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INFORMATION-ANALYTICAL LEARNING MANAGEMENT SYSTEM UNIVERSITIES

We consider conceptual approaches to creation of information systems, learning management school, which uses modern methods of decision-making and simulational modeling, web-technologies. The main criteria for the selection of development tools of the system are: openness, free of charge, easy to use and independence from system software and hardware. The chosen technology and the system itself satisfies such requirements as: focus on national and international standards in the field of higher education, adherence to service-oriented architecture, ensuring stable operation with a large number of users, support for a clear division of user rights to obtain and change information resources, software modularity the final product and its ability to integrate into the corporate information system of the university.

Keywords: *Informatization, Information-analytical system, Digital University, Distance learning, Simulation, Petri Nets, Web-technology high school.*

Introduction

Informatization of higher education is a set of interrelated organizational, administrative, economic, scientific, educational, educational processes aimed at creating conditions to meet the informational needs of all participants in the educational process (students, teachers, university staff) of their intellectual capacity, self-realization and self-improvement, to ensure full preparation for professional work and life in the information society through the creation, development and usage of modern information and communication systems, networks, resources and technologies. The problem of information is the core around which today the whole system of modern universities must be build. Solving this problem will allow to execute the order of the Information Society to prepare professionals who are able to date to apply ICT in their professional activities and daily lives.

Formulation of the problem

One way to solve the problem of information institutions is the creation of information-analytical learning management system (IAS LMS) Universities that will enable:

- step up the use of existing and new relevant and high-quality educational and research resources;
- expand access to these resources for students, teachers, employees of the Department of Education and Science, public organizations, a wide range of users; create organizational and technological framework for the implementation of e learning in traditional educational process, as well as for remote, mobile and e-learning in higher education;
- reduce the cost of the educational process;
- improve the training of students of all learning; universal access to educational and scientific resources of the general population;
- improve the interaction between departments of universities and other educational and research institutions; increase the effectiveness of students' learning and productivity of the faculty;
- a single platform to provide educational services;
- ensure transparency and investment attractiveness of the university;
- to increase the competitiveness of graduates in the labor market;
- integrate universities in regional, national, European and world educational and scientific space.

The analysis of domestic and foreign universities management information systems ([1]-[6]) showed that:

- existing systems do not provide the right level for feedback in the management of the educational process of high school, which is essential for improving the educational process at as a separate discipline and training units as universities;
- in these systems virtually no means of simulation training process, which would provide an opportunity based on the results of learning activities of students professional work of teachers, operation of educational units universities to optimize the parameters of the organization and control of the educational process, predict success rates and the quality of education and the level of training future professionals in various fields of human activity;
- most common IAS management institutions are commercial products, with English and Russian interface require licensed software and hardware high cost and usually do not address specifics of Ukrainian universities.

Conceptual approaches to the development of IAS LMS Universities

The draft IAS LMS universities, developed with the participation of authors considered the above drawbacks and it is the next step after the creation of information system for monitoring and evaluation of educational activities of university students that was developed in 2009-2010 GG for the state budget theme №IT / 535-2009 (registration №0109U006094) for the State Program «Information and communication technologies in education and science» for 2006-2010 [7].

The main criteria for choice of creating IAS LMS universities are: openness, free of charge, ease of use and independent of system software and hardware. In addition, the technology selected and the system itself will meet the following requirements:

- focus on national and international educational standards in higher education;
- compliance with service-oriented architecture;
- ensure stable operation of a large number of users;
- support for a clear division of user rights to obtain and change information resources;
- ensuring modularity of the final product and its ability to integrate into the corporate information system of the university.

Given that IAS – is «part of the software support of information infrastructure that provides special task management» [1] of the IAS LMS includes:

- subsystems collecting, storing, editing and archiving;
- subsystem of information interaction in business processes (process control training units, educational process);
- analytical subsystems;
- subsystem modeling of educational process;
- decision support subsystem.

In particular, analytical subsystems IAS will provide:

- analysis of curricula and their improvement;
- calculation of the workload of departments and teachers,
- analysis of the performance of university education departments;
- analysis of the performance and quality of student learning in groups, courses, areas of training, specialties, departments, in universities as a whole;
- analysis of the impact of new ways of learning management institutions on the effectiveness of the educational process;
- formation of schedule, taking into account the number of students, available teaching staff and classroom fund universities.

Subsystems decision support AIS will provide:

- decisions on the management of educational process on the basis of different types of monitoring and modeling results of the educational process;
- decisions on the workload of departments and teachers;
- decision making on how to improve the effectiveness of the training units of the university;

- decision making to improve the quality of education and educational services institutions.

One of the key components of IAS LMS Universities should become a subsystem simulation training process, which is based on techniques of object-oriented modeling of complex systems modeling and simulation technology systems using Petri nets will take into account the complex relationships between all the actors of the educational process and will effective tool for development and research of new technology learning management universities.

Technological Universities LMS IAS architecture involves the use of these components with open source:

for the server side:

- operating systems (FreeBSD, GNU \ Linux);
- management databases (PostgreSQL, MySQL, Firebird);
- middleware (Apache Tomcat, Apache HTTPd, Oracle Glassfish, RedHat JBoss, Apache ServiceMix);
- creation tools and support (PHP, CMS Joomla!);
- a system of distance learning at the LCMS Moodle;
- for the client side: web-browser (Mozilla Firefox, Google Chrome).

The project also plans to explore and develop the system architecture using IAS technology of corporate service bus (ESB) technology to JEE 5/6 stack to enable integration of IAS LMS universities with digital components of the university as IAS «University Handbook», IAS «Schedule», IAS «Student», IAS «Department», IAS «Educational work», IAS monitoring and evaluation of educational activities.

The subsystem of simulation training process Universities

An effective management system to create complex object experimenting with this system or its model. Experimentation in education leads to consequences that affect people's lives because of the model of the educational process for determining the structure and parameters of the learning management system is appropriate.

Universities Educational process includes preparation of dozens of directions and specialties of classes from hundreds of disciplines work of hundreds of thousands of teachers and education students that are interrelated, so, based on the system approach should be considered as the university system. At the same time, the efforts of many researchers aimed at creating a model of the educational process within the same discipline [8], it is appropriate for distance learning systems, but not acceptable for university education system.

Simulation models learning activities, as opposed to analytic models make it possible to reproduce the educational process and management training activities of students based on individual characteristics of teaching (students and teachers) training according to schedule, control training and decision-making on the results of monitoring.

Model complexity university educational process makes use of it for building object-oriented approach. In [10] the combination of technology object-oriented approach and technology simulation modeling Petri nets to create a model learning management system universities.

Class of objects that are structural components of the learning management system Universities are the following classes: Specialty, Expertise, Group, Discipline, Teacher, Student, Time, History, Dean, control of attendance, control debts simulator. Class facilities simulator designed to reproduce the dynamics for the functioning of Petri nets, which is given in one of the fields of the object and sets the simulation model of the object. All models are dynamic objects as objects subclasses one superclass – class Simulator.

