imagine. This paper includes the description of some companies that have been developed within the student incubator: ROBOTIC d.o.o., AUTOMATIC d.o.o. and CAD/CAM PRO d.o.o. The companies were named according to the area related to their operation.

This idea is used to encourage interested students of Mechatronics to develop projects that might be interesting on the market.

The electro-mechanical laboratory provides the student incubator with material and technical conditions, and is equipped with the following systems:

- Computers with the Siemens Sinumerik Operate software (ShopMill, ShopTurn);

Enabling the computers to work with virtual versions of control units of CNC machines (Figure 1), Siemens Sinumerik units (Figure 2).



Figure 1. ShopTurn and ShopMill interface [4]

The laboratory is equipped with a control cabinet with an installed Siemens Sinumerik 840Dsl. control unit and a three-axes CNC turning machine (Figure 3).

The equipment will be used for real testing of machine processing (milling and turning), programmed on 16 virtual units Sinumerik Operate.



Figure 2. Sinumerik Operate workplace [4]

- Control cabinet with an installed Siemens Sinumerik 840Dsl. control unit [3];

This didactic training device is used for training in the construction of new CNC machines or in retrofit of old machines (Figure 3). Drive units for four servo axes and an input/output card for collecting external information are used. The control unit supports the turning (ShopTurn) and milling (ShopMill) functions. It is used for controlling a three-axes CNC milling machine (Figure 3).



Figure 3. Control cabinet and three-axes milling machine [4]

- Three-axes CNC milling machine;

A machine with three translational axes has been developed [4]. Axes' movement was obtained by means of trapezoidal thread spindles. Axes are driven by servo motors. Simultaneous movement of three axes and the control of the main spindle are carried out by the Sinumerik 840 Dsl control system (Figure 3). Classical machine was transformed into a CNC machine of exceptional performances. Drive motors of the main spindle are equipped with encoders. The next logical phase in the work of companies ROBOTIC d.o.o., AUTOMATIC d.o.o., CAD/CAM PRO d.o.o. refers to adding the fourth and the fifth simultaneous axis. The next, preparatory phase refers to the realization of automated tool exchange, clamping work pieces by pneumatic and/or vacuum, and the implementation of sensors for controlling the length of tools for material-removal processing.

- Two-axes CNC lathe;

The automation of a conventional lathe by means of a PC-based Mach3-Lathe system. The company CAD/CAM PRO d.o.o. has purchased a conventional two-axes lathe in a very bad state. The conventional lathe was transformed into a CNC machine with two simultaneous axes. In order for this to be possible, and due to the lack of adequate machine documentation, it was necessary to create new, complete documentation of the machine. Step motors on two axes were installed (Figure 4).

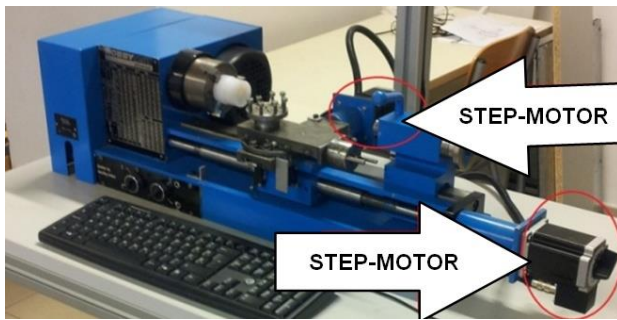


Figure 4. Installed step motors on the lathe [4]

The main spindle is not controlled by a computer, but this option exists. Mechanical end-switches were installed, which serve for referencing the machine and as protection against uncontrolled movements of the machine. The automation of the conventional lathe is currently carried out by means of the PC-based Mach3-Lathe CNC system (Figure 5).

