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ALGORITHMS FOR MODELING PROCESS SPENDING AND REPLENISHMENT OF RESOURCE GROUPING TECHNOLOGY

This article explores the basic initial steps for constructing an enlarged structural diagram of an algorithm for modeling the processes of spending and replenishing resource of a grouping military objects in normative planning mode.

The organizations responsible for operating the groupings have an important task of timely planning for repair of weapons and military equipment (WME) and military equipment and supplies to the grouping of new objects. Obviously, solution of such a problem is possible only on the basis of applying a mathematical model process of expenditure and replenishment of resource (PERR) of grouping objects, with which you can predict the composition and resource of the grouping, and taking into account the forecast obtained, find (calculate) optimal plans for replenishing its resource.

The article shows the results of studies various groups in terms of elucidating patterns of the occurrence of PERR in them. To do this, using the model, various grouping options can be generated with the specified characteristics, as well as calculating the optimal plans for replenishing resource for a specific group of military equipment (user groups), save these plans in a database, and then make refinement calculations taking into account current changes in grouping.

It is assumed that by the time this algorithm is launched, all the necessary data structures have already been created in random access memory of the personal computer, user has already selected an implementation option for the grouping for which simulation is performed. Also, the number of implementations of modeling process and coefficient specifying range of variation limit on the consumption of resource objects (in percent) are given. In each iteration, process of PERR objects the i-th type is simulated at a given forecast interval

Key words: complex objects of military equipment, process of expenditure and replenishment of resource, regime of normative planning.

Introduction and statement of problems. Complex objects of weapons and military equipment (WME) are used for their intended purpose, usually as part of groups (military units, formations, associations). Examples of such objects are radar stations, anti-aircraft missile systems, electronic warfare stations, and others. Groups are created temporarily or on an ongoing basis to solve certain problems in a certain territory. In order for the group to satisfy the requirements for its quantitative and qualitative composition established for it. Quantitative composition (hereinafter simply composition). Groupings are determined by the number of objects various types that are available in the group at a given time and are ready for immediate completion of tasks for their intended purpose. In this case, the number of types objects and the distribution of the number objects by types must correspond to specified grouping requirement. The qualitative composition of the group is determined by residual resource of the objects available in the group. The larger average residual resource of grouping objects, more qualitative is its composition, the greater will be the duration of group's existence in a state in which all tasks will be performed with required efficiency.

During operation of grouping, resource of individual objects is spent randomly, as a result of this, qualitative composition of group deteriorates over time ("safety margin" of group decreases). After exhaustion of resource by individual objects, their operation should be stopped, objects that have exhausted the resource should be repaired, restoring resource, or decommissioned (irrevocably removed from the group). To maintain required efficiency of functioning of the grouping, it is necessary, instead of decommissioned objects, to put in the grouping new objects of corresponding types.

Thus, for higher bodies (headquarters) responsible for operation of group, an important task arises of timely planning of repair military equipment and supplies to the group of new facilities. Obviously, solution of such a problem is possible only on the basis of applying a mathematical model process of expenditure and replenishment of resource (PERR) of grouping objects, with the help of which it would be possible to predict composition and resource of the grouping, and taking into account forecast obtained, find (calculate) optimal plans for replenishing its resource.

Therefore, an important problem is the modeling of processes for determining and replenishing the technical resource of grouping objects. To do this, it is necessary to solve two problems.

1. To explore various groups in terms of elucidating the patterns of the occurrence of PERR in them. To do this, using the model, various grouping options with specified characteristics can be generated.

2. Calculate the optimal plans for replenishing resource for a specific group of OME objects (user groupings), save these plans in database (DB), and then make refinement calculations taking into account current changes in the grouping.

Analysis of recent research. Recently, research in Ukraine aimed at improving the processes technical maintenance of military equipment, its restoration and modernization is being restored in Ukraine [1-8]. So, in [1, 4, 5], models process of research and replenishment of resource objects of complex radio engineering were investigated. In [2], new technologies for determining the reliability of objects were proposed. In [3], optimal system of scheduled repairs for individual objects was proposed. In [6], maintenance was offered “as-is” with an adaptive change in the frequency of control.

In [7–9], the authors have come close to studying the grouping of objects to optimize the number of repair bodies and evaluate effectiveness of maintenance military equipment. This is all the basis for development of an algorithm for modeling PERR of grouping objects.

The basic results of research

The integrated structural diagram of modeling algorithm. In figure 1 shows an enlarged structural diagram of the algorithm that explains structure of computation process that is implemented when modeling PERR grouping. In fact, this is an algorithm that is implemented by operator 8 (“Modeling”) of the algorithm circuit shown in [1].

