ASPECTS OF DISTANCE LEARNING FOR ENGINEERING SCIENCES

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Abstract: *The article deals with advantages of distance education over the classical one. The deficiencies and difficulties of distance education programs in the field of the technical expertise have been revealed. It considers modern innovative study and research methods of mechanical and metallurgical processes to explain complex scientific problems of these areas by applicants of distance education. The publication contains concrete theoretical results obtained by the use of innovative computer technologies to study transportation processes in metal rolling. The results of modelling and forecasting programs have been described.*

Keywords: distance education, innovation, research, transportation, mechanical processes, information, educational process.

INTRODUCTION

The modern world is impossible without technology, the results of which were inherently a part of our social life. The development of innovative solutions concerning the existing issues falls on the shoulders of young scientists and inventors, as scientific progress, for the most part, requires so urgently needed resource-saving and alternative energy sources use. Existing research institutes and applied laboratories of classical school do not meet the progressive needs of the markets, as they are based on the "foundations" which have the roots in the previous periods of establishing statehood. These institutions are desperately needed as supportive bases for the formation of highly qualified professionals. But the times we live in call for new requirements and need qualified staff of new formation with world experience and international education. Such requirements will be further demanded by candidates for various positions of companies which are developing dynamically. And, thus, there is a need for such personnel and this raises the question of creating conditions with the aim of promoting their level of training.

For most students, education in the world-famous universities is not possible for a number of reasons. The main causes are: the financial constraints of living in cities of university location, substantial cost of training and the need to work in the post they have occupied now. So we have two main obstacles to the desired level of education - the need for significant financial costs and lack of time because of the need to work and develop their career.

An alternative that copes with contemporary requests and meets the above conditions, is only distance education. There are many books that demonstrate advantages of this form of education (Vasyuk 2011; Veremchuk 2013; Verba 2010; Warzar 2014; Zhevakina 2009). All existing distance education programs are derived techniques to study humanities. With regard to the technical areas, there is a substantial gap in teaching methods and programs.

The **OBJECTIVE** of the paper is to discuss the introduction of information technology in bachelor and master courses "Metal forming" where professors from DSTU use software package ESV-Deform. This package is unique in its kind due to the description of the process of shape change in the initial profile with the predicted deviations. The purpose of using this software product is to eliminate the defect at design stage.

BASIC MATERIALS

The metal rolling process is accompanied by complex deformations caused by stresses inside the workpiece. The number of runs through the work roll directly affects the quality of the finished surface and is reflected in the technological time, which is included in the calculation formula for the cost of production. The use of programs describing the rolling process helps to prevent the defective products, due to predetermined dangerous sections of deformation of the material. The development of educational innovative technologies will allow, without reducing the quality of educational process and considerable investments, to significantly improve mastering of disciplines due to including new formation elements of skills and abilities in the educational process in solving the practical problems together with means of applied information science both by the teacher and the student.

The application of training programs for distance education in technical areas is based on the classic postulates and theories. Accordingly, the learning of the material obtained is "boring" and narrowly used. Physical, chemical, mechanical properties and laws find their explanation on experimental laboratory stands and installations, giving much wider knowledge and faster perception of certain processes. Assuming that it is distance education, students (student) acquire practical knowledge owing to videos that explain or reveal the themes studied. However, these methods are not effective enough, because even high-quality video cannot capture all the aspects of processes and phenomena studied. The following

is necessary for a full and thorough information learning and understanding from video resources:

- psychological preparation of student for the perception of information;

- better understanding of the lecture purpose, key part of the main messages and ideas;

- internal sensation of lecture content.

This software product is designed for educational use, since it allows to import calculations effectuated for specific production conditions. The program allows you to transfer theoretical calculations into the applied and industrial plane. This piece of software is installed on internal electronic resources of the university and can be run offline by full-time bachelor, master and post-graduate students. Distance students can profit from remote access when they do not have sessions of presence classes. The software unit ESV-Deform makes it possible to identify possible deformations and fractures due to the application of forces to prototypes at any time and every point in a three-dimensional body. Remote access allows you to specify the parameters of interest and get the result without getting distracted from the production process itself. Also, remote access simulates real-time production process when the operator cannot assist the control panel all through the production process. Offline use can facilitate the operator's work in cases when the program requires correction of some variable parameters, while the modelling of load is very time-consuming.

