UDK 681.3 Ph.D. **Gaysha O.O.** (NU shipbuilding of the name of Makarova)
Ph.D. **Gachovich S.V.** (MIKNU)
Zhyrov B.G. (MIKNU)
Solodeeva L.V. (MIKNU)

MODEL OF USER TRAINING PROCESS IN DISTANCE EDUCATION SYSTEM BASED ON NETWORK GRAPHS

The necessity of the using the model of learning process for user of distance learning systems (SDL) is grounded. For the creation of the model it is suggested to use the well-known method of network charts from an area a management projects. The specific of subject industry causes the certain features and differences from the generally accepted network charts in a description of educational user of SDL. In the SDL it must be a standard chart of educational process and the individual study chart should be formed in his education. Here are offered the simple methods of comparison of standard study chart of disciplines during the semester and individual chart of this user that is necessary for the possible correction of educational process.

Keywords: network chart, educational process, electronic studies, distance education.

The ground of a problem. High-quality system of distance learning (SDL) must have the subsystem of monitoring and process control of getting the knowledge as one of the component parts. It is necessary because of the substantial difference with the subject who studies (we will call this person a "user" or "user of SDL" regardless of the fact what qualification level of education he obtains: it can be graduate student, magistrant (undergraduate) , student, listener of courses, etc) and subjects who teaches (teachers). In a whole teachers operate on a student through the set of information that is brought by them to the SDL. The information given by a usual teacher (who is not a programmer-developer of SDL) is passive: lecture notes, examples solving practical problems, descriptions of laboratory equipment and methods of work with it, exercise test, test papers etc. In the best variant the teacher can point the links (hyperlinks) between the individual elements of the course, and it is not enough for complete replacement of teacher. In fact the user is alone with this sometimes very voluminous information.

So, very often there is a situation in SDL when the user has access to many useful and more or less qualitative information resources but doesn't know or doubt how to start the regular classes, what is the sequence learning and what size of information should be learnt for the one lesson. To address this critical shortage of SDL it must have the active system of management. The system should have such functions:

- strategic or global control for the user's passing the material with the help of which the SDL checks the topics that user learnt and what is his level in the learning (by measurement and analysis of time given to user for learning the materials of the topic, and by current and final evaluation (control). Thus, strategic control indicates whether the learning strategy is stored;
- tactical or ongoing monitoring of the user's activity at the concrete time, with the help of which the SDL checks the correctness of the user's learning process. For a example, rapid transition during ten minutes between several different topics or even disciplines is not a correct approach to learning and SDL should trace this and indicate the failing to the user. If it is necessary (threshold exceeding degree of deviation from the normal process of learning) the SDL can make adjustments to the process of learning forced;
- saving the history of the learning process of a particular user for further statistical analysis. The details about the time for leaning each topic, the length of the intervals between periods of teaching this subject and education in general, etc. are interesting for us. Such information after averaging over a large number of users would allow adjustments to the ideal strategy of education(if, for a example, applicants each year are becoming less prepared due to the high competition between different universities or, for example, to the contrast of this by improving the medium level of knowledge through the increased competition for entering this university).

To perform the functions the administration (management) system needs some reference information that is the "perfect" strategy of study this specialty. There has to be specified the order (sequence) in which different blocks of materials on different disciplines should be studied and the time that should be devoted to this. The main terms of this study is that this sequence must be implemented and described. There must be a certain model of the learning process and the rules for its assembly. Then there will be and the ability to compare the activity of the student with the "standart", with the presence of a particular model a distance or a degree of deviation from it can be introduced and it will be controlled. With the increasing of the deviation the SDL shall adjust the training plan of user to guide to the appropriate direction.

Thus, there must be a certain model through which it would be possible to describe the sequence of actions of the user of SDL with the right training.

The analysis of recent research and publications.

The significant contribution to the study of mathematical foundations of functioning SDL was made by Fedoruk P.I.[1], who descry the use of different models, in particular, as a directed graph vertices and edges of which are structural machines of various designs. Because of the fact, that the author learns only one study course (that consists of a set of successive elementary facts - quanta) rather than a set of individual courses-disciplines that is necessary to construct a model of the learning process in higher school this model is not complete. According to the Regulations on Distance Learning [2] in Ukraine the term of study for students on distance learning is established by the institution of higher education and must not be less than it is in a full-time course by the relevant education, skill levels, training areas and specialties. Thus the model of SDL in high school must use the principles of full-time study: the number, sequence and timing of the study subjects that are similar to full-time study. So by looking to the totality of the courses that are taught at the same time by a student it must pay attention to jumps between them in modeling the learning process.

As the learning process can be represented as a collection of some of the required works the implementation of which led to given outcome, the method of network graphs can be used for the description of the process. The principles of works with online schedules are described in the literature on project management (for a example, [3] and [4], but the features of constructing the models of learning process certainly are not excluded.