Petri net is an object Petri nets with time delays of conflict and multichannel transitions, links to information [9]. Transitions Petri net adds additional properties to perform certain actions provided start transition described in this specially designed simulator class method. For example, actions related to entering data on the performance study in the Journal as well as actions related to the transfer of information to another object. Communication between objects by means of common positions and by initializing the event. The common position is that carry information on resource sharing common objects or accumulation of initial information. For example, the position of

«teacher» containing information on teacher unemployment is common for objects discipline (which reads Teacher), student (studying subjects) and teachers. Resource «teacher» Discipline is captured object if the classes of disciplines on the schedule, and the object is captured student if the student debt of certain subjects. Initialize event markers means of transmission of the conversion facility to position other objects, resulting in conditions for the events in these facilities. For example, the event «top pair» object Discipline initiating event «conducts classes on schedule» and the event object Teacher «will visit classes on schedule» for all student objects belonging to the group object. Petri Network facilities Schedule, discipline, and students are represented in Fig. 1,2,3,4.

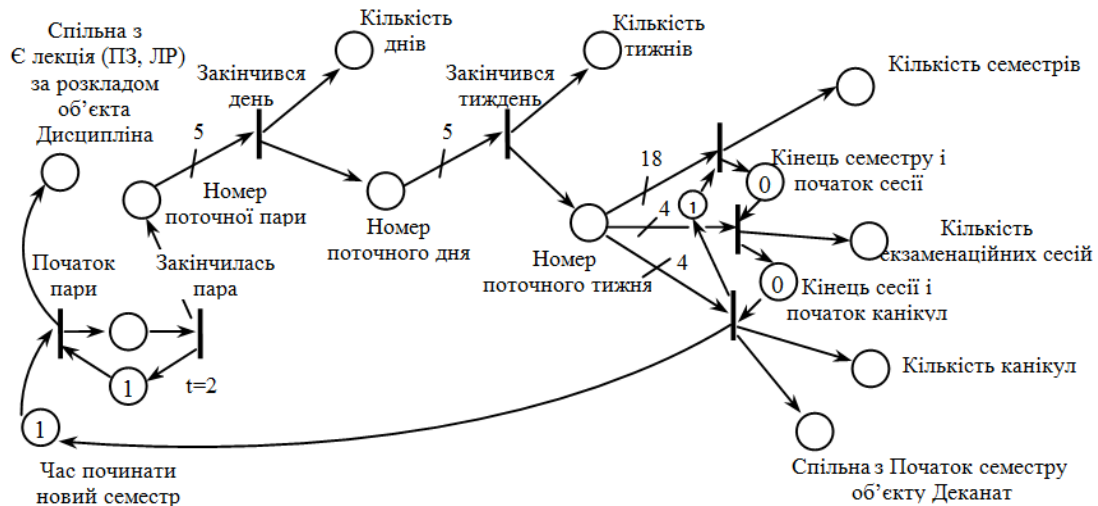


Fig. 1. Petri nets object «Schedule»

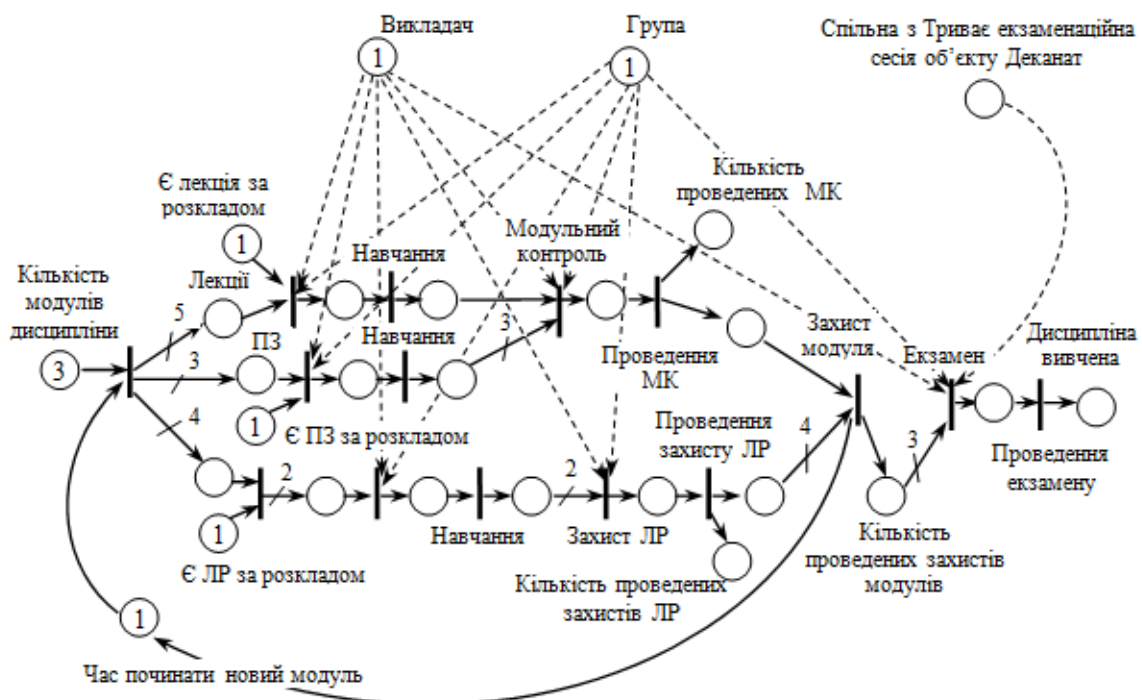


Fig. 2. Petri nets object «Discipline»

Flight Facility is intended to generate events «Getting couples», «Start session» depending on the current point in time and track number of the current week, current day and current pair to determine the type of class schedule.

The object of discipline designed to track events related to the study subjects according to the curriculum of discipline, field of study curriculum and schedule.