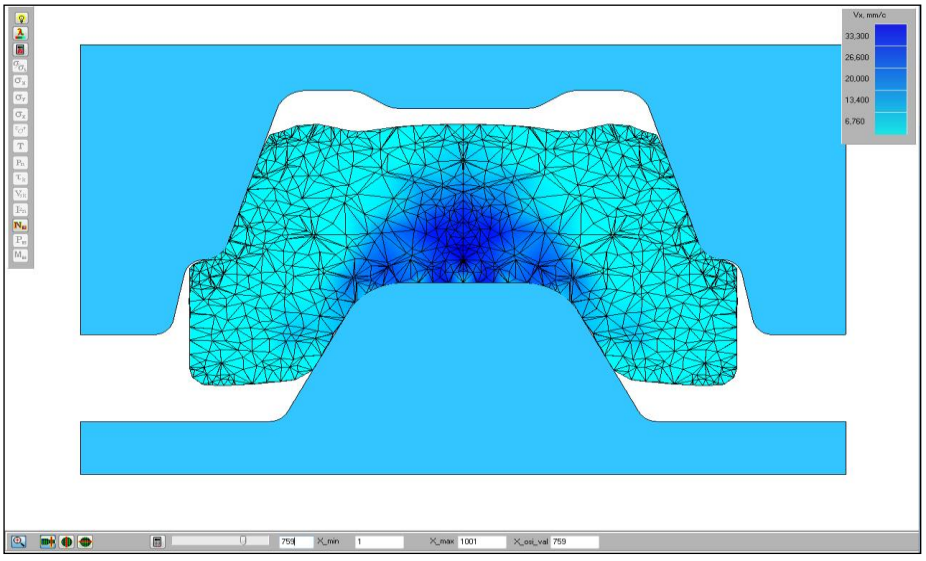

Figure 1. Load and deformation in horizontal plane

Source: *ESV-Deform programme (Developer prof. S.V. Ershov, DSTU)*

The use of the software product will help the future qualified employee and today's student to master the programming skills of rolling processes that help the transition of metallurgy to a new quality level, namely:

- to identify dangerous sections of deformation in all planes – horizontal, vertical, frontal and in intersection (Figure 1);

- to clearly identify the parts of the billet with the greatest loads for specific varieties of forms (Figure 2);

- to calculate the effort necessary to obtain the desired profile at a particular stage of processing;

- to simplify and accelerate the calculations of the predicted profile with detailed and step-by-step control;

- to calculate the minimum initial size of the workpiece for working in a no-waste mode;

- to vary the number of runs through the work roll and their depth to eliminate the risk of defect.

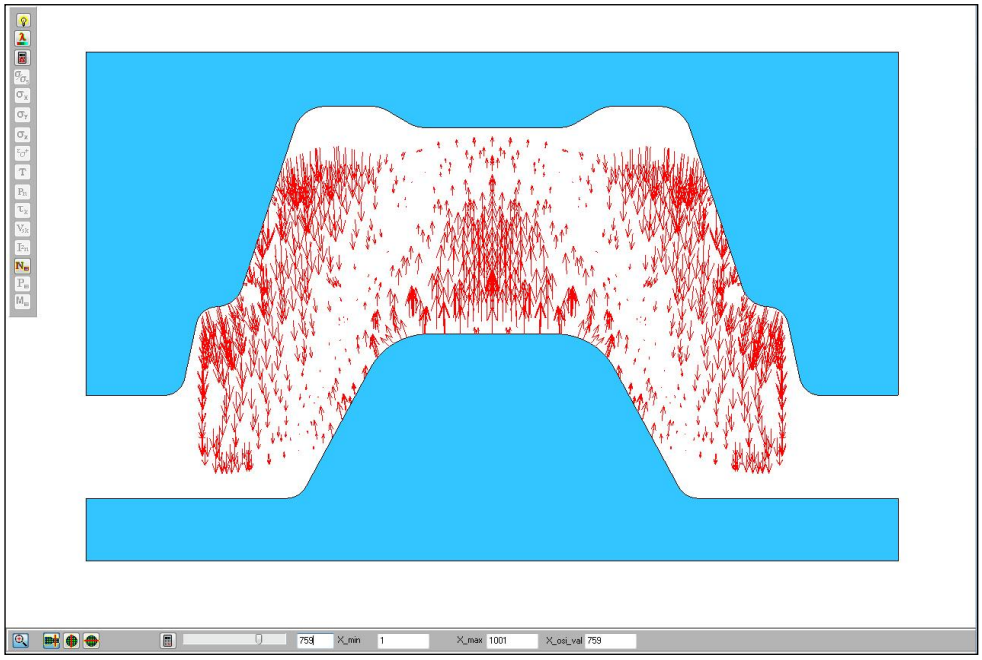

Figure 2. The direction of forces inside the billet

Source: *ESV-Deform programme (Developer prof. S.V. Ershov, DSTU)*

The student's understanding of the need for this material is responsible for psychological training. With regard the understanding and internal sensation of the purpose content, the physical perception of studies performed is necessary. The

most effective method of mastering physical processes is to perform the described experiments in video materials without assistance. But it is not always possible to construct or reproduce the experimental or pilot installation in conditions outside laboratories. So we need to create a prototype that corresponds to the existing ones. There are two main ways to implement this goal:

- the use of upgraded research analogues;

- modelling of investigated processes using computer technology.