It is assumed that by time this algorithm is launched, all the necessary data structures have already been created in the PC’s RAM, the user has already selected implementation of *GR* grouping for which simulation is performed. Also, the number implementations of modeling process N_I and coefficient KV_{Lim} specifying range of variation limits on the expenditure of resource objects (in percent) are given. In each iteration, process of PERR objects of *i*-th type is simulated at a given forecast interval $T_{п}$. As a result of the simulation, functions $T_{п}$ of average values $\overline{R}_{\Sigma i}(t)$, $\overline{N}_{\Sigma i}(t)$, $\overline{N}_{\mathrm{р}\Sigma i}(t)$, $\overline{N}_{\mathrm{сп}\Sigma i}(t)$ and $\overline{N}_{\mathrm{н}\Sigma i}(t)$ ($\forall t \in T_{п}$) predicted on the interval are formed, which are displayed on PC screen in form of graphs. Corresponding averages are accumulated according to results of implementation of the real-time simulation of real-time simulation. The operation of the algorithm briefly consists in following.

Operator 1 sets the initial value of *iter* variable, which is used to count the number of completed simulation implementations.

Operator 2 creates a copy of List_O list, which contains information about the objects of GR grouping. Operator 3 increments value of iter variable by 1, thus forming the number of current iteration. Operator 4 restores the initial state of List_O data from the copy. Operator 5 generates random values of resource consumption limit by individual objects that are part of the grouping. This is done by executing the following statement for each object:

$$\mathtt{O.Lim} := \mathtt{O.Lim0} \cdot (1 - KV_{\mathrm{Lim}}/100/2) + \mathtt{R},$$

where `O.Lim0` – is the initial value of the resource spending limit specified for object O (h / year);

– user-specified value of the coefficient of variation of the limit of spending the re-source of objects (in%);

R – is a random variable uniformly distributed in the interval .

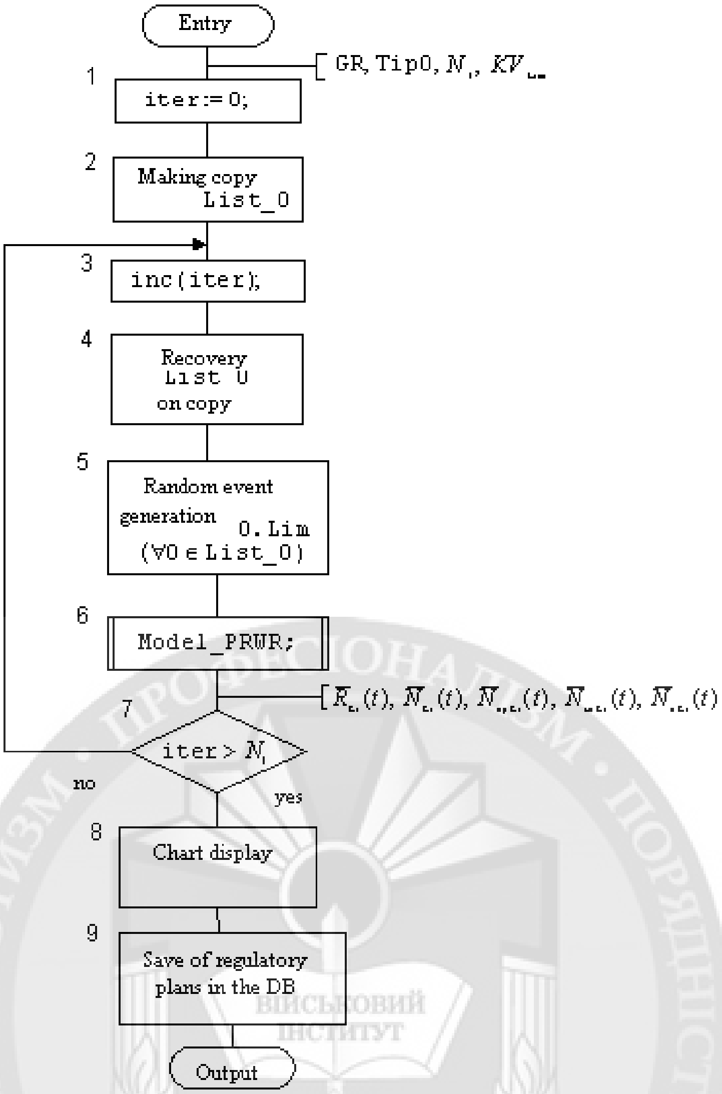


Figure 1 - An enlarged block diagram of modeling algorithm

Operator 6 (procedure Model_PERR) imitates ERR process with objects of GR grouping. Inside this procedure, information is accumulated necessary for constructing function schedules, and regulatory plans for repairing, decommissioning and delivering new objects to the group are also formed. An algorithm that implements this procedure is discussed in detail below.

Operator 7 checks the condition for a given number of iterations. If not all iterations have been completed, control is transferred to operator 3 and the simulation process continues. If all iterations are completed, the simulation process is interrupted, and operators 8 and 9 are executed. Operator 8 displays function graphs on PC screen, operator 9 saves the generated normative plans for repairs, write-offs, and deliveries of new objects to database. This completes work of the algorithm.

The modeling algorithms implemented by the Model_PERR procedure are slightly different, depending on program mode selected by the user. Let's consider these algorithms separately.

Regulatory planning mode. Consider structural diagram of the simulation model algorithm (SM) of PERR (procedure Model_PERR) in the standard planning mode without delivery of new objects. The block diagram of the algorithm in this mode is shown in Fig. 2.