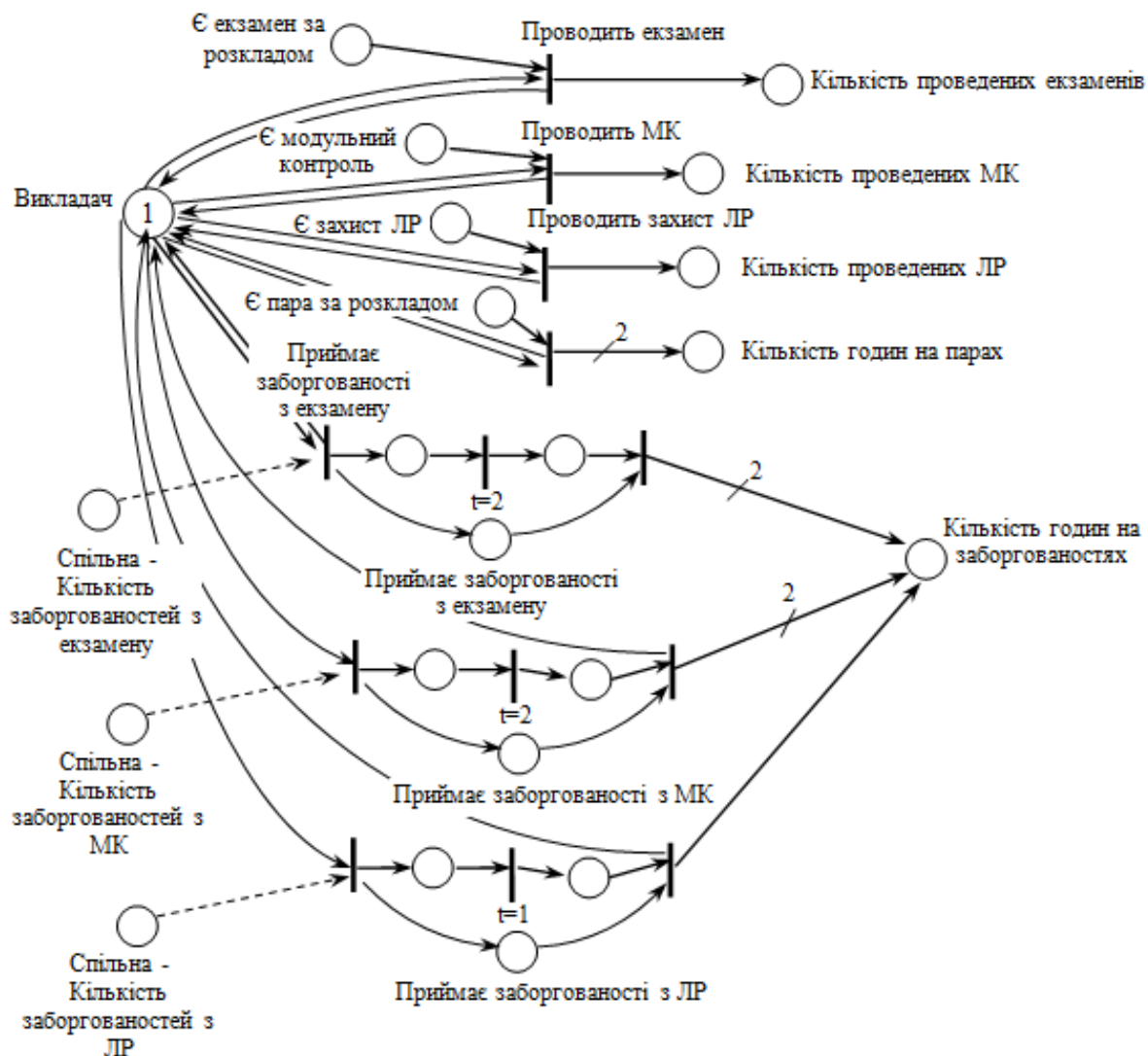


Fig. 3. Petri nets object «Teacher»

Object teacher recreates events related to the employment of the teacher in the classroom and on schedule with taking debts from various learning activities of students. Object student plays the activity of student learning in the classroom with the schedule, the protection of laboratory work, the protection module tests, surrender tests (exams).

The process of learning management institutions modeled objects Dean (Fig. 5), debt control (Fig. 6), control visit. Object Dean appointed to take appropriate decisions during the semester and interviews with students.

Model learning management system is implemented by means of Universities programming language Java (J2SE) and IDE Netbeans IDE 6.5. The verification of models and experimentation to study the impact of control options for the weekend of the model and determine the optimal control parameters based on the existing selection criteria. The experimental results show the correctness of the constructed model and its ability to properly characterize the effectiveness of the learning management universities.

Creating educational process modeling subsystem universities as part of the information-analytical learning management system provides universities solve these problems:

- 1) integration with other subsystems IAS LMS universities, including volume in the system of distance learning subsystem and decision making;
- 2) creating a graphical user interface;
- 3) development of intelligent subsystems analysis of simulation results.

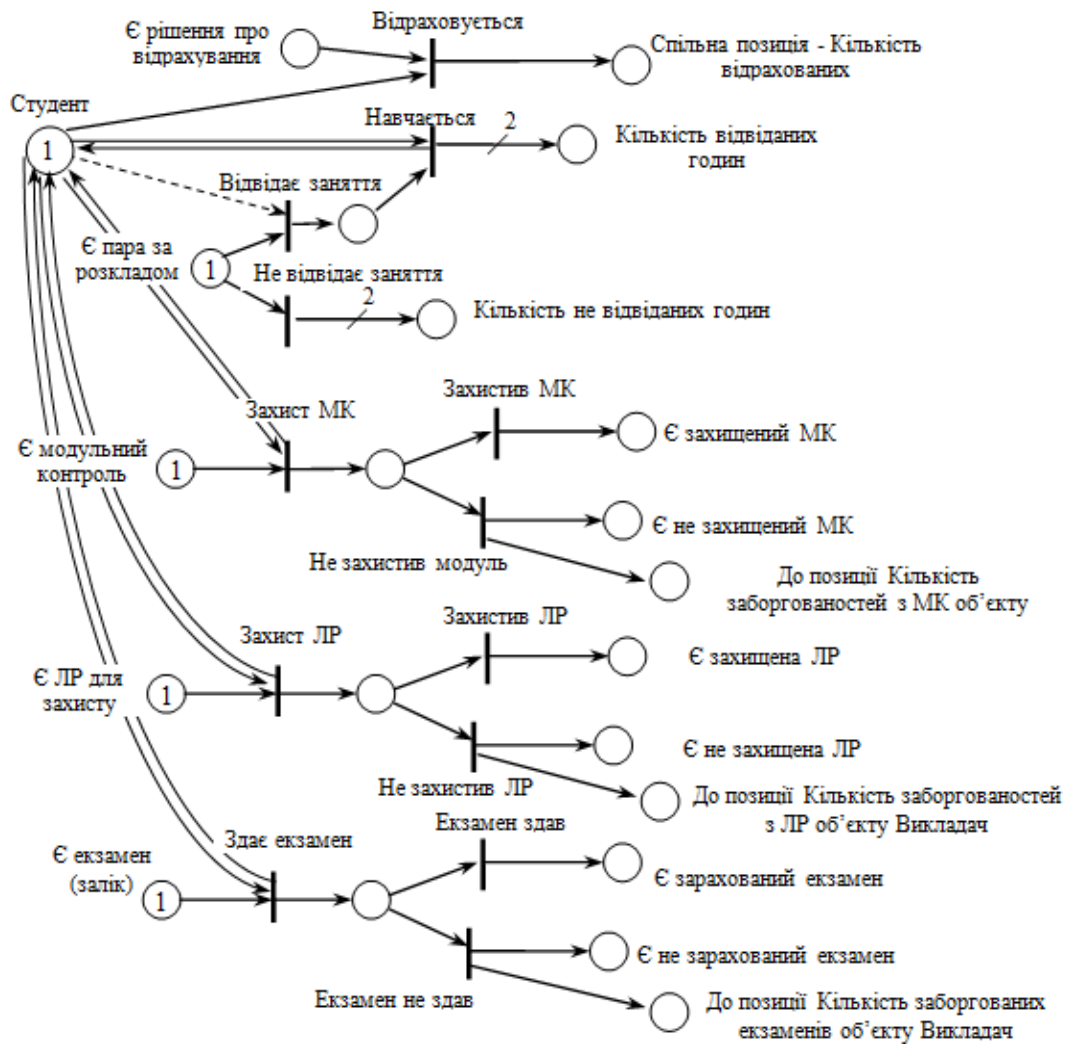


Fig. 4. Petri nets object «Student»