As for the use of modernized analogues, emphasis should be given to the practical significance and their further possibilities of use and implementation. Any laboratory prototype should be applied in everyday activity, taking into account the essence compliance of compared models. Thus, in the case of complex lift-and-transport mechanisms, we can use derivative structures that are consistent with the principles and laws of interaction of the transported material with structural elements of machines. Educational applicant may be widely consulted with the theoretical justification of the positive impact of additional blades on screw conveyor to reduce lifting-driving force to move the metal chips by decreasing the forces of internal friction of transported materials, which is achieved due to the partial removal of layer load from the general stream in the trough of screw conveyors by additional blades on the example of an ordinary snow-plough. They can also study the laws of plates and belts wear and deflection under the load transportation by belt, scraper and plate conveyors represented with belt conveyors in consumer supermarkets in everyday life.

Modelling of the investigated processes using computer technology is an integral part of distance education and full-time studies, as complex processes in any industry require accurate description in order to control and arrive at rational power-efficient characteristics. Thus, using the set-up parameters the performance of conveyor can be calculated or the most effective parameters of its structural elements can be determined.

Specific examples of innovative use of computer technology for education and science can reveal the following experimental data obtained of the transportation process of materials by screw conveyor with additional blades (Chasov 2015; Chasov 2016):

- mathematical relation for determining the effective angle of metal chips march-off point on additional spiral screw blade which is within 28,7 ° to 8.7 ° in cross section has been obtained and the law of its blade motion has been established;

- the angle of attack influence of additional screw conveyor blades on its transporting capacity has been theoretically established and theoretical dependence, which allows to determine the critical frequency of the screw conveyor rotation with additional blades located within 0,31-0,42 c, has been obtained;- the effective angle of attack value of additional blades within 40-50 ° and the number of

additional blades from 2 to 4 pieces and the trough filling of screw conveyors up to 30% have been determined;

- the opportunity to design and predict the desired setting for the original data to model (growth performance of screw conveyors at different angles of extra blades, dependencies on quality growth of screw conveyor efficiency with variable filling of screw conveyor trough, quantitative growth of screw conveyor efficiency with different number of extra blades, the effective ranges of studied growth parameters of screw conveyors effectiveness depending on the amount of energy consumed);

- that no extra blades on the body of the pen auger reduces energy intensity by 25-30% and improve process performance transport of metal chips by 30-40% analytically proven;

- the prototype of screw conveyor, which can be used in the design of similar conveyors for specific shop conditions was designed, developed and tested in laboratory and industrial conditions;

- the results of theoretical research have made it possible to develop a methodology of technological and design factors calculation and give practical guidelines for screw conveyors design with additional blades.

Modern software for modeling allows to process data for other industries, that promotes innovative solutions in science and rapid spread of distance education through a broader scope of information received. An example of this result is metallurgical development (Gavrilin 2016; Ershov et al. 2016):

- the possibility of taking into account the specifications of metal flow characteristic for piling bar profile rolling of "Larsen" type with interlock base of more than 500 mm;

- the ability to identify the factors that have the greatest impact on the flow of metal in the sizes used in rolling of piling bar profile of "Larsen" type with increased interlock base, and monitor locking elements;

- laws governing draft ratio impact of sidewall area to the area of lock element on the filling of the latter in rough caliber in the production of piling bar profile of increased base have been defined;

- design method have been improved and theoretical relations which allow to join rough form of tongue-and-groove caliber with proportionality factor have been obtained;

- the opportunity to calculate figure change of deformation in rough sizes, which are used for the production of sheet profiles of open-pan form has been obtained.

Also, theoretical data of given systems that simulate the processes can be derived by means of innovative programs, for example, the value variation of spatial angle at the start of material motion β depending on the angle of attack α (Figure 3).

Analytical research into the process of transportation of metal shavings by a screw conveyor are based on the condition of equilibrium when passing from a state of rest to motion. When the screw rotates, the chips located on the surface of the additional blade will bear gravitational and centrifugal forces.