The initial information for the algorithm is GR and TipO data structures created in the main memory at time the algorithm started to execute. The output of the algorithm are functions $\overline{R}_{\Sigma i}(t)$, $\overline{N}_{\Sigma i}(t)$, $\overline{N}_{\text{р}\Sigma i}(t)$ and $\overline{N}_{\text{сп}\Sigma i}(t)$, as well as the standard repair $\Pi^{\text{н}}_{\text{р}i}$ and decommissioning $\Pi^{\text{н}}_{\text{с}i}$ plans stored in the arrays of simulation results.

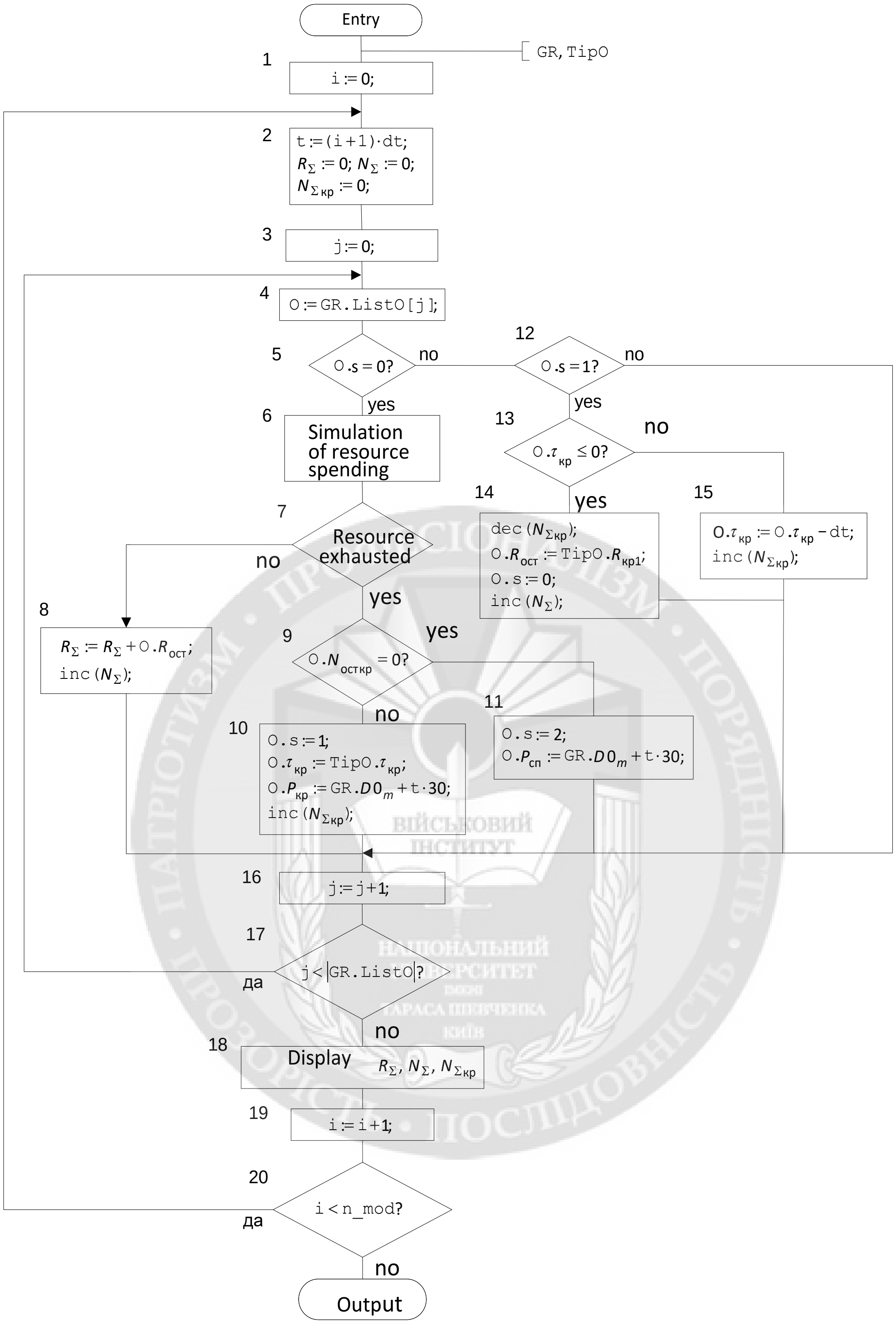


Figure 2 - Block diagram of the algorithm for modeling PERR in regulatory planning mode

Simulation parameters (in addition to the selected Reg_p forecasting mode) are:

- type of objects for which calculations are performed (data on the type are available through TipO pointer);
- duration of operation period of the grouping DT_MOD;
- date corresponding to the beginning of specified period of operation D0_MOD;

- interval discreteness modeling RWR DT.

These parameters are entered by the user from PC screen immediately before starting simulation.

The idea of the algorithm is very simple - it consists of two cycles: the external (by i), in which the operation time intervals of group are sorted, and the internal (by j), in which the group objects of a given type are sorted.