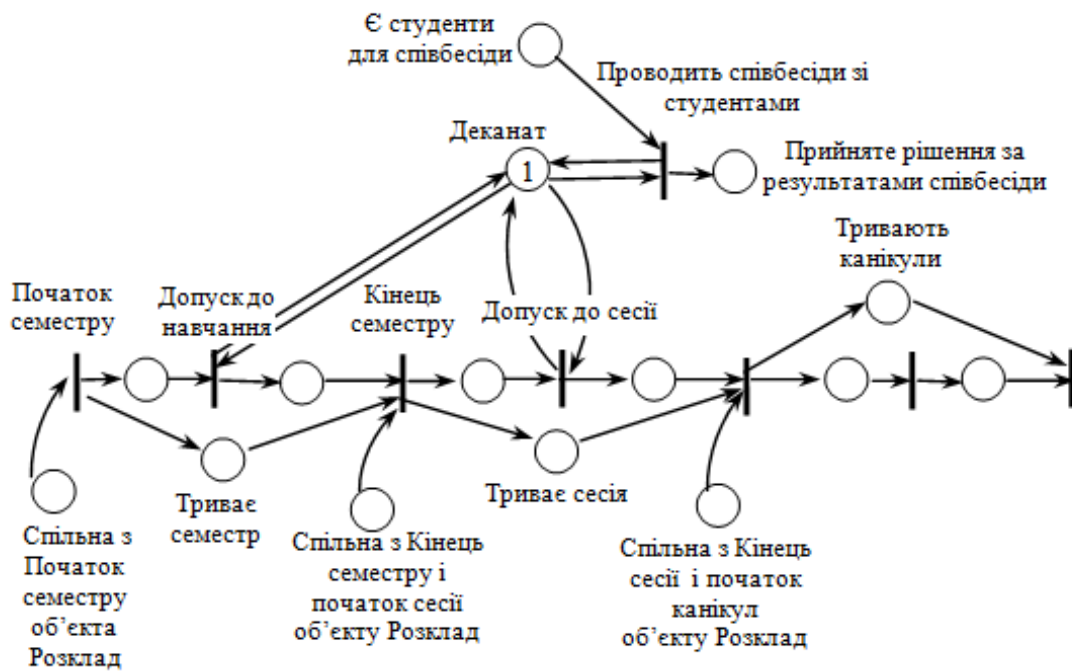


Fig. 5. Petri nets object «Deanery»

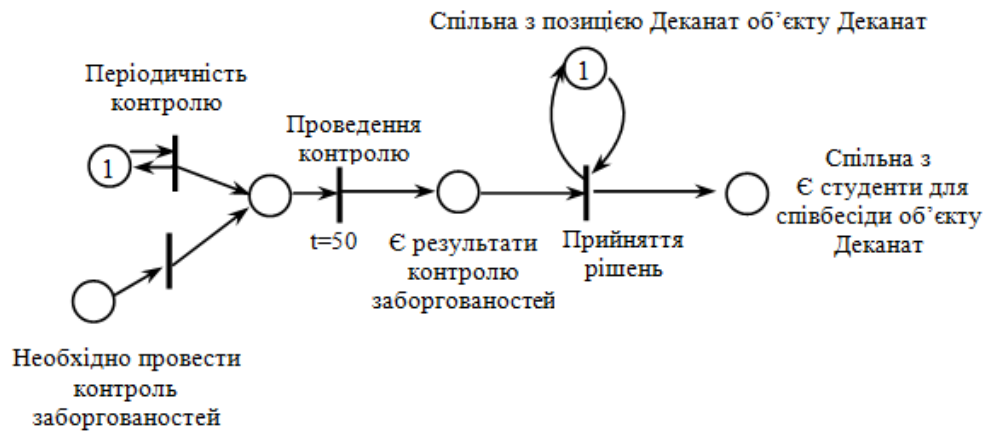


Fig. 6. Petri nets object «Control»

At the stage of modeling subsystem integration with other subsystems IAS LMS universities to solve the problems of formation of input data for modeling the information contained in e-learning subsystem and subsystem formation schedule Universities «electronic controller»; forming initial information processing subsystem for decision. Creating a GUI development interface provides viewing and editing models of objects that are part of the educational process models; interface input and editing basic model parameters that are required to perform modeling; WEB-UI start modeling and monitoring results. Subsystems mining simulation results designed to convert numerical simulation results in specific recommendations to improve the quality of the learning management institutions; preliminary processing simulation results to transfer them to the subsystem decisions.

Modeling subsystem university educational process designed to solve these problems:

- determine the characteristics of the operation of the learning process, faculty, university with specified input parameters;
- finding the optimal frequency of monitoring visits, monitoring progress.
- determine the impact of quota absenteeism student from each discipline allowable number of academic student debt on the characteristics of the educational process.
- determine the effect of complexity discipline (number of modules, the amount of hours in modules, the average time spent on the protection of laboratory work and the likelihood of a successful defense of laboratory work, average time spent on the protection of modular test and the likelihood of successful protection module tests, the average time spent on the exam (test), and the likelihood of passing the exam (test)) on the characteristics of the educational process.

Design of Subsystem Learning management of IAS Management of University

Let us consider in more detail the process of creating Subsystem Learning management of IAS Management University (IASM).

Before creating a model IASM University consider the model its interaction with the external and internal objects of educational activity (Fig. 7).

The source a key role in organizing and setting of this interaction is owned ICT department, that is why this model is presented as the unit coordinating the interaction of the vast majority of other objects. Since communication and interaction with internal targets will consider the description IASM model of the university, so focus only on external objects:

School – the interaction of University with the school has a positive impact on the development of common educational space, creates and deepens students' knowledge about the world, contributes to a more conscious choice of future profession.

Ministry of Education and Science in Ukraine – the cooperation with the relevant ministry aims to perform basic functions assigned to it: universities ensure regulatory legal acts, coordination and control of universities to provide a quality of education. The main forms of interaction in terms of using this process IAS is to obtain information from the Internet, MES portal and formation

University for reporting or data entry to single state electronic database on education (<http://www.inforesurs.gov.ua/dataedbo.html>).

Labor market – constant interaction with employers significantly affects the quality of training in higher education. The main forms of interaction between universities and employers may be the part of employers to develop and implement educational and professional standards; Employers involved in the educational process; organization of presentations by representatives of employers, lectures, workshops, etc.; partnership in research and technological development: conferences, competitions, business incubators, technology parks etc. implementation of various mechanisms of the external evaluation of the quality of education and university; forecasting needs for specialists; formation employers requirement for training or retraining.