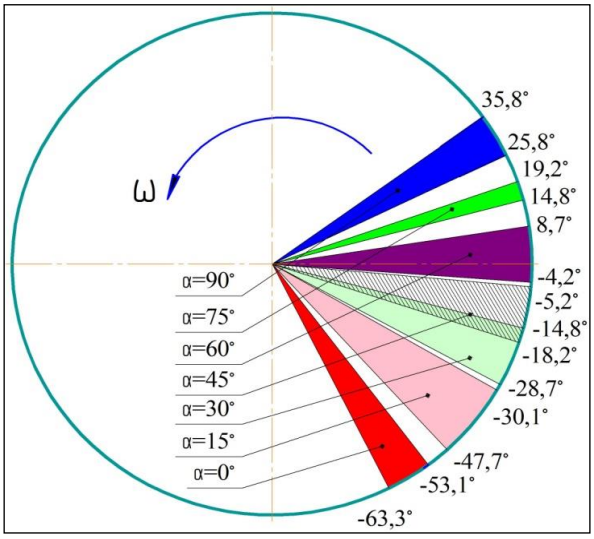

Figure 3. β angle variation depending on the angle of attack α (ω - angular speed of rotation of the screw conveyor)

Source: *ESV-Deform programme (Developer prof. S.V. Ershov, DSTU)*

The numerical value of the angle α where particles of metal chips begin to move depends on its position on the surface of the additional blade, that is, on the value of the angle β.

The transition from a state of rest to movement of a particle of metal chips characterizes the steady movement of the entire mass of metal chips located on the surface of the additional blade.

The influence of the attack angle and of the number of additional blades on the conveying capacity of the screw conveyor can be considered as a change in the magnitude of the driving force of the material being transported.

The physical nature of the motion of metal chip along a spiral along the axis of the screw describes the relationship between the angle of the spiral rise and the resistance force of metal chips.

The current hypothesis of screw conveyor operation is as follows: the productivity of the screw conveyor depends on the movement of the transported material along

the groove, which is determined by the auger design and the use of additional blades on the screw conveyor, and by mathematical modelling of the kinematics behind the movement of transported material along additional blades.

Taking into account the aforesaid, we developed a mathematical model of chip motion in the groove of the screw conveyor. Based on this model, a working model of the material transportation was formed. The basis for the design was the dependence of the angle in the beginning of movement of the material on the angle of attack of the additional blade, as well as kinematic characteristics, dynamic loads and forces that act on a piece of material in the conveyor groove.

With the help of computer analysis of interaction between transported material and installed blades of the screw conveyor, as well as the effect of installation angle of the conveyor blades on transporting efficiency of the screw conveyor we obtained a pattern of the motion of material inside the conveyor (Fig.4).

The forecasted distribution of material in the gutter of the screw conveyor has shown that transported material is concentrated on the definite side of the gutter as to the vertical symmetry axis of the conveyor. A part of the material goes up in spiral to a definite angle until it falls down. The rest of the material stays in the formed chip flow.