The external cycle is implemented by operators 1, 19, and 20. Operator 2 generates the current model time t and initializes variables R_{Σ} , N_{Σ} and $N_{\Sigma\text{кр}}$ in which total resource, total number of workable objects in the group, and total number of objects that are currently under repair will be accumulated.

The inner loop (operators 3, 16, and 17) is re-executed for each value of the model time t. In this cycle, all elements of the GR.List_O list are enumerated - a list of pointers to objects that are part of grouping. Operator 4 selects a pointer to the j-th object from this list.

Operator 5 checks the current state of object $\mathtt{O}.s$. If $\mathtt{O}.s = 0$, then the object is currently in a healthy state and performs the task as part of grouping. Operator 6 simulates consumption of an object's resource over a period of time $\mathtt{dt} = [\mathtt{t} - \mathtt{dt}, \mathtt{t}]$ by executing the following instructions:

$\mathtt{O}.R_{\text{ост}} := \mathtt{O}.R_{\text{ост}} - \mathtt{dt} \cdot \mathtt{O}.L\mathtt{im0}/12;$

$\mathtt{O}.T_{\text{ост}} := \mathtt{O}.T_{\text{ост}} - \mathtt{dt},$

где $\mathtt{O}.R_{\text{ост}}$ и $\mathtt{O}.T_{\text{ост}}$ –

where $\mathtt{O}.R_{\text{ост}}$ and $\mathtt{O}.T_{\text{ост}}$ – value of the residual resource and residual life of object at time t;

$\mathtt{O}.L\mathtt{im0}$ – annual limit of the resource consumption of the object;

dt – is the value of the discrete interval (dt = DT).

Operator 7 checks condition of exhaustion resource of object at time t:

$(\mathtt{O}.R_{\text{ост}} < 0) \vee (\mathtt{O}.T_{\text{ост}} < 0)$.

If this condition is not met, then operator 8 is executed, in which the current total resource R_{Σ} and number of objects in grouping are calculated N_{Σ}.

If the resource of the object is not exhausted, operators 9-11 are executed. The operator 9 checks whether the set number of scheduled repairs has been completed. If "no" (remaining number of repairs $\mathtt{O}.N_{\text{ост кр}} > 0$), then operator 10 is executed, which simulates the transfer of an object to a repair state. In this case, following actions are performed:

$\mathtt{O}.s := \mathtt{1};$ – sets a new value for the state variable of object;

$\mathtt{O}.\tau_{\text{кр}} := \mathtt{TipO}.\tau_{\text{кр}};$ – value of duration stay object in repair;

$\mathtt{O}.P_{\text{кр}} := \mathtt{GR}.D0_{\text{m}} + \mathtt{t} \cdot 30;$ – planned (normative) time of sending the object for repair is formed:

$\mathtt{inc}\,(N_{\Sigma\,\text{кр}});$ – current number of objects under repair is calculated.

If all the set (normative) number of scheduled repairs the facility $\mathtt{O}$ ($\mathtt{O}.N_{\text{ост кр}} = 0$) is completed, then operator 11 is executed, which imitates conversion of the facility to a decommissioned state. In this case, following actions are performed:

$\mathtt{O}.s := 2;$ – value of the state variable is set to the state "object decommissioned";

$\mathtt{O}.P_{\text{сп}} := \mathtt{GR}.D0_{\text{m}} + \mathtt{t} \cdot 30;$ – value of planned time to write off the object is formed.

If during execution of operator 12 it is discovered that the object is in a repair state ($\mathtt{O}.s = \mathtt{1}$), then operators 13-15 are executed that simulate the object being in repair. The operator 13 checks condition for completion of the repair. If the repair has not yet been completed ($\mathtt{O}.\tau_{\text{кр}} > 0$), then operator 15 is executed, simulating the continuation of the repair:

$\mathtt{O}.\tau_{\text{кр}} := \mathtt{O}.\tau_{\text{кр}} - \mathtt{dt};$ – residence time of the object in the repair is reduced by dt;

$\texttt{inc}\,(N_{\Sigma\,кр})$; – current total number of objects under repair is calculated.

If the repair is completed ($\texttt{O}.\tau_{кр} \le 0$), then following actions are performed:

$\texttt{dec}\,(N_{ост\,кр})$; – unit decreases the residual number of scheduled repairs of the facility $\texttt{O}$;

$\texttt{O}.R_{ост} := \texttt{TipO}.R_{кр1}$; – simulated replenishment resource of the object as a result of repairs;

$\texttt{O}.s := 0$; – simulates the restoration of operational state of the object;

$\texttt{inc}\,(N_{\Sigma})$; – total number of workable objects in the group is calculated.

Next, operator 16 counts the number of objects j for which simulated actions were taken to expend and replenish the resource in current interval dt. If these actions ($\texttt{j} < |\texttt{GR.ListO}|$) have not yet been performed for all objects, then operator 17 transfers control to operator 2 and then execution of operators 2-17 is repeated as described above. The cyclic execution of operators 2-17 ends after condition is met $\texttt{j} = |\texttt{GR.ListO}|$. In variables R_{Σ}, N_{Σ} and $N_{\Sigma\,кр}$, values corresponding to the grouping state at the current time t will be generated.