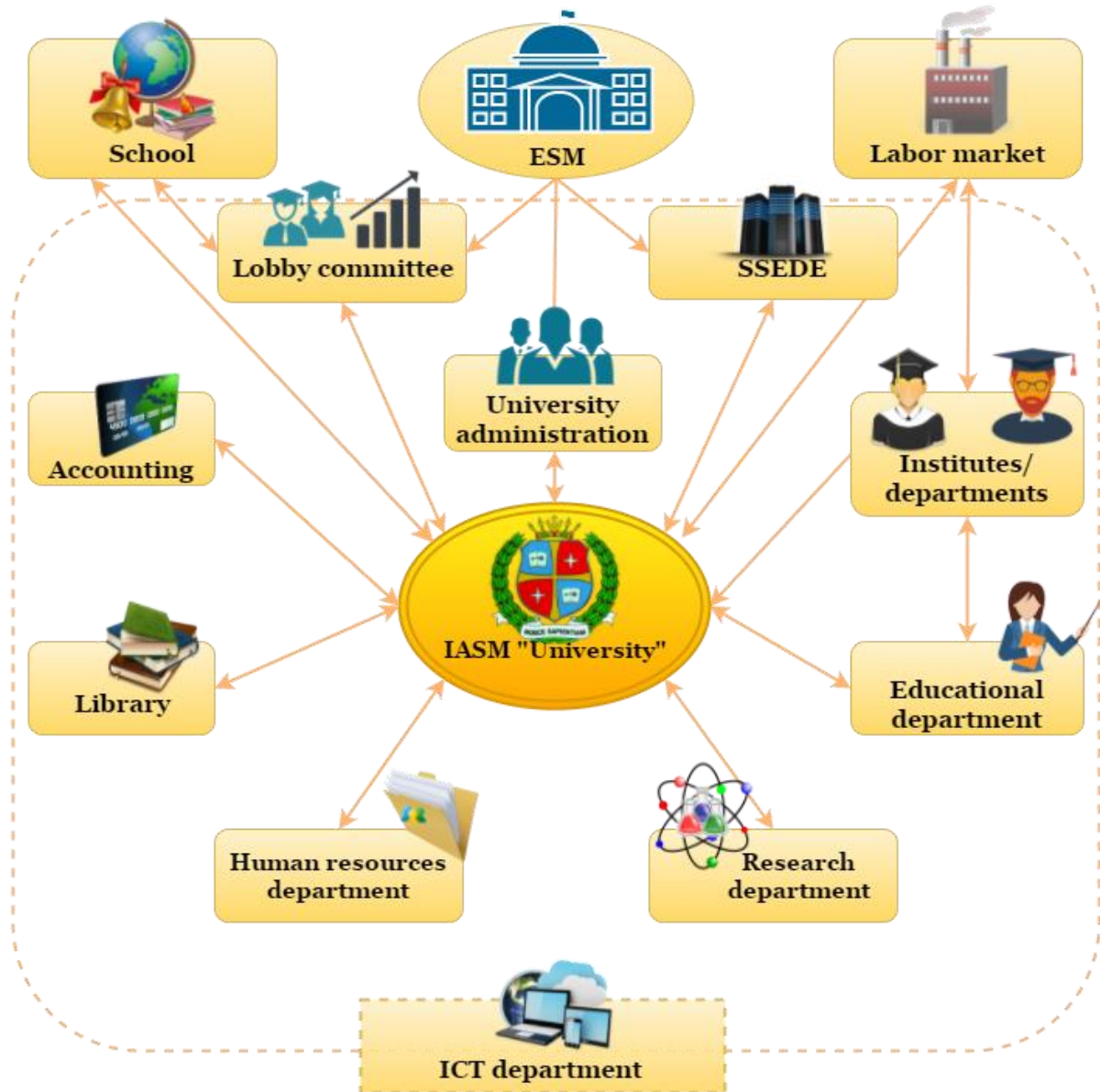


Fig. 7. Model IASM interactions with external and internal targets of educational activities

Business Process Management University

At the initial design stage IASM University worth a procedural model of university management. The study of business processes of a number of domestic universities form the generalized model of Business Process Management University (Fig. 8). This model has four components: educational process management, management of research activities, management of administrative and economic activity, financial management, within which and carried out research departments of the university.



Fig. 8. Generalized model of Business Process Management University

Business processes which were studied within a component of IACS «Management of educational process»:

1. The organization and management of the selection committee;
2. Managing contingent of students;
3. Planning of the educational process;
4. Management of scientific and pedagogical staff;
5. Organization of the educational process;
6. Monitoring the educational process;
- 7 control of the. Quality of educational process.

Business processes were studied within IACS part of «Management of research activity»:

1. The organization and management of the department of research;
2. Managing enrollment of graduate students, doctoral students;
3. Planning of research;
4. Rating evaluation of results of research activity.

Business processes were studied within IACS part of «Management of the administrative and economic activity»:

1. Management of economic operation of facilities;
2. The organization of material and technical resources;
3. Ensuring the safety and health of students, teachers and university employees.

Business processes were studied within a component of IACS «financial management»:

1. Organization and provision of pay;
2. Planning and cost analysis;
3. The provision of paid services.

Information-analytical subsystem of management of educational process University

Let's consider the key features of the model of information-analytical system of Management of university (Fig. 9) relating to subsystem «Management of educational process» the most complex and resource-intensive component of an integrated system of university.

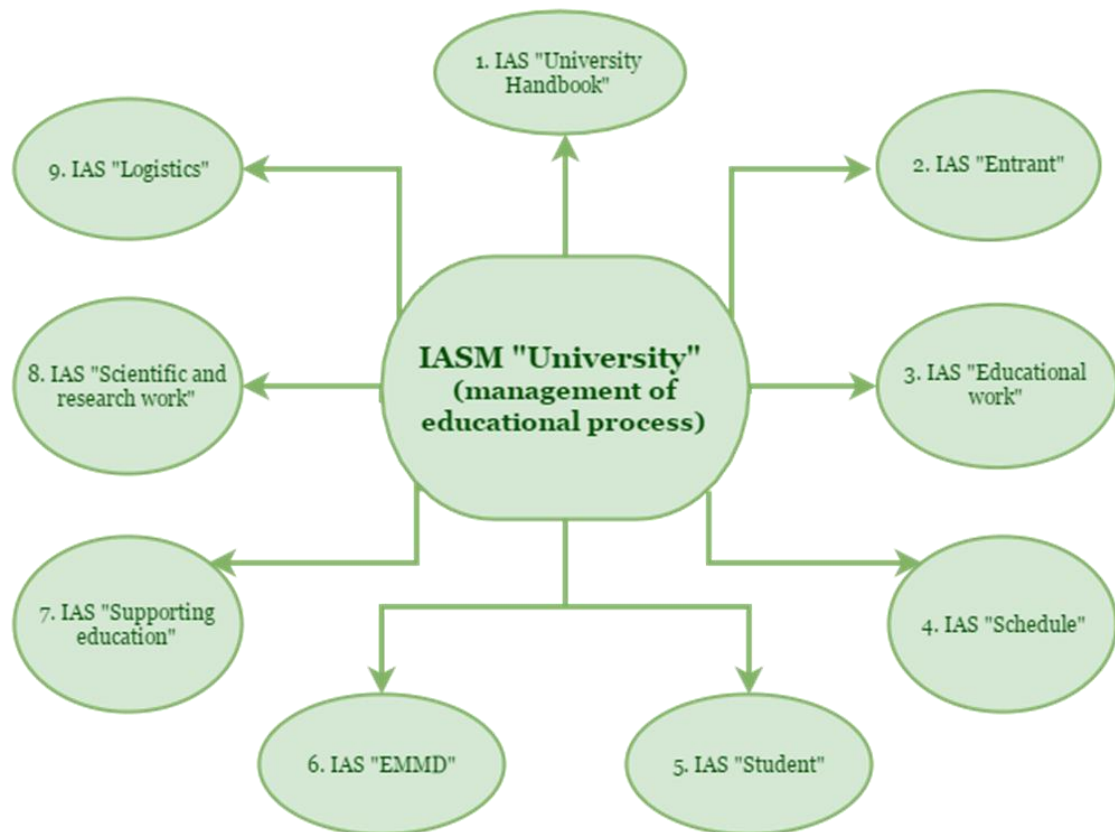


Fig. 9. Model IASM «University» (Management of educational process)

As it is shown in Fig. 3 IASM University (Management of educational process) has a modular architecture. Modularity implementation of IS is that it consists of relatively independent modules.

Implementation of separate modules and is standardized by a single scheme. This allows you to organize simultaneous development of several independent modules of various developers.

Let's briefly look at basic functional subsystems IASM «University».

1. *IAS «University Handbook»* contains the most popular of the various subsystems data, specialty institutes, departments, faculty, positions, roles, permissions, users, etc. This subsystem communicates with all the below mentioned subsystems under a common format for data exchange and control their relevance for each of the subsystems.

2. *IAS «Entrant»*. The subsystem provides information and analytical support processes management candidates and applicants and automates routine processes (Fig. 10) at all stages of the admission campaign of higher education [11].

Subsystem «Entrant» contains a number of search tools contenders in entrants (electronic questionnaires, competitions, courses, etc.).