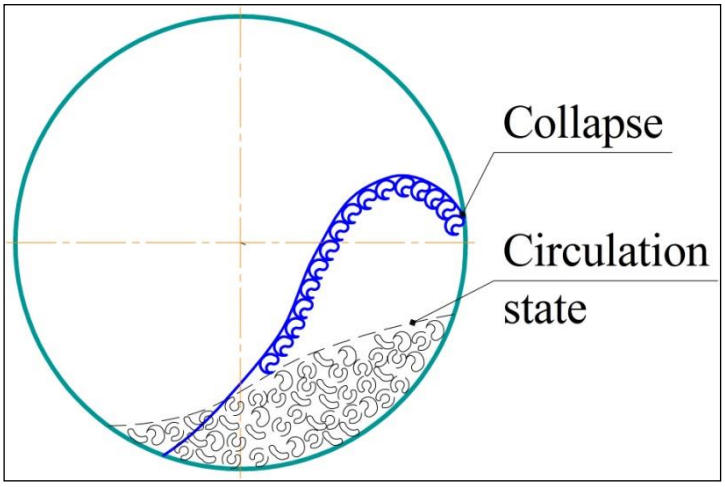

Figure 4. Distribution of material in the gutter of screw conveyor

Source: *ESV-Deform programme (Developer prof. S.V. Ershov, DSTU)*

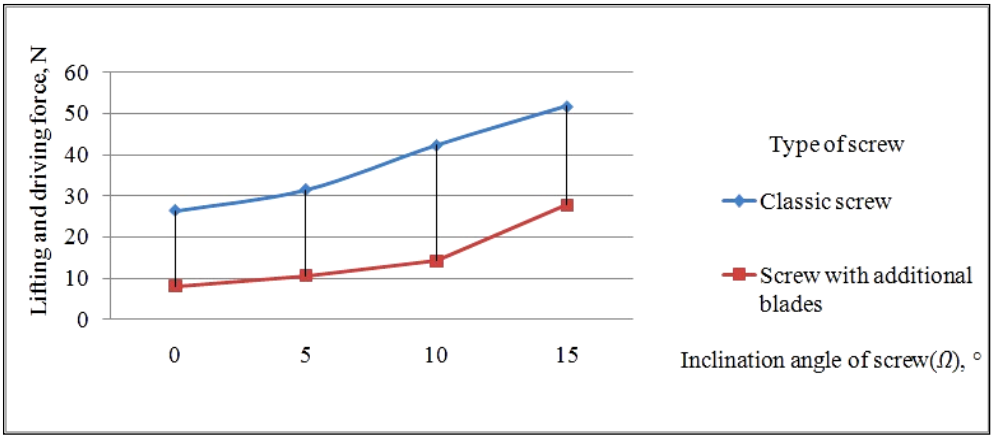

Figure 5. Dependency of lifting and driving force on inclination angle of the screw

Source: *ESV-Deform programme (Developer prof. S.V. Ershov, DSTU)*

There was developed an experimental test bench and we managed to support the theoretical claim about the material transfer process in the groove of the screw conveyor, which confirms the reliability of the computer simulation of the chip transportation process.

Modern software helps calculate amount of the driving force, which argues the predicted superiority of the performance of a screw conveyor with additional blades above the classical structure (Figure 5).

The biggest difficulty in studying the above mentioned process of transportation lies in comparison of theoretical and practical results. The presence classes supported by experimental test bench promote advanced analysis of complex processes taking place in the gutter of the conveyor. During their laboratory practice students can verify the validity of theoretical calculations. Accordingly, in case if there appears a considerable difference in the results obtained, students can hold extra laboratory research in necessary number. This can happen due to a number of aspects: design characteristics of the transporting mechanism (the number of blades, inclination angle, the number of repetitions) and the characteristics of the material transported (type of the material, is size and coefficient of friction). We need to bear in mind that students present in the laboratory can apart from learning about the processes, also affect their running and results – in this way they can get a full idea of the studied process with their own eyes.

Distance students face the problem of partial cognition of the process being studied. This is due to the fact that they are demonstrated only video materials showing the essence of the work. It remains difficult to manufacture experimental test benches outside the laboratory conditions and most distance students are limited only by the theory of the process being studied. The results of analytical

calculations may differ from laboratory measurements due to the lack of specificity of conducting an experimental study.

Forecasting program is also used in rolling - transfer of material layers by external forces. The values of moving points were used to determine the field of displacement, distribution of strain rate intensity, intensity and degree of deformation strain and shear deformation degree in deformation zone. Theoretical calculation was carried out for complete evaluation of metal flow mechanism in the above caliber. This calculation was performed using the software package ESV-Deform, developed at the Department of Metal Deformation Processes in Dniprovsk State Technical University by means of finite element method for approximation of the velocity fields of metal flow and variational principle of continuum mechanics.

CONCLUSIONS

The use of the software package ESV-Deform to define risky intersection of the designed metal profile helps students to make the calculations faster, renders them familiar with the interface of similar programs. This piece of software is applied at Joint Venture Dniprovsk Metallurgical Works (Kamianske) and in manufacturing laboratories of Dniprovsk State Technical University. The software is quite intuitive in interface and can be used in distance mode, which permits the professors exchange information with the students and demonstrate the forecasted results visually.

Modern computer technologies help to create programs for quick and easy calculation of difficult problems. Introduction of innovative technologies in the educational process makes it more understandable and interesting for education applicant and attractive for people who independently master modern science. The desire of self-development in the modern world is driven by distance education opportunities which break all barriers and go beyond all possible borders, both geographical and philological, and political.

Innovations in research have become a national property, making science understandable worldview process for everyone who seeks it. In the case of complex phenomena and patterns that can be transferred in practical commonplace, it is getting clear how science is vast and interesting. And thanks to possibilities to take part in distance learning, "attending" lectures of eminent scientists of the world, the audience have a great deal of opportunities, which are not affected by the cost of training or difficulty of chosen profession, or personal relationship with the teacher, or the location of the institution, or living conditions and life. They only need their personal awareness of the importance to acquire knowledge and time.

PROSPECTS

The author sees the prospects in further development of innovative computer technologies and multimedia projects which can give a qualitative leap in the dissemination and promotion of distance education in all areas of knowledge, including technical ones.

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