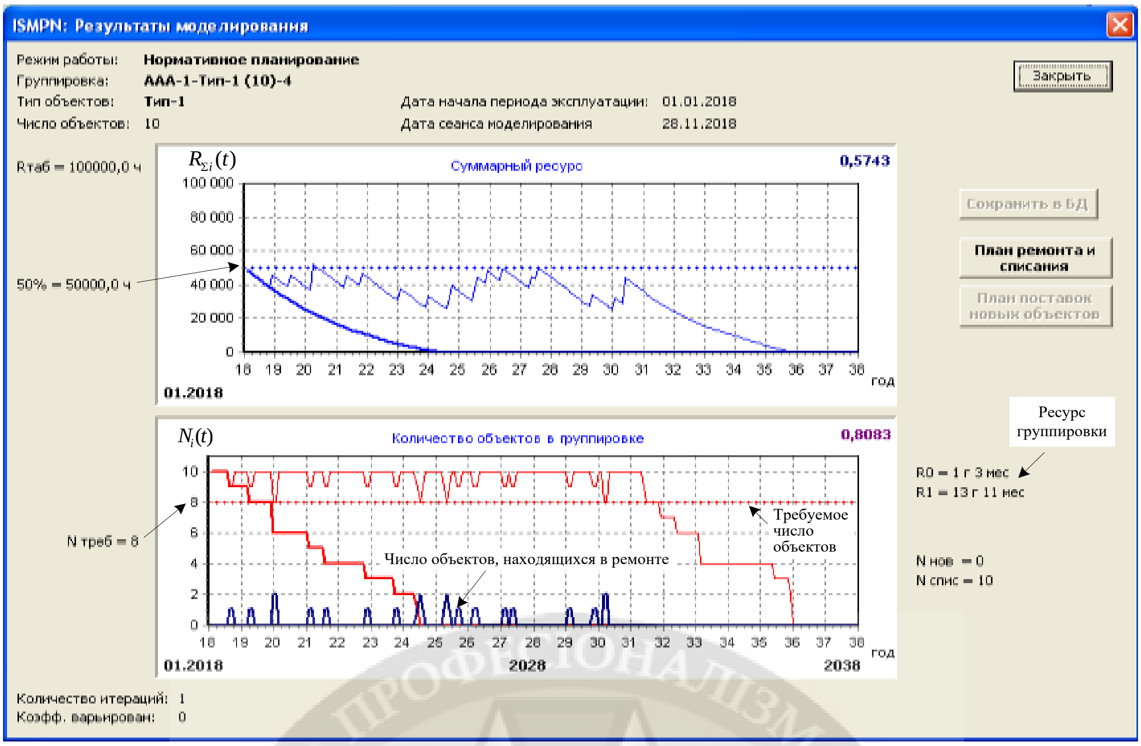
The operator 18 displays obtained values on the PC screen R_{Σ}, N_{Σ} and $N_{\Sigma\,кр}$ in the form of points on the function graphs, and. Next, operator 19 provides a transition to next time section t (forms the number i of the next point on the time axis). Operator 20 checks the condition for completing the graphing. If all points of graphs ($\texttt{i} = \texttt{n\_max}$) are formed and displayed, then operation of the algorithm ends here.

As an example in fig.3 shows graphs of functions $\overline{R}_{\Sigma\,i}(t)$, $\overline{N}_{\Sigma\,i}(t)$ and $\overline{N}_{кр\,\Sigma\,i}(t)$ obtained as a result of execution of considered algorithm. The graphs are given for the case when the group contains 10 objects of type **Type-1** (**Type-1** is the name of type objects in TipO structure). The maximum number of repairs after which the object must be written off is set to 2.

In the upper graph in fig.3 shows function of total resource $\overline{R}_{\Sigma\,i}(t)$ (for objects of type **Type-1**). The bold line shows the initial part of function, which displays the forecast for the case if no planned repairs (PR) are carried out. With a thinner line, this same function represents the forecast, provided that PR are carried out within the standard time frames established for this type of object. The lower graph (in red) shows the graph of the function $\overline{N}_{\Sigma\,i}(t)$. Also, the bold line shows the initial part of the graph for the case if PR had not been carried out, a thinner red line shows the continuation of same function, provided that all PR are carried out within the established regulatory periods. The lower graph in the same coordinates shows a graph of the function, which displays the number objects that are in a state of repair at each moment of time (currently missing in the group).

