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DEVELOPMENT OF A RESOURCE MANAGEMENT SYSTEM OF THE UNIVERSITY IN THE CLASS SCHEDULES PREPARATION

Morkun V.S. ScD, Professor, Burnasov P.V., Senior Lecturer.

Kryvyi Rih National University

Abstract. The structural scheme and algorithm of functioning of the system of operational resource management of the University, features a dynamic combination of automatic mode of assembling schedule with a manual. When impossibil of further automatic forming of the schedule because of tight restrictions, performed their automatic mitigation. The inability to automatically mitigate the restrictions, or other needs they may be soften manually in the scheduling process. In the generalized criterion taking into account interests of students which consists of four partial optimality criteria: the number of "Windows" in the schedule of educational groups, balance of the load in the educational groups schedule, implementation of rules of grouping classes on the days of the week, the execution rules of grouping classes in order of classes in one day. The criterion of interests of teachers included the following casting criteria: the number of "Windows" in the schedule of teachers, the implementation of restrictions on the maximum number of busy days a week for teachers, the implementation of restrictions on the minimum number of classes in any day of the week for teachers, teachers personal wishes. Generalized optimality criterion teachers schedule takes into account the degree of optimality of individual schedules for each teacher. For the quantitative comparisons and rankings of partial optimality criteria, type the numeric equivalent of the degree of importance of each partial criterion of optimality is icluded.

Keywords. Resource management, class schedules, university, algorithm, partial criterion of optimality.

Introduction. Among the characteristics that can be measured and monitored, which determine the quality of management of educational process, significant patterns are indicators of the quality of resource management. As for downloading of classroom Fund quality criteria are objective and simply defined in a quantitative measure. The quality of the faculty, the situation is somewhat more complicated: every teacher has their personal idea of the quality-made schedule and quality of the schedules of the students regarding discipline. As is known [1, 2], the schedule has quite a significant impact on the quality of training at all. For the purpose of management of educational process and identify hidden factors that negatively influence mathematical models, which are based on the unit of classical regression analysis are used. Based on these models, forecasts are made of quality class schedules, which are used in the process of scheduling that reduces the number of variants of classifications in searching for the optimum.

Numerous studies in the field of scheduling theory proves that the problem of creating an optimal schedule for one cycle is very complex, since there is no single criterion of optimally for the schedule of classes [3, 4, 5]. Various types of integral optimally criteria are a compromise and in most cases they are in conflict with local criteria [6]. The task of drawing up an optimal schedule is decomposed into two sub problems: a complete schedule and resolve all the contradictions and optimization of the timetable [7]. The task of drawing up an optimum training schedule in General is characterized by high dimensionality, that is, many elements in the vector of unknowns, many constraints and optimally criteria. In [3, 7, 8] the necessity of decomposition of this complex task into sub tasks are grounded. Existing methods of compiling training schedules differ in the number and kind of constraints that are taken into account, and optimally criteria. In addition, very often these problems are NP – hard [9], and therefore their solutions different approaches and methods are used.

Materials and methods. Really optimal schedule is only possible when the optimally criterion one. In this case, the schedule is optimal if the optimally criterion is extreme value. Or can schedule have one optimally criterion? No, not because the subjects of class schedules for students, teachers and audiences that have different, sometimes conflicting, criteria of optimally, the satisfaction of which simultaneously is impossible. The construction of integral criteria of several partial criteria will create a pretty good schedule, but they will not be optimal, since the criterion is a compromise.

The task of scheduling classes the University has large dimension [4] and under any conditions generally may have no solution. For example, if lack of resources (some laboratories, teachers) it is impossible to schedule sessions within the specified time frame. In the absence of the scarcity of resources that is characteristic of the powerful universities, a task of scheduling classes has a solution and the main question becomes the optimally of the schedule.

The problem of the optimal schedule has two components: the optimally of the schedule from the point of view of usage of resources of the University (let's call this phenomenon "optimally in the large") and optimally from the point of view of the subjects of decomposition, primarily students and teachers (on- call this phenomenon "optimally in the small"). The problem of optimally in the large can be formulated as a search problem or the optimization problem [10, 11, 12, 15] and in this case the integral optimally criterion is appropriate. The problem of optimally in the small is an attempt to satisfy numerous requirements and wishes of teachers and students to schedule.

