Using of interactive web-based electric drive design tools in e-learning in pandemic time

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***Abstract*— The purpose of this paper is to discuss the e-learning opportunities provided by Internet technologies and web-based engineering tools for electric drive design on the websites of specialized companies. A method for online conducting interactive laboratory exercises for electric drive disciplines for students during the pandemic time has been proposed. An analysis of the results achieved by students and a comparison with previous years have been made.**

Keywords—e-learning, web-based tools, electric drive design learning and training

I. INTRODUCTION

Coronavirus COVID-19 suddenly changed our lives in all its aspects, including education. The accelerating e-learning in recent years from an opportunity for remote learning has become the just possible opportunity for effective learning in pandemic time. This also applies to education at technical universities. How to conduct training in technical specialties without access and working in laboratories and compliance with the topics and activities set in the curricula has become a major problem for the professors. The only solution was to use specialized simulators [1]. Unfortunately, most universities do not have simulators for all specialties, because laboratory training has proven effective in training future engineers. On the other hand, with the sudden pandemic, there was no time or resources to develop specialized tools.

On the other hand, the sudden establishment of restrictive measures has left many students without access to computers. The installation of the simulation systems at home is limited by licensing rights and hardware and software requirements. But all students have access to the Internet with satisfactory quality. Therefore, the only option remained the use of web-based platforms available via the Internet. The Internet provides a wide range of opportunities for interactive exchange of information, online training, webinars, cloud technologies for collaboration [2]. But many companies also provide web-based projecting tools. In the field of electric drives, large companies in the industry offer online tools for designing all kinds of units.

Thus arose the idea of using such platforms and web-based tools in the specialties of design of production units and elements and their drives. This article aims to illustrate the results of using such tools for the design of production units and analysis of the results obtained.

II. WEB-BASED TOOLS FOR ELECTRIC DRIVE DESIGN

Most of the biggest electric drive producers are developing specialized for electric drive projecting on the base of own production – electric motors, gearboxes, frequency inverters, and other equipment. SEW-EURODRIVE, ABB, Mitsubishi Electric, SERVOTAK as a world leader in drive technology and pioneers in drive-based automation, are providing on-line drive selection tools. The use of these tools gives an opportunity for step by step to design electric drives of the main types of actuators as elements of automation systems - conveyors of different types, transport mechanisms, lifting mechanisms of different types, pumping equipment, various servo drives, and others. These companies providing access to web-based tools just after simple registration without any restrictions.

SEW-EURODRIVE USA allows customers a fast and detailed design of electric drives using a specialized tool PT Pilot [3]. PT Pilot – Fig.1, is compatible with all major browsers for PC and MacOS. No installation or purchase is necessary. PT Pilot is a cutting edge online selection tool that provides all of the following features: drive application calculator and formulas, includes thermal and mechanical ratings, 2D or 3D electronic CAD files, a quotation with net price, online ordering.

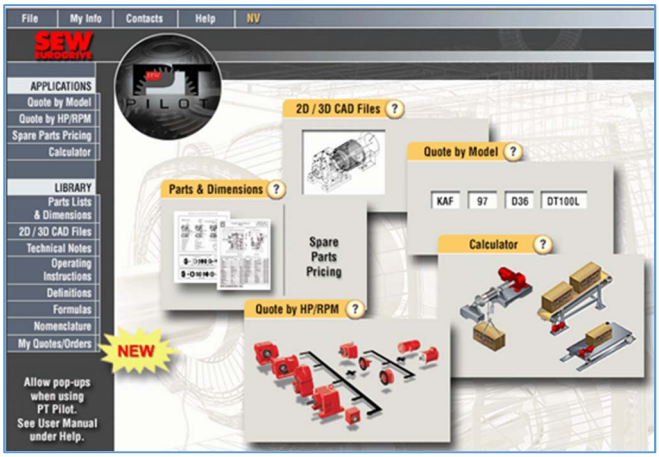

Fig. 1. Main screen of PT Pilot – design tool of SEW EURODRIVE.

Specialized included tool Calculator, Fig.2, provides the opportunity for drive projecting of following mechanisms – belt conveyor, roller conveyor, travel drive, crane hoist, lift, palletizer. PT Pilot generates detailed reports on the designed drive. The system also allows automatic ordering of the necessary equipment to the company by the customer through the standardized report formats for ERP systems.

ABB is a leading global engineering company developing and manufacturing products for electrification, robotics and automation. Part of the portfolio of ABB is also a specialized tool DriveSize Web [4].