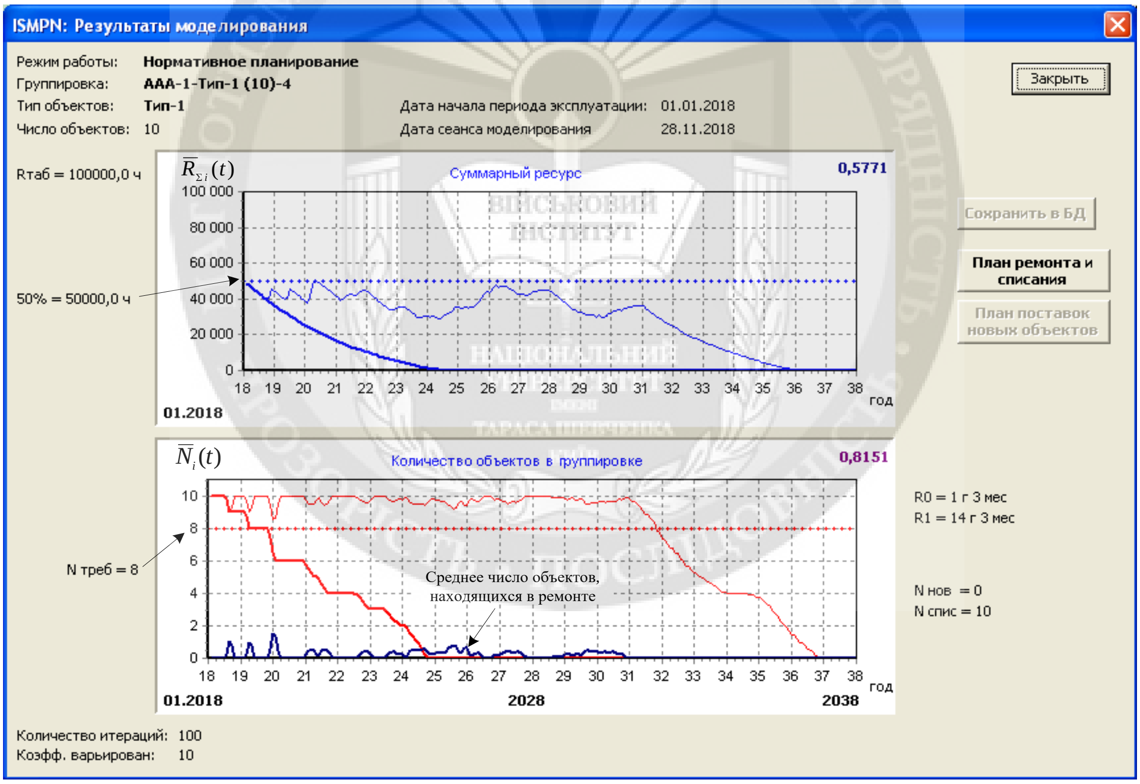
In fig. 3a shows results for the case of performing 1 implementation of modeling process, in fig. 3b - for 100 implementations. Comparing the graphs in these figures, we can see that with a large number of implementations, average time for sending to the 2-nd repair and the time for writing off objects become more “blurred”, stretched over time. This is consistent with the physical meaning of average indicators (average number of objects under repair $\overline{N}_{кр\,\Sigma\,i}(t)$ and the average number of objects remaining in the group $\overline{N}_{\Sigma\,i}(t)$).

The graphs (in the upper right corner) show the values of quality indicators Q_{Ri} and Q_{Ni} (Q_{Ri} - in upper graph, Q_{Ni} - in lower).



Режим работы: **Нормативное планирование**
Группировка: **ААА-1-Тип-1 (10)-4**
Тип объектов: **Тип-1**
Число объектов: 10
Дата начала периода эксплуатации: 01.01.2018
Дата сеанса моделирования 28.11.2018
Rтаб = 100000,0 ч
50% = 50000,0 ч
N треб = 8
R0 = 1 г 3 мес
R1 = 13 г 11 мес
N нов = 0
N спис = 10
Количество итераций: 1
Коэфф. варьирован: 0

a) one implementation ($N_I = 1$, $KV_{\text{Lim}} = 0$)



Режим работы: **Нормативное планирование**
Группировка: **ААА-1-Тип-1 (10)-4**
Тип объектов: **Тип-1**
Число объектов: 10
Дата начала периода эксплуатации: 01.01.2018
Дата сеанса моделирования 28.11.2018
Rтаб = 100000,0 ч
50% = 50000,0 ч
N треб = 8
R0 = 1 г 3 мес
R1 = 14 г 3 мес
N нов = 0
N спис = 10
Количество итераций: 100
Коэфф. варьирован: 10

b) 100 implementations ($N_I = 100$, $KV_{\text{Lim}} = 10\%$)

Figure 3 - Example of simulation results (**Normative planning** mode)

