

# The Use of Multimedia Technologies in the Study of Engineering Disciplines

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## ABSTRACT:

This paper is devoted to the use of multimedia materials (electronic educational resources) for the study of engineering. As an example, the authors show a method of using multimedia in laboratory workshops in one of the engineering disciplines, thermal engineering. Along with the use of a special modular objective oriented dynamic learning environment (Moodle), it is proposed to use a simple and ready-to-use software Auto Play Menu Builder for creation of hyperlinked material, photo- and video files, educational presentations etc.

## 1 INTRODUCTION

E-learning is one of the modern world developments in education. E-learning is based on the use of Learning Management Systems (LMS). LMS represents a set of software and hardware based on Internet technologies, teaching methods and organizational measures that ensure delivery of an educational resource to trainees, implement control of received knowledge (by means of providing response to class assignments, intermediate testing and finals, and other forms of getting feedback in the process of learning). LMS provides an opportunity to implement different forms of training to meet educational needs of students who have different intellectual profiles. Training can take place in the form of pre-scheduled classes with involvement of a teacher, e.g. lectures, webinars, video conferences. As an alternative, distance learning students use tutorial lectures, presentations, videos, tests and assignments prepared in advance. Intercourse between students and the teacher is performed via email, forum chat, etc.

It has not been long since Russian universities (except some leading schools) began to engage in problems of electronic education (e-learning). The emergence of so-called Massive on-line Open Courses (MOOCs) intensified this process.

The biggest suppliers of open online courses that gain popularity in Russia are Coursera, Edx, MIT

OpenCourseWare etc. Coursera includes video lectures with subtitles, lecture notes, homework assignments, tests and final exams. Access to courses is limited in time; deadlines exist for homework assignment or test submission. Upon completion, students may receive a certificate of completion, provided that interim exams and finals are finished successfully. Mainly, the courses are in English, although many of them contain subtitles in different languages (including Russian).

EDX offers interactive online courses and MOOCs from top international universities (such as MITX, HarvardX, BerkeleyX, UTX etc.). Offered disciplines include biology, business education, chemistry, informatics, economics, finance, electronics, mechanical engineering, food and nutrition sciences, history, the humanities, law, literature, mathematics, medicine, music, philosophy, physics, science, statistics and much more. EDX is a non-profit online initiative created by Harvard and MIT.

Unfortunately, engineering disciplines are not so widely affordable among the variety of electronic courses.

We shall not dwell on the advantages and disadvantages of this educational system. She has many admirers and enemies no less [1,6,10]. It cannot be denied that her appearance drove many Russian universities to develop and introduce online educational material (multimedia educational resources). The best of them are placed after appropriate examination to online databases, including Coursera and Edx.

Preparation of multimedia educational resources for use in the study of engineering disciplines is complicated and time consuming.

Contemporary multimedia training courses are developed by groups of experts (leading teachers, programmers, etc.), nevertheless, taking a multimedia training course solely is evidently not enough for the study of such complex subjects as engineering. Courses must be thoroughly adapted to the related field or discipline, educational background of trainees, etc.

On-campus laboratory workshop remains one of the most important components in training of a specialist in engineering. It is not easy to prepare virtual labs for engineering disciplines. One reason is that laboratories in different universities are not equally equipped. Some schools create virtual multimedia laboratory courses, which are paid and their educational value is ambiguous. For example, in the study of work processes in heat engines, students use action models or standard engines to perform pre-launch activities and engine start, take the readings using electronic devices (PCs, portable infrared temperature gauges, etc.), i.e. students acquire technical skills of machine operation, which can't be acquired by means of a virtual lab.

Multimedia resources can act as an additional teaching material, contributing to a better understanding of the processes occurring inside the engine. Numerous researches show that learning environment created with the help of multimedia facilitates perception of information by means of activation of different senses and enhancing cognitive skills of each individual [1].

The use of the so-called modular objective-oriented dynamic learning environment allows removing a number of problems encountered in the preparation of multimedia training courses. For example, Moodle-Modular Object-Oriented Dynamic Learning Environment is a free web application that provides the ability to create sites for learning, including storage of educational material, record keeping, dynamic interaction with students, etc.