DriveSize helps to select an optimal motor, drive and transformer. It contains current versions of ABB motors and drives catalog. DriveSize can also be used to compute network harmonics and to create dimensioning documents.

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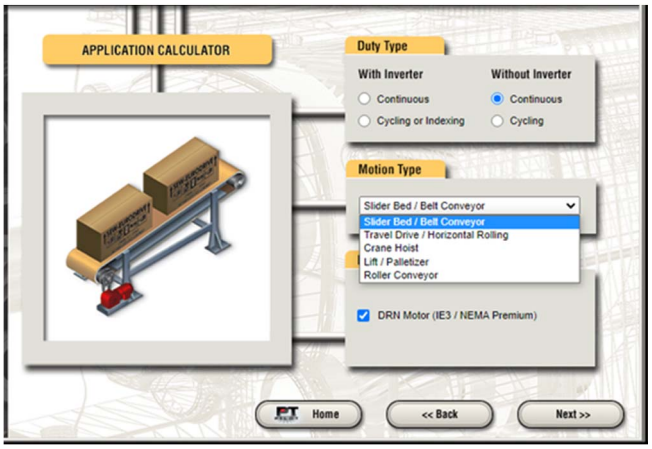

Fig. 2. Calculator module of PT Pilot.

DriveSize, Fig.3, assists the engineers in selecting optimal motors and drives for variable speed drives applications from ABB low voltage AC drives and 3 phase AC motors. DriveSize consists of a user interface, computing part and product databases. The databases contain about 60 000 data rows for catalog motors with many voltages, thousands of drive types and the modules of the drives.

Fig. 3. Main screen of DriveSize Web – design toll of ABB

SERVOTAK engineering solutions focus on customers who need custom precision gear units with superior performance. Site of Servotak consists tool Engineering Calculator – Fig.4. This tool allows customers to project ball screw mechanism, conveyor, rotary table, elevator, vehicles, etc.

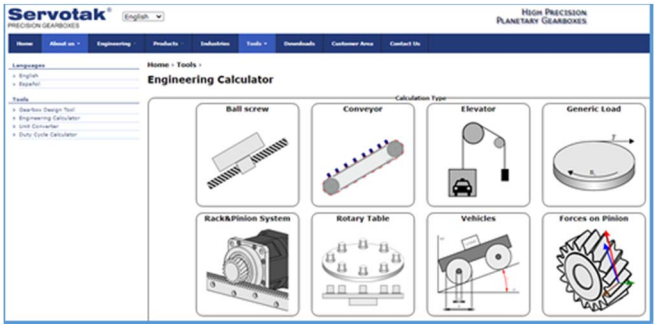

Fig. 4. Engendering Calculator of SERVOTAK.

This tool is created to assist engineers with the sizing of the different parts of the system. There also are provided detailed methods of calculations for different actuators. Together with the interactive tools, mathematical algorithms for calculating the parameters of the electric drive are presented. Therefore, this application can be used as an engineering guide.

Mitsubishi Electric provided the Servo selection tool –Fig. 5. This is an online selection tool for Mitsubishi Servo motors and amplifiers. It helps users to select the correct components to match their system requirements. The selected configuration is listed with the respective article numbers and can be exported to an Excel file.

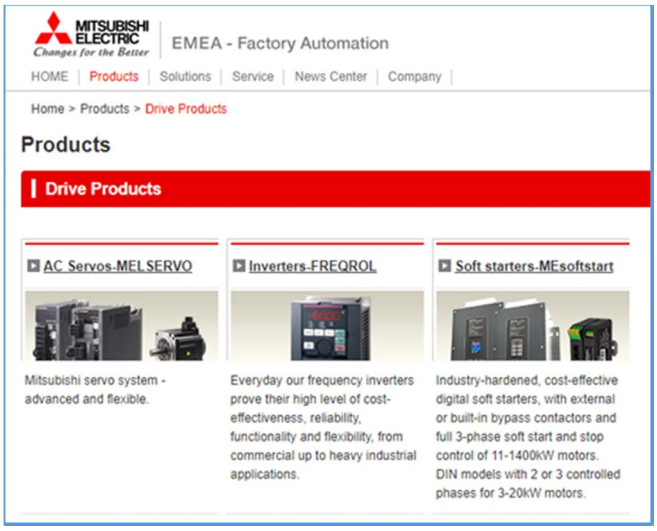

Fig. 5. Tools for selection of the electric drive from Mitsubishi Electric.