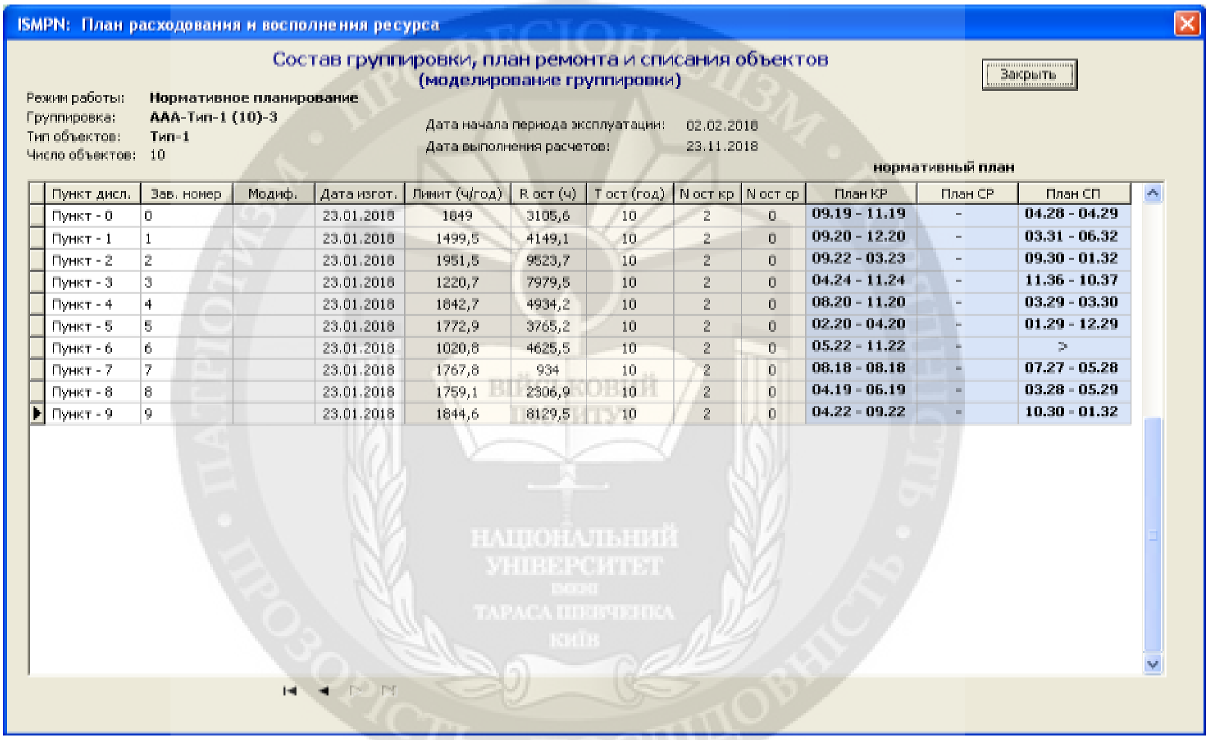
On the form of simulation results (to the right of graph $\overline{N}_{\Sigma i}(t)$), value of the grouping resource $R^1_{\text{групі}}$ (duration of grouping with the required composition) is displayed. In this example, the required number of objects $N_i^{\text{тр}} = 8$. Under this condition, the group's resource is 13 years 11 months. (one implementation) and 14 years 3 months. (according to the predicted average composition). The discrepancy between corresponding values at 1 and at 100 implementations is quite understandable, since the predicted functions are different.

The initial grouping resource $R^{0}_{\text{груп}i}$ is also displayed, defined as the grouping resource, provided that no repairs are made to restore the resource of the objects. The initial grouping resource in this example is 1 year 3 months. (with 1 and with 100 implementations).

The graphs corresponding to the initial resource are shown in bold lines in figures.

Along with the functions $\overline{R}_{\Sigma i}(t)$, $\overline{N}_{\Sigma i}(t)$ and $\overline{N}_{\text{кр}\,\Sigma i}(t)$ as a result of the simulation, a plan of repair and decommissioning of grouping objects is also formed, corresponding to the specified intensities (limit) of the resource consumption of objects `O.Lim0` and the established standards for replenishing the resource `TipO`.$R_{\text{кр}1}$, `TipO`.$T_{\text{кр}1}$ and `TipO`.$N_{\text{кр}}$.

The plan of repair and decommissioning of objects is displayed in a separate form when you click the **Plan of repair and decommissioning** button (fig. 3). The form in which this plan is displayed is shown in fig 4.



Состав группировки, план ремонта и списания объектов
(моделирование группировки)

Режим работы: **Нормативное планирование**
Группировка: **ААА-Тип-1 (10)-3**
Тип объектов: **Тип-1**
Число объектов: 10

Дата начала периода эксплуатации: 02.02.2018
Дата выполнения расчетов: 23.11.2018

нормативный план

Пункт дисл.	Зав. номер	Модиф.	Дата изгот.	Лимит (ч/год)	R ост (ч)	T ост (год)	N ост кр	N ост ср	План КР	План СР	План СП
Пункт - 0	0		23.01.2018	1849	3105,6	10	2	0	**09.19 - 11.19**	-	**04.28 - 04.29**
Пункт - 1	1		23.01.2018	1499,5	4149,1	10	2	0	**09.20 - 12.20**	-	**03.31 - 06.32**
Пункт - 2	2		23.01.2018	1951,5	9523,7	10	2	0	**09.22 - 03.23**	-	**09.30 - 01.32**
Пункт - 3	3		23.01.2018	1220,7	7979,5	10	2	0	**04.24 - 11.24**	-	**11.36 - 10.37**
Пункт - 4	4		23.01.2018	1842,7	4934,2	10	2	0	**08.20 - 11.20**	-	**03.29 - 03.30**
Пункт - 5	5		23.01.2018	1772,9	3765,2	10	2	0	**02.20 - 04.20**	-	**01.29 - 12.29**
Пункт - 6	6		23.01.2018	1020,8	4625,5	10	2	0	**05.22 - 11.22**	-	>
Пункт - 7	7		23.01.2018	1767,8	934	10	2	0	**08.18 - 08.18**	-	**07.27 - 05.28**
Пункт - 8	8		23.01.2018	1759,1	2306,9	10	2	0	**04.19 - 06.19**	-	**03.28 - 05.29**
Пункт - 9	9		23.01.2018	1844,6	8129,5	10	2	0	**04.22 - 09.22**	-	**10.30 - 01.32**