In Kazan Federal University, implementation of e-learning has been held for the past 15 years. Electronic educational resources created by teachers and co-workers of the University are located on three sites of distance learning (called "Zilant", "Bars" and "Tulpar"), all of them based on LMS Moodle.

At one of these sites, we have placed an electronic course "Hydraulics and Hydraulic Machines" which includes a short course of lectures, laboratory practice, and typical problems solving set, glossary, questions and test section for the purpose of knowledge control etc. The course contains plenty of multimedia resources (such as presentations and videos) hyperlinked to the text material.

The course is designed for self-education (distant-training system), and the traditional on-campus education (full-time education).

In [1] the author cites interesting statistics from one of the open education platforms eDX, showing advantages and disadvantages of massive online learning: 35% of respondents show they never looked through the content of educational materials of the chosen course, and only 5.1% of respondents have studied the material sufficiently to receive a certificate of completion.

According to the author [2], "there is nothing new: an abyss lies between the desire to learn and the ability to learn! Some problems that existed in classical education continue to exist in the projects like MOOC: firstly, one needs to take into account personal ability to learn, secondly, education is mostly being enforced".

There is a bit of truth in these categorical theses. As an example, observation of a group of students involved in the course of "Hydraulics and Hydraulic machines" shows to be inhomogeneous in its composition, where about 40% of students are able to perform the training program successfully, ca. 50% have a satisfactory knowledge of subjects, and about 10% of students are subject to further improvement.

Our experimental course placed on the distance-learning platform complements the traditional educational course and is not mandatory. As an incentive, it was announced that students could significantly improve their ratings if they successfully pass the online training course.

To our surprise, ca. 20% of the students were engaged in the multimedia course. Most of the students showed no interest to the online course vs. traditional lectures.

Of course, no serious conclusions can be drawn from observing the results of one student group in one university. On the other side, it seems to be too early to talk about the mass use of remote learning systems as an alternative to traditional forms of education, as well as the prevalence of Massive online Open Courses above the traditional system.

Modular objectively-Oriented Dynamic Learning Environment Moodle which we have started to use two years ago, in our opinion, better suits for study of the humanities and less for the study of engineering.

There are some technical reasons to it. Preparation of an engineering multimedia course requires upload of a large amount of video, text material and presentations to the server. Video files are then transferred to YouTube, where HD download is not always possible due to absence of high-quality Internet in many areas. The students who try to upload home assignments report same problems.

Before moving on to work with Moodle, we had used Auto Play Menu Builder [8] for the preparation of multimedia educational resources, written on CD-

R discs with colorful decor and music [3-5]. The abovementioned software creates a disk image, electronic materials are recorded on a CD-R with the help of special programs like Nero [7]. Students receive the material on disks or USB in the beginning of the study course and work with them throughout the semester. They can consult the teacher during face-to-face encounter or via e-mail.

In this article, we show how educational resources can be used for laboratory workshops in one of the most difficult engineering disciplines, Thermal Engineering.

## 2 THE USE OF MULTIMEDIA IN LABORATORY THERMAL ENGINEERING WORKSHOP.

### 2.1. Preparing educational material.

The first step in creation of a multimedia course is to determine the scope of educational material, considering the field for which this course is designed.

Next step is the most difficult part of the job. The teacher should prepare brief theoretical information on the subject, usually adapted for a group of students depending on their major, photo slides, presentations, videos (elaborated by the teacher or downloaded from the Internet, which offers plenty of material for an educator), etc.

For the preparation of the multimedia, we usually engage students who have relevant skills for work with digital technology (computers, video recording equipment etc.) which we consider to be beneficial for both parties.

The next step is binding text material and multimedia material via hyperlinks. It is a simple job for the teacher and or his / her assistants with computer experience. For better communication, the teacher creates a directory for all the prepared materials on a SharePoint, as well as basic files of the Auto Play Menu Builder. This software allows linking the current directory with any files by using hyperlinks, and opening any document or running any program from the main page.