During the opening campaign ensured rapid exchange of information with YEDEBO, in particular, to date version of the rating list of applicants, automated test data in electronic applications, submitted through the official service [12] automated their registration in the subsystem «Entrant» to date magazines submission of applications, Early obtain statistical data on applicants submitted applications, automated decisions of the Admission Board (status change applications according to the decision).

Based on data from subsystems always formed the rating list of applicants for later publication on the website of the university. Data on students enrolled at the request automatically passed to the subsystem «Student».

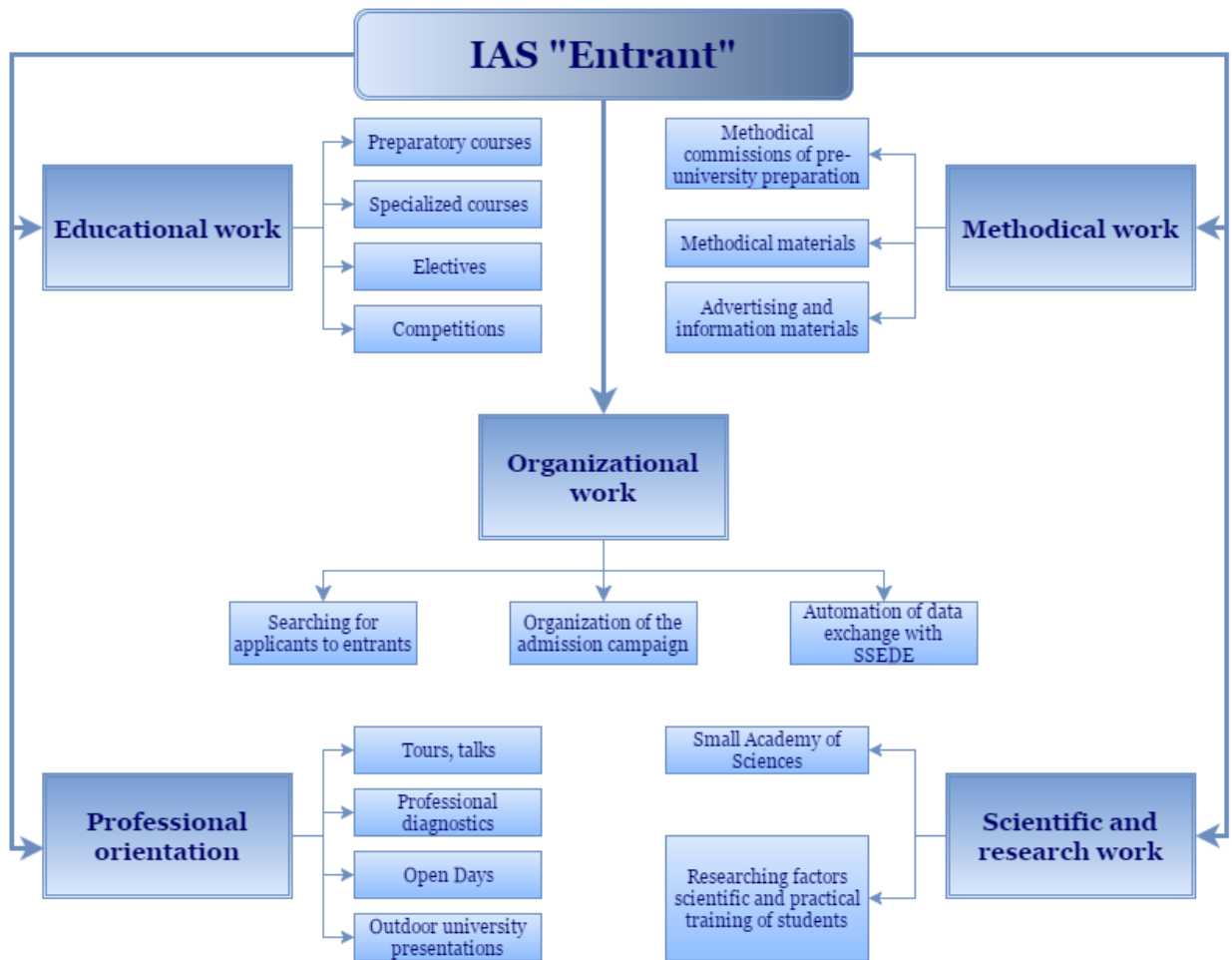


Fig. 10. IAS Process Model «Entrant»

3. IAS «Educational work». The subsystem provides information and analytical support for the planning and organization of educational process University and automates all activities involved in the educational process of structural units [13].

IAS «Educational work» consists of modules shown in Fig. 11.

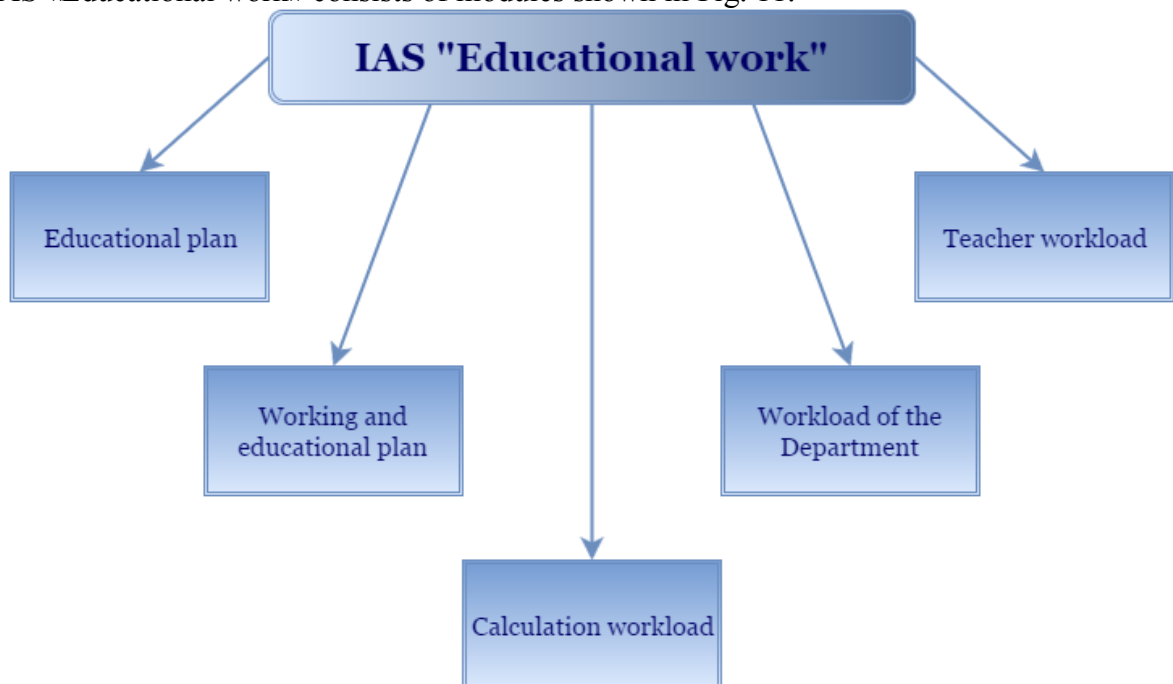


Fig. 11. The structure of the IAS «Studying»

On the basis of the educational standard of a specialty module «Curriculum» automated formed curriculum.

Every year, on the basis of the curriculum module «curricula» is automatically formed a working curriculum and schedule of the educational process.

After approval from work curriculum and schedule of educational process used in the subsystem «Student» to create individual curricula of students.