Given that the main task of scheduling classes in high school is to ensure the implementation of the educational plan of specialists training fully with the unconditional implementation of stringent schedule requirements and the implementation is not strict requirements, the study was tasked with developing the structure and algorithm of functioning of system of management of the resources of the University in scheduling classes.

Results. Fig. 1 shows a block diagram of the system of intellectual support of decision-making operational resource management of the University [13].

Automated system of formation schedule has four modes of operation [14]: manual, service, auto, intelligent. Service mode (semi-automatic) is suitable for various kinds of transfer classes, or finding the most appropriate placement classes. Automatic mode is provided for the generation of schedules in batch mode without human intervention, with the possibility of adjusting the dispatcher if necessary. Intelligent mode-multi-objective optimization of the schedule in automatic mode. The automated process of formation of the optimal schedule of the university can be divided into two stages: the generation of an initial feasible schedule of classes in the auto- mode may be put at risk and improve the schedule by using the other three modes. At the same time it is allowed arbitrary alternation of manual and automatic mode – that is, perhaps, for example, some first class post in the schedule in the manual mode, then the automatic mode, then manual, etc.

In the process of scheduling there decreases the number of possible options for placement in the schedule, left out of the schedule that decreases the number of free resources. The more resources involved in the lesson (for example, the glass flow is given of several groups), or a more scarce resource is used (for example, the lesson should be conducted in a unique laboratory) the less likely it becomes possible to schedule this activity. To solve this problem there is another (priority) of classes on the schedule. First in schedule "go" classes with higher priority.

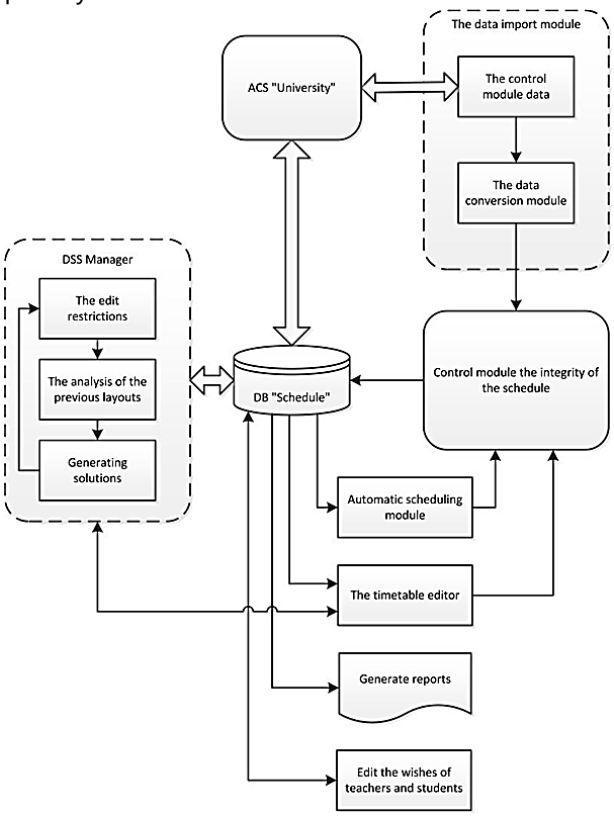

Figure 1. Structural diagram of the operational management of the resources of the University

Automatic generation of schedules is performed in accordance with the following priorities.

Classes in each faculty are planned, as a rule, in the appropriate (primary in main or the only) building. Some unique laboratories are physically located in only one building, so faculty classes can be planned in several buildings. Classes are grouped by buildings and are planned primarily those groups that are enrolled in the current day in a "foreign" building.

Distribution of streaming lectures proportional to the number of students. The more students in the stream, the higher the priority. More groups – the higher the priority.

The number of hours of classroom activity per week. More hours – the higher the priority.

The number of available classrooms of the appropriate type. First, classes are distributed in order of decreasing scarcity in highly specialized audience (e.g. laboratories for chemistry, physics, automated electric, microprocessor means), then specialized (computer classes), and at the very end, in the classroom, General purpose is based on their capacity.