Thereby because of the absence of a suitable model the purpose of the work is to create a model of the learning process for individual student based on the method of network graphs.

The main part.

Later under the mains schedule we will keep in mind net schedule of events where the vertices of are the certain states of an object and the arcs are works that are conducted by the object. Traditional features of objects the networked graphics are build for are the possibility of parallel execution of works on site, the interdependence of work, the opportunity of permutation independent work for the optimization (time or cost of the project). If the object is the user of SDL (or rather, the totality of his knowledge) and the works are learning some small portions of educational material V_{ni} (their amount depends on the level of detail of the model it can be concrete chapters, paragraphs, indivisible pieces of information - atoms or photons, such as rules, formulas, definitions, facts, theorems, descriptions of settings, etc.) or passing different types of control X_{nq}, then the graph that can be represented as learning process will have some differences from the classical concept of network graph (here we have n - number of subjects, i - number of the portion of educational material, q - number of control).

The main difference is that in a short time Δt works can't be made simultaneously because there is only one performing device in a system. It is a user (simultaneously in a given time only one subject can be taught, only one specific work (task) can be made):

$$\lim_{\Delta t \to 0} N = 1$$

where N is amount of works for making simultaneously.

However, if the time interval is considered as period equal to the semester and with the conditions for successful learning of all the subjects, this limit shall be equal to the total number of subjects during this semester:

$$\lim_{\Delta t \to T} N = \max n$$

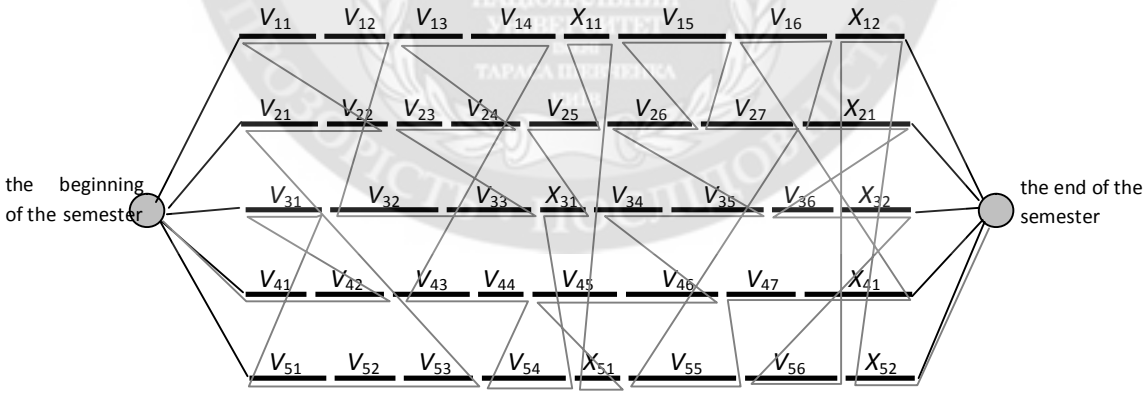
where T is the duration of the semester (e.g., 18 weeks).

But despite of the simultaneous study of several subjects in the semester, only one work can be done during the given time, and the user has to jump between learning particular subjects (works).

The common feature in modeling the learning process with the classical definition of network graph is interdependent of works i.e. the material that is studied. I t is well known that the curriculum in it's ideal form should account the interdependence of material in different disciplines. However, in practice such interdependence is too aggregated and truly realized only at the level of concrete semesters(particularly in Flow Chart of specialty or direction). Interdependences of material sciences in a module, and especially at the level of small subjects are neglected, and this is primarily related to the enormous complexity of the problem with considering such dependence.

Another difference between the model of network graphs that is developed here and the traditional one is the inability to reshuffle the works of one discipline (presentation of which has its sequential logic) and limited opportunity to reshuffle the works in different disciplines. This is explained by the fact of situation when, for example, at the beginning of the semester the user has already learned the entire course of physics as the most interesting to him, and the course of mathematics is studied at the end of the semester, because Mathematics is undesirable for him because of the reason that it reduces the quality of his learning. It is well known that for the best learning the speed of learning the educational information must be low; the information that he studied at the beginning of the semester will be quickly forgot before the exam; learning all the material at the end of the semester for a small period of time before exams is not possible too because of the limited properties of the human brain. So, it is better to learn the stuff of every discipline during the whole semester and then repeat all the material before final control.

So, because of everything foregoing, the "reference" learning process (schedule) that is offered to the user can be represented by the type of network graph in pic. 1.