Based on the data from your curriculum and data contingent received from subsystem «Student», taking into account the standards of time to implement the different types of educational work in the module «Calculation workload» is automatically calculated volume of workload for the corresponding contingent (flow group subgroups). This module provides the possibility of combining certain contingent on certain disciplines to flow, groups or subgroups.

Based on data from the module «Calculation workload» module «workload Department» carried out automatically sharing workload between departments and automatic calculation of state teaching staff using approved algorithm of the university rates.

Using data from the module «workload department» module «teacher workload» at the department calculated the automated distribution of workload among teachers.

4. *IAS «Schedule»*. The subsystem provides information and analytical support of the formation and schedule sessions. Based on the data received from the module «teacher workload» subsystem «Educational work» and with relevant schedule of the educational process and the existing auditorium fund subsystem «Schedule» automated formed: the schedule of the educational process, graphics consultations and examinations.

The subsystem includes automated search tools available classrooms that are required for certain types of employment, examines the possibility of a certain class teacher at a certain time for certain groups of students.

In subsystem provides various presentation formats for printing schedule (DOC, XLS, PDF) and for displaying on websites university departments using a number of filters (for faculty, specialty, group, teacher, etc.).

5. *IAS «Student»*. The subsystem provides information and analytical support students learning management processes and automates activities directorates (deaneries) [14].

After publication order on the subsystem «Student» transmitted data subsystem «entrant» on a certain degree of enrolled students. Based on these data automatically generated personal cards of students and using automated quantitative characteristics contingent formed groups and subgroups. After creating contingent student groups of data are transferred for the subsystem «Educational work» to calculate the workload.

Based on data from the module «curricula» subsystem «Educational work» and personal statements of students formed in the subsystem «Student» on the list of their chosen subjects out of the 'chosen by the student «, produced individual learning plans for each student for the current school year. Data from individual plans analyzed and summarized and transmitted for the subsystem «Schedule».

The subsystem comprises means automatic generation of exam-scoring information for the number of students based on their individual learning paths for each discipline.

Also subsystem inherent mechanism of automatic data collection subsystem «Support education» the single register of student achievement contained in this subsystem.

Based on the success of the register automatically generated orders: to transfer to the next course, the appointment of scholarships, of contributions of access to certification and so on, forming applications for certificates and other supporting documents. All data required for verification (approved orders etc.) are automatically transferred to YEDEBO. Information on the current and final success of students sent for the subsystem «Logistics».

6. *IAS «EMMD»*. The subsystem provides information and analytical support of the formation and systematization of educational-methodical maintenance of discipline (EMMD), automation of data exchange with IAS «Supporting education».

Based on educational programs and specialty module data «curricula» subsystem «Studying» in automatic mode lecturer made the formation of educational programs and work programs of disciplines. Also lecturer formed a list of appropriate training and educational materials contained in electronic repositories University, formed a list of questions for the provided controls.

Based on the collected data subsystem «EMMD» carried automatic generation of all necessary documents and requirements provided for public access to them from different subsystems, in particular the subsystem *Supporting education*» portal and the university.

The subsystem includes analytical controls the availability, completeness and quality of teaching of disciplines.

7. IAS «Supporting education». The subsystem provides information and analytical support of the educational process (Fig. 12), provides an effective means for interaction of the participants, using integrated support learning, which was created based on system Moodle and Google APPS for Education.

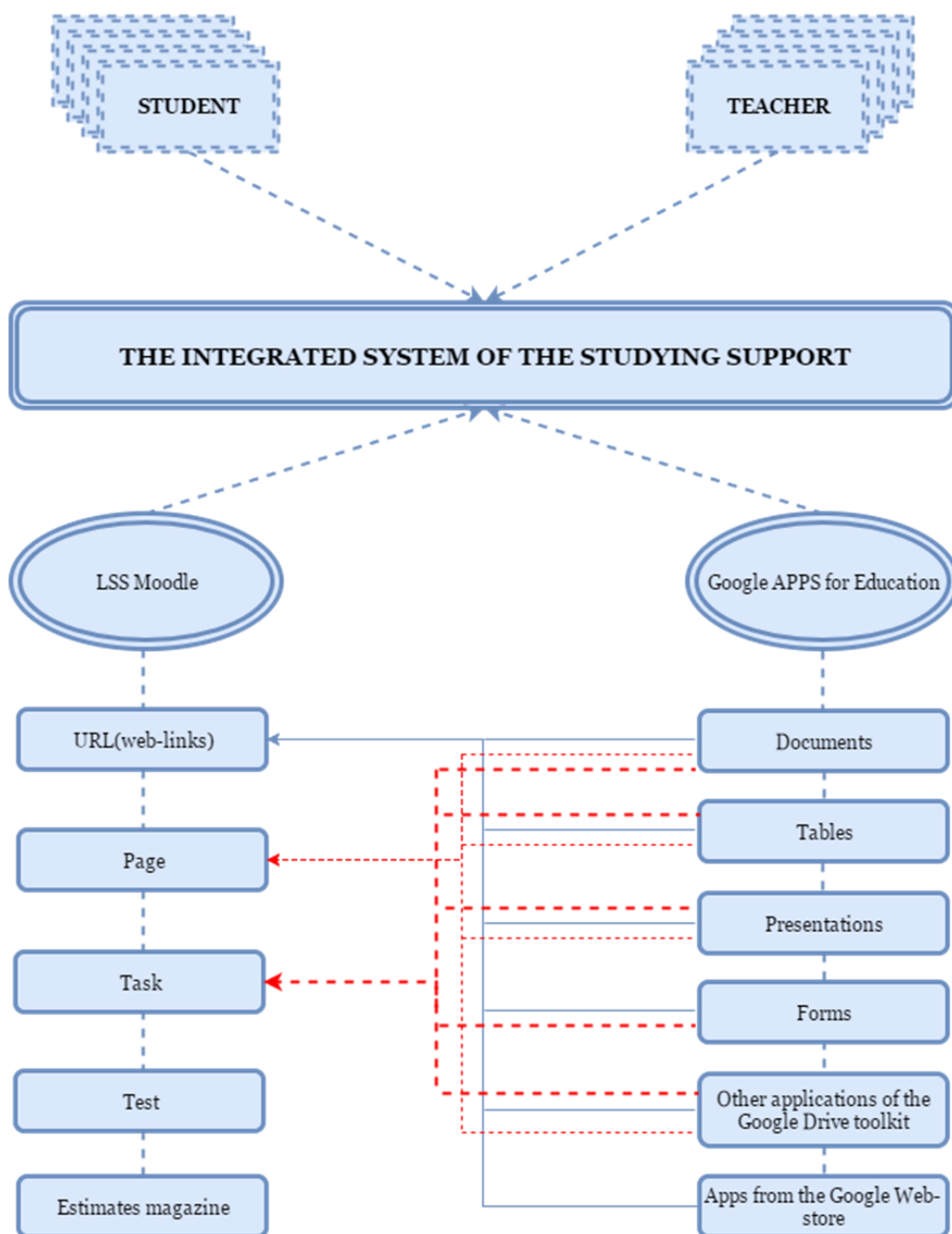


Fig. 12. The structure of an integrated system of support for learning

Such system interaction with subsystems «Educational work», «EMMD» and «Student» is able to provide:

- management development training materials sciences;
- formation of various training programs using a single database of educational materials;
- management development and support of electronic courses disciplines;
- organization and support of student learning;
- control training.

8. *IAS «Scientific and research work»*. The subsystem provides information and analytical support of research professors, doctoral students and students.