The wishes of the teachers. These rules are not absolute, they reflect the experience of scheduling in each school and there may be others. The data import module is used for entering the necessary information into the system. Thus, it is necessary to include verification of input data structure and its transformation if necessary. Responsible forthis as the module to validate the structure and data control and conversion module. This module provides tight integration with the AIMSSL. (Automated Information Management System Study Loads). The data saving module is a database that stores the original information in the relevant tables that are logically interconnected. The logic of the relationship and interaction between the data is implemented using the built-in database of functions that ensures data integrity. Editing module is designed to change the input information, if necessary. Module schedule includes a module for scheduling in automatic mode (provides automatic scheduling on a particular algorithm and the possibility of further transition to the module editing) and module scheduling in manual mode. Module schedule in the manual mode includes:

Module data output (for data output from the curriculum and close loads on the specified criteria); Module selection and verification (includes automatic verification of employment structural units). Module timetable editing is to edit the schedule manually. The storage module of the schedule provides the conversion of the timetable in the necessary structure to store in the database.

Module of generation and printing of reports provides the creation of reports showing: the schedule for groups, a busy classrooms schedule, schedule for teachers. The majority of reports are generated in Microsoft Excel format that allows you to quickly create different versions of the schedule.

The result of this system is the schedule in terms of faculties, groups, departments, teachers, buildings and classrooms in Microsoft Excel format.

System for decision support (SDS) Manager is composed of the module editing restrictions, the analysis module layouts of the previous periods, the module generating solutions. Editing module of teachers wishes provides a friendly user interface through which a Manager has the ability to manipulate the wishes of the teachers regarding the optimally of a schedule, motivated to prioritize requests and to mitigate the limitations in the cases where in case there are conflicts. The analysis module schedules of previous periods creates a database of "experience" acceptable schedules, based on which the module generating solutions provides intelligent advice for module editing the wishes of the teachers. In Fig. 2 presents a generalized algorithm for the formation of class schedules.

Fully formed load of teachers and students is imported from an Automatic Working Place (AWP) "Load" (block 2). Data are checked (incoming inspection), converted and analyzed prior to the formation of the schedule (block 3). Further, the Manager can enter or modify restrictions on the creation of schedules and the wishes of the teachers (unit 4). If necessary, the Manager can in advance before the beginning of the automatic scheduling (block 6) manually allocate some classes that automatically in the future will not be changed (block 5). During automatic scheduling of classes there will be established for which we were able to meet the

restrictions and requests, including a series of permutations practice. If the schedule has been completely formed (block 7) reports are generated (block 9) – timetable of groups and teachers, download audiences and export the schedule data on the website of the University and departments. In the case where the schedule is not fully formed and there is no way to complete it under the given constraints and the wishes of automated attenuation is no hard limit and accounting for low-priority requests (block 8). If this automatic attenuation has been at least in one case unit (11) there performs automatic re-scheduling (block 6), otherwise it executes the dispatcher manual to ease the restrictions (block 12). Therefore, the scheduling occurs in the combined manual – automatic modes, step by step and under the control of the human expert bringing the schedule to the optimum state.

The final version of the schedule is considered acceptable if all classes are scheduled in the timetable. In automatic mode this result can be achieved only in the absence of hard constraints or the presence of unlimited resources, and since the limit actually is and resources (classes and teachers) are limited, the schedule automatically is not completed, and will need manual "mitigation" requirements.

Automatic Working Place (AWP) "Schedule of the UNIVERSITY" allows taking into account the following teachers wishes:

The teacher wishes on the day of the week and time of training. There are following forms of feedback: the advantage of a particular time, an indication of an undesirable time and the absence of any requests to a specific time.

Junk time is a severe limitation when working in automatic mode. In the automated mode assignment operator for classes at an undesirable time teacher leads to a corresponding warning to the provision of choice of future action. The best time is not strict. Wishes to build their own schedules. It is a fuzzy requirement and not subject to rigorous taking into account.

Wishes to the maximum number of pairs per day. It is a stringent requirement on the phase of automatic placement. It may be ignored by the operator for manual adjustment.

Wishes to the maximum number of lectures, practical and laboratory classes per day. It is a stringent requirement on the phase of automatic placement. May be ignored by the operator for manual adjustment.

Wishes to the maximum number of busy days. It is a stringent requirement on the phase of automatic placement. May be ignored by the operator during manual adjustment.