The online tools of Mitsubishi Electric are oriented mostly to selection elements of the electric drives as part of factory automation.

III. Web-based tools as part of e-learning in pandemic

At the beginning of the coronavirus pandemic there was a need for rapid implementation of remote e-learning. In these conditions, the University proved MOODLE be an excellent solution for sharing lectures, materials and conducting tests and exams. There are, of course, many other universal and specialized platforms for knowledge sharing, some of them focused directly on student learning. But what to do with laboratory exercises? Technical universities train their students using specialized laboratories, equipped with the appropriate technical stands. The development of online stands requires time and resources. The training of students to design electric drives without access to laboratories was a serious challenge for the professors in pandemic time.

Therefore, was decided for developing interactive online laboratory exercises on the base of web-based tools on sites of SEW-EURODRIVE, ABB, Mitsubishi Electric and SERVOTAK.

Were developed laboratory exercises for the design of electric drives for various actuators and actuators using the online tools of these companies:

- Travel drive;
- Belt conveyor;
- Roller conveyor;
- Crane hoist;
- Palletizer;

- Elevator;
- Drives for pumps and fans;
- Rotating table;
- Ball screw mechanism;
- Rack and pinion mechanism.

For more half of them are using PT Pilot because of the wonderful visualization and organization. Each student in each exercise received an individual task online, which they had to solve using the interactive tools on the company's websites. From the first exercise, was observed an exceptional interest from the students. Most of them with passion and enthusiasm start alone using these tools and send additional examples, developed individually.

IV. Comparison of Results from the Laboratory Exercises in the Laboratory in University and Remotely Using Web-Based Interactive Tools.

The laboratory exercises were conducted with students in the discipline Design of Electric Drive Systems. At the Technical University of Sofia, branch Plovdiv, faculty of Automation, Information and Control Systems, are trained in this discipline usually one or two groups with a total of up to twenty students. The results from using these online tools can be illustrated by the summary Table 1. This table consists the data of attendance and student grades from last semester, 2020, at the Technical University of Sofia, branch Plovdiv.

TABLE I. Table of Attendance and Student Grades

Form of training			In laboratory			Remote											Students grades
Week №			1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Laboratory exercise №			1	2	2	1	2	2	3	3	4	4	5	5	6	6	
Group			б	а	б	а	б	а	б	а	б	а	б	а	б	а	
№	Faculty №	Group	27.2.2020	5.3.2020	19.3.2020	2.4.2020	9.4.2020	16.4.2020	23.4.2020	30.4.2020	7.5.2020	14.5.2020	21.5.2020	28.5.2020	4.6.2020	11.6.2020	
1	613021	а				1				1		1		1		1	5
2	613057	а								1		1			1	1	4
3	612991	а		1						1		1		1		1	5
4	613019	а				1		1		1				1		1	6
5	613007	а		1		1		1		1		1		1		1	6
6	613033	а		1		1		1		1		1		1		1	6
7	612989	а		1		1				1	1		1	1		1	6
8	613045	а		1		1		1		1		1				1	6
9	613071	б					1				1						3
10	613108	б	1		1		1		1		1		1		1		6
11	613110	б							1		1		1		1		6
12	613069	б	1		1				1		1				1		4
13	613095	б	1		1				1		1				1		4
14	613122	б	1						1				1		1		6
15	612509	б	1		1	1		1					1				5
16	613083	б	1		1	1	1		1		1		1		1		6
	Total:		б	5	5	8	3	5	б	8	7	б	б	б	7	8	Average
	Attendance, %		75	63	63	100	38	63	75	100	88	75	75	75	88	100	5,25
	Average attends %		66,67			97,22											81,94

The following results are observed from the attached table:

- After the crossing to distance e-learning and preparing and presentation the new laboratory exercises, respectively, the attendance increases sharply from 66.67% up to 97.22%.
- Thanks to the increased interest and commitment of students, the student grades reached an average 5.25.

To compare the results of this year, we compared them with the results of the previous two years. The data from the last three years are presented in Table II.

TABLE II. Comparison of Results for Last Three Years.

№	Year	Students	Attendance, %	Students grades				Students grades on average
				Fair	Average	Good	Excellent	
1	2018	12	74	2	4	2	4	4,67
2	2019	10	61	1	4	2	3	4,70
3	2020	16	82	1	3	3	9	5,25

There has been an increase in attendance in the last year and correspondingly higher results of student grades. The comparison is shown in Figures 6 and 7.