The main structural components of subsystems are shown in Fig. 13.

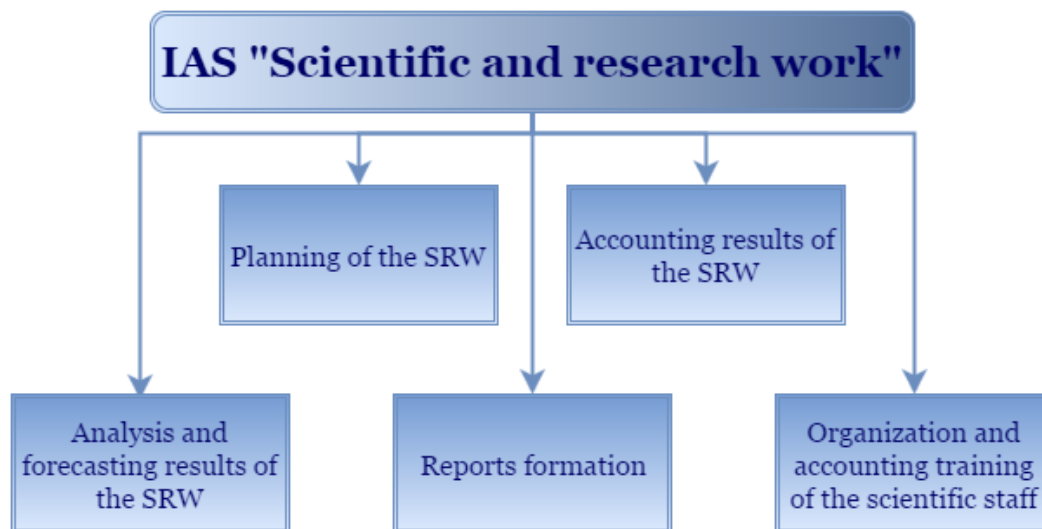


Fig. 13. The structure of the IAS «Scientific and Research work»

The module «Planning of the SRW» provides general plans of forming research, thematic research plans, plans of scientific activities (competitions, exhibitions etc.).

Module «Accounting results of the SRW» provides registration of applications for research, switch applications approved research plan, provides accounting staff involved in research activities, reports and other documents.

Module «Analysis and forecasting results of SRW» provides an analysis of scientific publications, the impact of the research activities of teaching staff, current performance and protection graduate and doctoral students.

Module «Organization and Accounting training of the scientific staff» manages contingent of graduate students, doctoral assembly Schedules and events, documentation (orders, licenses, certificates, etc.).

Module «Reports formation» provides automated support processes of formation of the annual report on research activities of the University, the annual reports of departments of research and development staff, the annual report on the work of postgraduate and doctoral studies, reports of academic achievements of students and others.

9. *IAS «Logistics»*. Interacting with the mentioned above subsystems providing information and analytical support for the monitoring and analysis of educational activities, forecasting recruitment of students, university ranking analysis among educational institutions, creation of automated summaries graduates provides for automated search of vacancies in the labor market.

Expected results

The project is planned to create information-analytical environment for supporting educational and scientific processes within the university through the use of modern information technology and telecommunications that will provide:

- manage users, user groups and access rights;

- automated development (modernization) curricula in areas, specialties and specializations;
- formation automatically curricula in areas, specialties and specializations to the current academic year;
- analysis and valuation of all kinds of workload and calculation of rates determined by the number of students determined in accordance with government regulations;
- workload calculation university departments and faculty workload sharing components between several departments, calculation of rates of professors in university departments;
- generation schedule taking into account the number of students, available teaching staff and classroom fund universities;
- electronic support, remote and mobile modes of participants in the educational process;
- individual dialogue and feedback with the student teacher's knowledge base through the system;
- comprehensive automation of technological processes of various types of monitoring and evaluation of educational activities of students and processing their results;
- statistical analysis of results of different types of control: incoming, current, modular, semester, control, preservation of knowledge, research work, practices, state certification and visualization of the results in tables, charts, graphs;
- determine the levels of performance and quality of student achievement: individual, groups, streams, faculties, universities in general, as well as educational sectors, areas of training, specialties;
- support decision making on ways of increasing the quality of training of teachers, educational motivation of students, improve teaching learning systems from different disciplines in the conditions of higher education in Ukraine credit-modular system of training and the Bologna principles;
- training simulation process using Petri nets for research and development of new technology learning management institutions;
- formation of accounting documentation on the operation of educational and research institutions units (institutes, faculties, departments);
- Universities workflow between departments that monitor and learning management: rector, Academic, management institutes, deans of faculties and departments;
- support for learning management, depending on the results of various controls educational activity of students at the administration, management, dean, department;
- maintaining a database with the results of the various controls, database tests on various types of control, control tasks, examination tickets, materials SEC, bases teachers and students;
- Archiving information (corporate data warehouse to enable the extraction of new knowledge about the content and nature of the business processes of universities);
- limiting access to information and functions of the software for different categories of users.

Conclusion

Development and implementation of IAS learning management institutions will promote wider use of ICT in higher education, the creation of a unified information educational environment for all actors within the university community, democratization and openness of higher education and university integration in European and world news spaces.

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ІНФОРМАЦІЙНО-АНАЛІТИЧНА СИСТЕМА УПРАВЛІННЯ НАВЧАЛЬНИМ ПРОЦЕСОМ УНІВЕРСИТЕТУ

В роботі розглядаються концептуальні підходи до створення інформаційно-аналітичної системи управління навчальним процесом університету, в якій використовуються сучасні методи прийняття рішень та імітаційного моделювання, web-технології. Основними критеріями вибору засобів розробки системи є: відкритість, безкоштовність, простота застосування та незалежність від системного програмного та апаратного забезпечення. Обрана технологія і сама система задовольняє таким вимогам, як: орієнтація на національні й міжнародні стандарти у галузі вищої освіти, дотримання сервіс-орієнтованої архітектури, забезпечення стабільної роботи із значною кількістю користувачів, підтримка чіткого розподілу прав користувачів на одержання та зміни інформаційних ресурсів, забезпечення

модульності кінцевого продукту та його здатності до інтеграції в корпоративну інформаційну систему університету.

Ключові слова: *інформатизація, інформаційно-аналітична система, цифровий університет, дистанційне навчання, імітаційне моделювання, мережі Петрі, web-технології, вища школа.*

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ИНФОРМАЦИОННО-АНАЛИТИЧЕСКАЯ СИСТЕМА УПРАВЛЕНИЯ УЧЕБНЫМ ПРОЦЕССОМ УНИВЕРСИТЕТА

В работе рассматриваются концептуальные подходы к созданию информационно-аналитической системы управления учебным процессом университета, в которой используются современные методы принятия решений и имитационного моделирования, web-технологии. Основными критериями выбора средств разработки системы являются: открытость, бесплатность, простота применения и независимость от системного программного и аппаратного обеспечения. Выбранная технология и сама система удовлетворяет таким требованиям, как: ориентация на национальные и международные стандарты в области высшего образования, соблюдения сервис-ориентированной архитектуры, обеспечение стабильной работы с большим количеством пользователей, поддержка четкого распределения прав пользователей на получение и изменения информационных ресурсов, обеспечение модульности конечного продукта и его способности к интеграции в корпоративную информационную систему университета.

Ключевые слова: *информатизация, информационно-аналитическая система, цифровой университет, дистанционное обучение, имитационное моделирование, сети Петри, web-технологии, высшая школа.*

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