The system also allows taking into account the following requirements: unconditional lack of Windows in the group schedule on the day, the maximum allowed number of Windows in the schedule of teachers in a day, the maximum number of transitions between buildings for teachers in a day, the maximum number of transitions between the buildings for groups a day.

For automatic mode scheduling there will be taken for the quantitative indicators of the quality characteristics of the most important requirements: the amount of not number practice, the number of unfulfilled teachers wishes to unwanted time of training, the number of unfulfilled wishes of the teachers to the maximum number of pairs per day, the number of outstanding requests to the maximum number of busy days, the number of Windows in the schedule of teachers, the number of Windows in the schedule of groups, the number of transitions between buildings for teachers, the number of transitions between the buildings for groups.

Requirements that are associated with groups (the number of sessions per day, the number of employed days, restrictions on the timing of practice associated with the tuition), the mode of operation of the classrooms are rigid and must be followed strictly, therefore, their quantitative characteristics are not included in the list of criteria for assessing the quality.

Developed automated system has been put into commercial operation in the State Higher Educational Institution "Kryvyi Rih National University" and have been used for 8 years.

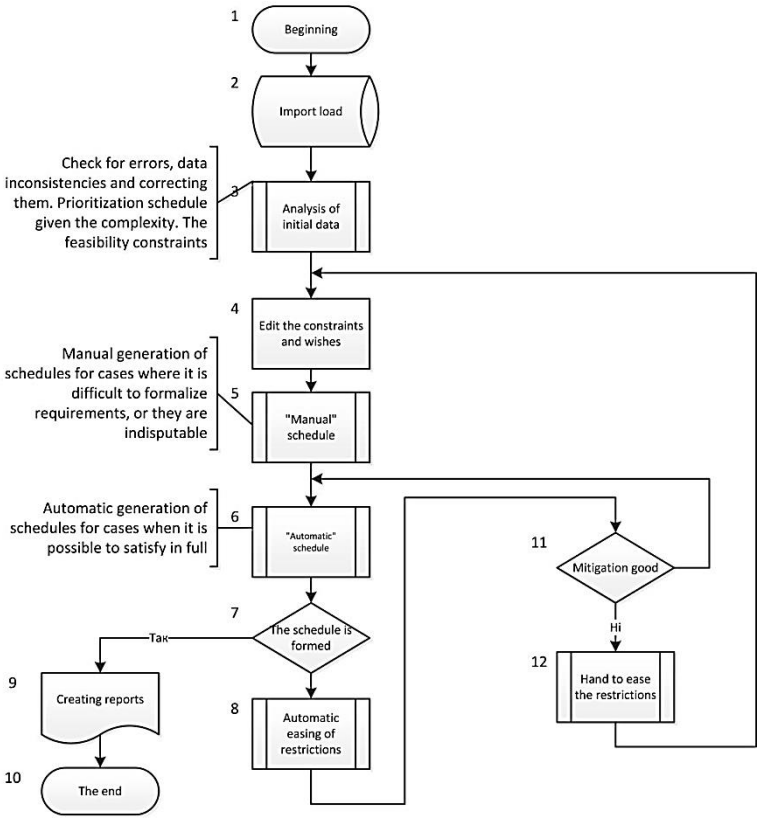

Figure 2. Generalized algorithm of formation class schedules

A powerful impetus to the implementation of the program of preparation of class schedules and active support from the University administration was the purchase of Kryvyi Rih technical University (the former name of the Kryvyi Rih national University) AIMSSL (Automated Information Management System Study Loads) developed in Cherkasy national University, named after Khmelnytsky is led by Professor Tesla Yu. M. This system provides the management of syllabuses, the load distribution between the departments and between teachers in the departments, planning of staffing, generates a complete set of documentation relative to the load. Thus, ASUN provided the input system of classes scheduling that will import the handbooks of the faculties, groups, departments, teachers, disciplines, curricula, the load is distributed to the teachers, and the like.

Conclusions. The practical use of the developed system showed that the quality of the timetable largely depends on the quantity and quality of the wishes of the teachers and of the restrictions imposed on the system. With a database of schedules for previous years there may, to some extent, to automatically generate and complement the wishes of the teachers, which undoubtedly will increase the quality of the schedule.

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