### 2.2. Creating a disc image.

We show the principle of creating a disc using as an example a lab assignment on thermal engineering: "The study of processes inside the diesel engine"

The processes inside the internal combustion engine are complex and not evident. Therefore, selection of animated movies showing the work of the diesel engine has a great advantage. We can choose them from freely available You Tube content (multiple videos).

Photos of instruments and laboratory stand equipment (in our case, size 6.8x5.8) can be easily obtained by using a digital camera.

Progress of the practical part of the workshop (preparation of the stand to work, engine launch and rating) are recorded on a video camera and later processed with "Studio Windows Live».

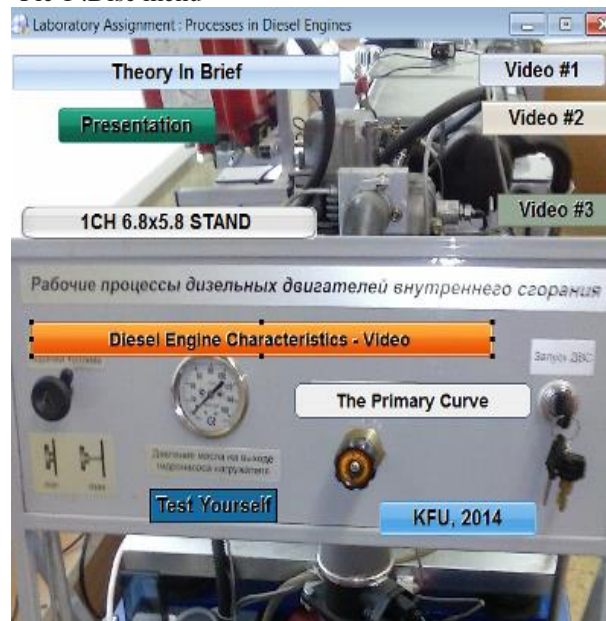
One of the difficult aspects of this workshop is engine-indicating (creation of an indicator diagram). We prepared a presentation, which assists students with this issue. First, we show photos of instruments and equipment used for this type of study. Then, we show the primary curve (dependence of mean indicated pressure from the crank angle). This is followed by description of the method of bringing it to the final form (mean indicated pressure depending on the gas volume). This curve determines IHP (indicated horse-power), one of the most important thermal parameters of the engine.

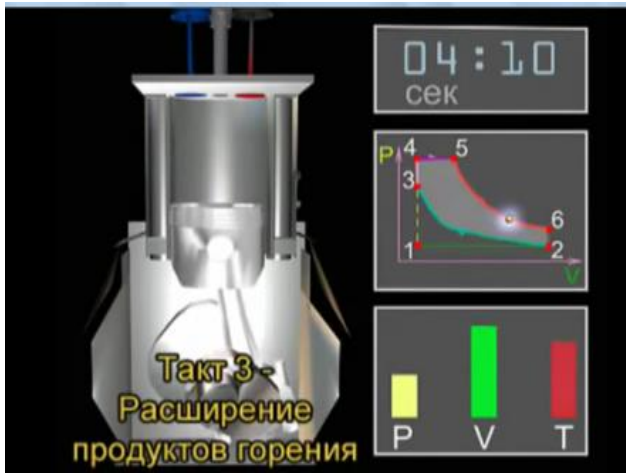
It should be noted that students observe the primary curve students on the display during operation of the engine.

Additionally, the students register important parameters of the engine, such as the torque on the crankshaft, the effective power of the engine, mean effective pressure, etc.

As the engine load we use gear pump, therefore, we offer students a small presentation on hydraulic machines (specifically, the gear pump), explaining this particular moment. It's assumed that the students have already got familiar with this subject during the study of Hydraulics and hydraulic machines, but repetition is very important.