Pic. 1. Example of standard learning process, proposed for the user

On the picture some bold lines represent the two types of work: V_{ni} – work on the study of concrete information from n-some courses (discipline) and X_{nq} – q- control work on n-some discipline. The upper horizontal band formed by works of n=1 corresponds to the first discipline, the second band corresponds to the second one, etc. The whole learning process is depicted by continuous thin broken line of light color. Thus, it is proposed to start the process of learning with learning chapters V_{41}, V_{42} of fourth discipline, then to switch to the third discipline to its part V_{31}, then the fifth one and study sections V_{51}, V_{52}, V_{53}, etc. In the middle of the semester the user should pass the test(control work) X_{31} then learn part V_{25}, then pass test (control work) X_{11}, X_{51} and learn

more material. Control works (tests) of subjects *2* and *4* (X_{21} та X_{41}) are scheduled only to the end of the semester.

At the right end of each segment the moment of time t_{ni}, that is ideal for completing the execution of a work. In addition to this, in SDL on the first and the last stage of learning the discipline that are studied during the semester an input and output controls should be provided for evaluating and adjusting the quality of the learning process. This will give the opportunity to construct the individual learning strategies including capacities to learning of the concrete student. The tasks for input and output control should be the same in form or can be tests, this makes it possible to qualitatively assess the progress of acquiring knowledge and then tie a qualitative mark with the time of learning.

The approached model of building process of learning allows to represent the entire sequence of user actions in the semester conveniently (visually), if it is necessary it gives the opportunity to make a detailed analysis and optimization, and the main it references to compare the proposed scheme with the sequence of user actions in a reality. Indeed, the user of SDL is much more free than the user in full-time education therefore he can deviate from the proposed scheme. His actions form their original scheme such as on pic.1. The big difference of the time (which can be roughly equated to performed work) and runtime of making the least done disciplines can be taken as a simple signal that shows a significant deviation from the ideal learning process:

$$\max_n t_n' - \min_n t_n' > \Delta t$$

where t_n' is the moment of time in the middle of the semester, when the making of a last currently made work on *n*-th discipline was completed.

Another sign of malfunction is a very little time of learning the majority of works. It is also can be a very long period of time between the execution of two consecutive works in one discipline. There are also other variants of analysis and comparison the standard schemes of learning and individual process of it; they are more sophisticated than these (planned for further research).

Conclusions. The work presents the use of network graphs for modeling the learning process in the SDL. This model has certain features related to the specific area of the subject (the works may not be made simultaneously in small time intervals and vice versa must be performed in parallel in large ones). The use of such model can be useful for managing of a process of distance learning by the information system (it allows making the visual analysis and comparison of learning and reference schedules that are offered by the educational organization).

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Рецензент: д.т.н., проф. Мочалов О.О., директор Інституту заочної та дистанційної освіти Національного університету кораблебудування імені адмірала Макарова

к.т.н., доц. Гайша О.О., к.т.н., с.н.с. Гахович С.В.,
Жиров Б.Г., Солодєєва Л.В.

МОДЕЛЬ ПРОЦЕСУ НАВЧАННЯ КОРИСТУВАЧА СИСТЕМИ ДИСТАНЦІЙНОЇ ОСВІТИ НА БАЗІ СІТЬОВИХ ГРАФІКІВ

Обґрунтована необхідність використання моделі процесу навчання користувача в системах дистанційного навчання (СДН). Для створення моделі пропонується використати загальновідомий метод сітьових графіків з області управління проектами. Специфіка предметної галузі спричинює певні особливості та відмінності від загальноприйнятих сітьових графіків при описанні саме навчального процесу користувача СДН. У СДН має

існувати еталонна схема процесу навчання, яка пропонується користувачу, а також в процесі його навчання формується індивідуальна схема. Пропонуються прості способи порівняння еталонної схеми вивчення дисциплін семестру та індивідуальної схеми даного користувача, яке необхідно для можливого коригування процесу навчання.

Ключові слова: сітьовий графік, процес навчання, електронне навчання, дистанційна освіта.

к.т.н., доц. Гайша А.А., к.т.н., с.н.с. Гахович С.В.,
Жиров Б.Г., Солодеева Л.В.

МОДЕЛЬ ПРОЦЕССА ОБУЧЕНИЯ ПОЛЬЗОВАТЕЛЯ СИСТЕМЫ ДИСТАНЦИОННОГО ОБРАЗОВАНИЯ НА БАЗЕ СЕТЕВЫХ ГРАФИКОВ

Обоснована необходимость использования модели процесса обучения пользователя в системах дистанционного обучения (СДО). Для создания модели предлагается использовать метод сетевых графиков из области управления проектами. Специфика предметной отрасли создает некоторые особенности и отличия от общепринятых сетевых графиков при описании именно учебного процесса пользователя СДН. В СДН должна присутствовать эталонная схема процесса обучения, которая предлагается пользователю, а также в процессе его обучения формируется индивидуальная схема. Предлагаются простые способы сравнения эталонной схемы изучения дисциплин семестра и индивидуальной схемы данного пользователя, которое необходимо для возможной коррекции процесса обучения.

Ключевые слова: сетевой график, процесс обучения, электронное обучение, дистанционное образование.