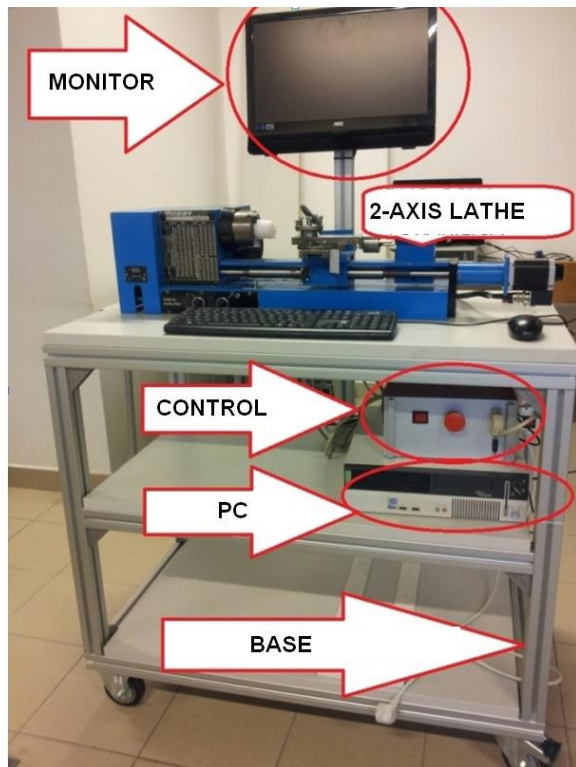


Figure 5. Mach3-Lathe CNC system [4]

- TTT manipulator;

The automation of the manipulator by means of the S7-200 system and computer visualization. Companies ROBOTIC d.o.o. and AUTOMATIC d.o.o. carried out the design and automated a TTT-manipulator, which was designed and constructed by the company CAD/CAM PRO d.o.o. A driver sets step motors and electromagnetic valves of the pneumatic system in motion, while feedback information is collected by mechanical end-switches (Figure 6).



Figure 6. TTT manipulator [4]

- Computers with the Siemens software (MicroWin, WinCC Flexible, TIA-Portal);

Enabling computers for working with Siemens Simatic PLC devices, by means of which further projects based on this technology shall be realized.

- Cart with a positioning system;

Automated cart positioning by means of the S7-200 system and visualization on the TP177B touch panel. Asynchronous drive motor 125 W is driven by the Sinamics frequency inverter of appropriate power, while feedback information is collected by end-switches of cart position.

- Solar tracker;

Automated positioning of a solar tracker by using a micro-controller assembly, along with the reception preparation of the external reference of positions. Step motors are driven by a driver, and feedback information is collected by mechanical end-switches and incremental electronic encoders.

- Pumping station;

Automated control of station pumps for increasing the level of water in the system. DC motors are driven by relays, and feedback information on water levels in the model is realized by mechanical end-switches.

3. TRAINING COMPANIES WITHIN THE STUDENT INCUBATOR

Training companies that are to be developed within the Student Incubator are described in the text to follow. For each company the focus of its work is described, as well as their possible connection with companies that successfully operate in the Bjelovar-Bilogora County, Koprivnica-Križevci County and neighboring counties, which use technologies that are to be dealt with by companies in the incubation process. Furthermore, the procedure of implementing a concrete problem from the industry into classes within the Professional Study of Mechatronics will be described on the example of cooperation with production companies that constructed the parts of TTT-manipulator, making contacts with suppliers of equipment that is not produced in Croatia (pneumatic grabbers, directional valves, motors, PLC etc.). TTT-manipulator is the project that connects the "companies" ROBOTIC d.o.o. and AUTOMATIC d.o.o. The focus of the activity was put on independent work of senior year students. Students contacted suppliers etc. The objective of this approach is to make students more adaptable to the real sector upon finishing their studies and prepare them for challenges that they can expect to face in their everyday work: late delivery of equipment, wrong items being delivered, wrong parts being made etc. In the text to follow objectives of training companies are described.

3.1 Robotic d.o.o.

The objective of this training company is the implementation of robotic manipulators for industrial application. The necessary equipment for the realization of activities is a 6-axes robot, pneumatic gripper for receiving and manipulation of work pieces and welding equipment for MIG/MAG welding. In the student incubator interested students shall acquire practical knowledge about the options of robotized production, especially in the area of welding, as 95% of installed industrial robots in the world work on welding, which is one of the most demanding and complex processes.