Pic 1 .Disc menu





Pic 2. Power stroke-expansion gas

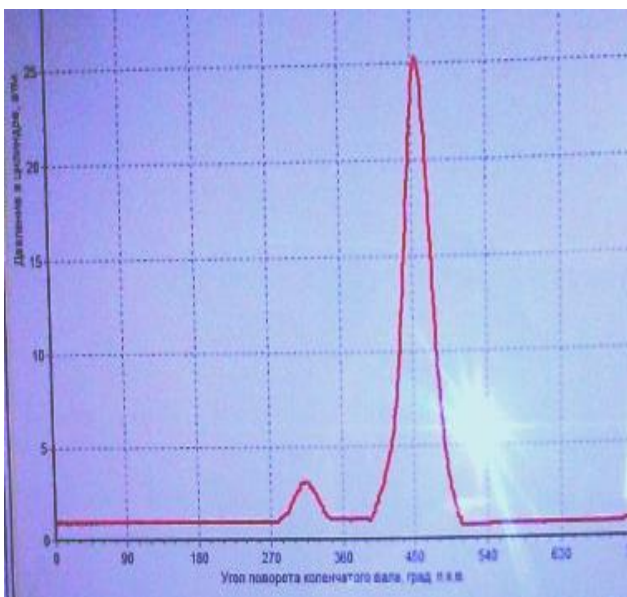
Figure 1 shows the disc menu, which contains links to all profiles in the directory of the disk.

Figure 2 shows a screenshot from the back-up video #2. This animated video demonstrates the construction of an ideal thermodynamic cycle of a diesel engine, depending on the piston stroke.

Figure 3 shows a photo of the initiated curve (dependence of the average pressure from the crank angle).

### 2.3. Method of the use of multimedia.

Prepared multimedia materials are designed for self-study. A week prior to the execution of a laboratory work, students are given the task to carefully study the related material, including tests. Prior to the class, teacher assesses the level of preparedness necessary for the workshop. Here we use



Pic 3. Engine Indicator Diagram

The Examiner software. [9] Each student is given 10 minutes for the test (10 questions containing 4 variants of answers with one correct). The program

is set to a positive assessment with no more than two wrong answers. Students, who have not passed the test, join in groups and engage in self-preparation, under teacher's guidance.

All moments that were not clear to the students during their preparation are explained in the beginning of class.

To work on the stand held conventional methods (check engine readiness for launch, zeroing performance of electronic scales, resetting of electronic registration system the most important characteristics of the engine, etc.).

Amount of used electronic material, as mentioned above, is determined by the teacher, depending on the field of study, level of preparation of students, etc.

Distance learning students also receive multimedia material and continue to work with it independently, in consultation with the teacher via e-mail. Since the classes take place outside of a university laboratory, which deprives the student of the ability to engage in lab experiments, students are given ready data, which they could get during a workshop. Students should do calculations and conclusions on their own.

Teacher supervision is performed via e-mail, generally, as well as in regular face-to-face contact with the teacher.

We prepared similar multimedia class content for the eight labs in two courses - "Thermal engineering" and "Hydraulics and hydraulic machines", and several discs on wood and sheet metal processing for secondary schools [5].

## 3 CONCLUSION

The following conclusions can be drawn from our work on the preparation and use of multimedia educational resources in the study of engineering subjects:

a) Multimedia educational resources allow wider use of the visual means in education which contributes to a better comprehension of many physical phenomena occurring in different machines and mechanisms;

b) The use of modular objective-oriented dynamic learning environment (Moodle) is advantageous under conditions of a developed network of high-speed Internet and free Wi-Fi. In other cases, preferable is the use of more simple electronic means such as Auto Play Menu Builder;

c) Academic material posted on the distant learning module (LMS Moodle) should be elaborated with regard to students' learning ability. For least prepared students it's easier to use multimedia material recorded on a disc.

Unfortunately, there isn't enough material on engineering disciplines currently. Even for one academic subject, they must have different degrees of

complexity and different costs, depending on the field of study. We offer multimedia discs to students free of charge.

We have not carried out specific research to determine the impact of electronic resources on the overall academic progress of graduates due to insufficient sampling and heterogeneity of the groups. Unofficially, students express positive impact provided by this kind of multimedia materials on their attitude to the subject, degree of comprehension, etc.

As for the distance (correspondence) forms of education, many years of experience in teaching engineering disciplines, including wide use of multimedia, higher efficiency is seen in class training rather than online learning. This is not purely distance learning, as students come to school twice a year for classroom training, but in a shortened version (about 25% of the full-time lecture volume).

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