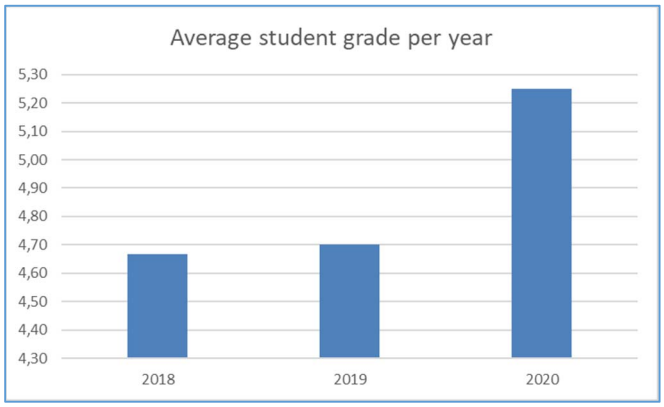

Fig.6. Comparison of attendance for the period 2018-2020.

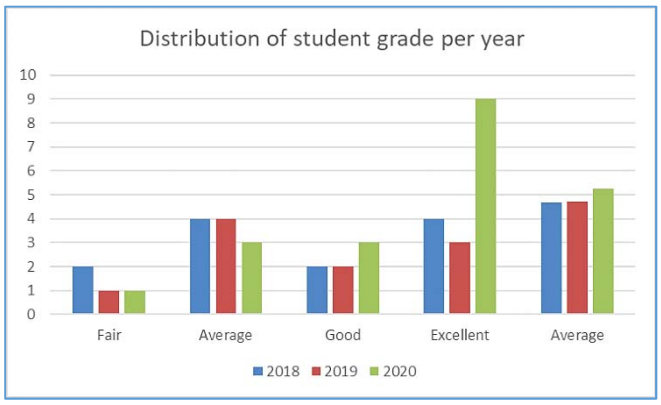

Fig.7. Comparison of student grades for the period 2018-2020.

Of course, we should not absolutize the role of e-learning for better student achievement. In this case the groups of students are relatively small, students have different basic knowledge and motivation every year, so the results obtained cannot serve as general conclusions. But the opportunity to use the Internet to attend classes, the use of real tools for designing electric drives, provided by companies, world leaders in the field of automation production, arouses legitimate interest and commitment among students.

The comparison between the analytical methods and the online-based tools showed the expediency and efficiency of the new methods for designing electric drives. Design time is reduced dozens of times while reducing the possibility of making mistakes, and this is really impresses students and makes them want to look for and use such tools.

V. Conclusion

The Internet has become one of the preferred ways to share knowledge in the form of available resources for research and learning. Technology-based e-learning encompasses the use of the Internet and other public information technologies to produce and publish materials for learning [7]. E-learning as a concept covers a range of applications, learning methods and processes no alternative in our Internet-connected life.

This article shows a new, COVID 19 pandemic caused, way of e-learning. Using this method, it is not necessary to develop new web-based learning and training materials and

tools. Idea is to use public web-based materials and design tools from the biggest word companies for purpose of education.

The advantages of this approach are many:

- No additional resources and time are needed to develop specialized e-learning platforms, materials and tools.
- The training begins immediately without wasting time from students and professors.
- The students are introduced to the learning process with the official sites, products and design tools of leading world companies in the field of control systems.
- They learn to use web-based interactive projecting tools. This allows them to compare different methods for designing electric drives. The students found the benefits and features of design tools provided by different equipment manufacturers.
- In the process of training in laboratory exercises, the students get acquainted with the world leaders in their professional field, which is important for their growth as automation engineers.

Last but not least, the comparative analysis shows increased interest from students and good final results. Therefore, the purpose of this article is to share the experience of using this method of e-learning, caused by the epidemic, but applicable in other forms of student education.

The training of students in engineering is best done with the use of specialized technical equipment and/or specialized simulators, but in the sudden COVID-19 pandemic, this way was a good and appropriate opportunity for training of the students in this discipline.

The main disadvantage of this method of conducting laboratory exercises is that students do not have the opportunity to work with real equipment. However, this is also a disadvantage when using expensive and complicated specialized simulators.

There are presented just some web-based tools for designing electric drives, because of the current discipline Design of Electric Drive Systems, but materials and specialized tools for other engineering disciplines can be easily found.

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