In Bjelovar and its surroundings there are several tens of companies that would upgrade their development by applying this technology. The development of experts who will, within the student incubator, be prepared for being included in the production of the existing or initiation of new production plants and trained for installing and maintenance of equipment justifies the purpose of the training company. In the student incubators students will work on examining technical characteristics and use-related efficiency of equipment, connecting robotic manipulators by means of PLCs with CNC process machines, work piece positioning devices, and including them into the process industry. Student Incubator provides the prerequisites for this activity: 30 computers were equipped with the CAD tool SolidWorks 2011, which is 100% compatible to the ABB Robot Studio and assures the conditions for the preparation of projects and develops team approach: project planning, production preparation, realization

plan, responsibility of team members, realization and achievements tracking. Future young entrepreneurs will be able to discuss a set topic in interest groups, exchange their experiences, while mentors will answer their questions and direct their students.

Such form of education and working with young people provides future entrepreneurs with better competitiveness on the added-value service market. The existing software support allows for programming robot trajectory, quality check by virtual simulation and testing the quality of the programmed process.

3.2 CAD/CAMPro d.o.o.

The objective of this training company is providing students with skills necessary for undertaking entrepreneurial activities directed towards the implementation of CAD/CAM technology. According to previous analyses, there are around ten companies in Bjelovar and its surroundings that use one or both tools, and preparing students for working with these tools will assure competent workforce for the development of the production sector.

Upon the preparation of machining in CAD/CAM packages SolidWorks and SolidCAM, the simulation of machining using program packages Siemens SinuTrain ShopMill/ShopTurn follows. The next step is programming on the CNC control unit Sinumerik 840D sl, with the supporting automation equipment, which may be used for equipping every conventional machine and transform it into a CNC machine. By taking this step students will be prepared for entrepreneurial activities that are to follow: from selecting necessary machines to programming of machines. Programming of CNC machines is a component of the study program in Mechatronics at the Technical College in Bjelovar. Within the student incubator students will additionally learn how to apply and control CNC machines and adapt to project needs.

3.3 Automatic d.o.o.

The objective of the training company is the implementation of programmable logic controllers (PLC) for the industrial application. Students will work on testing of technical characteristics and use-related efficiency of equipment, devices and smaller machines in the process industry. Students interested for gaining additional knowledge in automatics will be provided with skills necessary for creating cost-efficient solutions and acquire competences for future entrepreneurial activities of implementing automatics in production activities. The second part of the space is foreseen for students' independent work on projects. Seven workplaces are equipped with computers. Students will be able to discuss a set topic in interest groups, exchange their experiences, while mentors will answer their questions and direct their students. Technical College in Bjelovar purchased a part of the equipment for the automation of the S7-200 series and a new set of equipment for the automation of the S7-1200 series. It is planned to use this equipment for the purpose of projects that are current and

applicable in the production structure of the environment in which Technical College in Bjelovar operates. A characteristic product of the company is the robotic TTT (translation-translation-translation) manipulator, which is a sort of a robot that achieves three translations. Up to now, the project of a three-axes translational manipulator, controlling the motor spin speed by a frequency inverter 1.5 kW using S7-200 and controlling the speed by a frequency inverter 125 W using S7-1200 has been completely carried out. Two projects are currently in the process of development using S7-1200: a two-axes solar tracker and industrial flexible manipulation drive with belt conveyors and robotic arms, along with which the implementation of a completed TTT manipulator as a modular machine in a continually managed production process will be presented as well.

4. CONCLUSION

The described projects allow students to become included in the economy by setting up private companies upon finishing their studies [5]. For the purpose of improving the quality of the study program and preparing students to work in real sector by using equipment and machines, it is necessary to provide a part of automation and peripheral equipment that will upgrade the system to a higher level. As Technical College in Bjelovar possesses the required software for the creation of solutions of industrial plants, the next step refers to more advanced PLC devices (S7-300 and S7-400) and computers that will be connected with each of the systems implemented up to now. Such solutions will make it possible to conduct scientific measurements and experiments by using professional projects, according to the idea of upgrading scientific models. An example of such upgrading of scientific models is the simulation of a three-axes CNC machine on a three-axes TTT manipulator and upgrading the model of solar tracking or recording the production of electric energy by a two-axes solar tracker, based on the results of optimized production. All of this combined is going to increase the competitiveness of Croatian products, but also the value of young entrepreneur in the market race.

5. REFERENCES

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