Figure 4 - PC screen view when displaying form of the repair plan and decommissioning of grouping objects (**Regulatory planning** mode)

Planned dates for repair and decommissioning of objects are displayed in the three right columns of the table. The minimum and maximum values of the planned repair and write-off period, obtained as a result of forecast calculations, are displayed.

The table also displays additional information about the characteristics of facilities: location, serial number, production date, etc. In the case of a virtual grouping, this information is automatically generated when it is created. In the case of user grouping, all this information is set by the user.

Conclusions. This article explores the basic initial steps for constructing an enlarged structural diagram of an algorithm for modeling the processes of spending and replenishing the resource of a grouping of military objects in normative planning mode.

In the future, a regulatory planning regime will be developed taking into account the supply of new objects to the grouping.

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АЛГОРИТМИ МОДЕЛЮВАННЯ ПРОЦЕСУ ВИТРАТ І ЗАПОВНЕННЯ РЕСУРСНОЇ ГРУПОВОЇ ТЕХНОЛОГІЇ

В даній статті досліджено основні початкові дії з побудови укрупненої структурної схеми алгоритму моделювання процесів витрачання та поповнення ресурсу угруповання військових об'єктів в режимі нормативного планування.

В організаціях, відповідальних за експлуатацію угруповань, виникає важливе завдання своєчасного планування ремонту об'єктів озброєння і військової техніки (ОВТ) і поставок в угруповання нових об'єктів. Очевидно, що рішення такого завдання можливе лише на основі застосування математичної моделі процесу витрачання та поповнення ресурсу (ПВВР) об'єктів угруповання, за допомогою якої можна прогнозувати склад і ресурс угруповання, і з урахуванням отриманого прогнозу знаходити (розраховувати) оптимальні плани заповнення її ресурсу.

У статті показані результати досліджень різних угруповань з точки зору з'ясування закономірностей протікання в них ПВВР. Для цього за допомогою моделі можуть генеруватися різні варіанти угруповань із заданими характеристиками, а також здійснюються розрахунки оптимальних планів поповнення ресурсу для конкретного угруповання об'єктів військової техніки (угруповання користувача), зберігати ці плани в базі даних, а потім проводити уточнюючі розрахунки з урахуванням поточних змін в угрупованні.

Передбачається, що до моменту запуску цього алгоритму в оперативній пам'яті персонального комп'ютера вже створено всі необхідні структури даних, користувачем вже обраний варіант реалізації угруповання, для якої проводиться моделювання. Також задано число реалізацій процесу моделювання і коефіцієнт, що задає діапазон варіювання ліміту витрачання ресурсу об'єктів (у відсотках). У кожній ітерації імітується процес ПВВР об'єктів і-го типу на заданому інтервалі прогнозування

Ключові слова: складні об'єкти військової техніки, процес витрачання та поповнення ресурсу, режим нормативного планування.

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АЛГОРИТМЫ МОДЕЛИРОВАНИЯ ПРОЦЕССА РАСХОДА И ЗАПОЛНЕНИЯ РЕСУРСНОЙ ГРУППОВОЙ ТЕХНОЛОГИИ

В данной статье исследованы основные начальные действия по построению укрупненной структурной схемы алгоритма моделирования процессов расходования и восполнения ресурса группировки военных объектов в режиме нормативного планирования.

В организациях, ответственных за эксплуатацию группировок, возникает важная задача своевременного планирования ремонта объектов вооружения и военной техники (ВВТ) и поставок в группировку новых объектов. Очевидно, что решение такой задачи возможно только на основе применения математической модели процесса расходования и восполнения ресурса (ПРВР) объектов группировки, с помощью которой можно прогнозировать состав и ресурс группировки, и с учетом полученного прогноза находить (рассчитывать) оптимальные планы восполнения ее ресурса.

В статье показаны результаты исследований различных группировок с точки зрения выяснения закономерностей протекания в них ПРВР. Для этого с помощью модели могут генерироваться различные варианты группировок с заданными характеристиками, а также производятся расчеты оптимальных планов восполнения ресурса для конкретной группировки объектов военной техники (группировки пользователя), сохранять эти планы в базе данных, а затем производить уточняющие расчеты с учетом текущих изменений в группировке.

Предполагается, что к моменту запуска этого алгоритма в оперативной памяти персонального компьютера уже созданы все необходимые структуры данных, пользователем уже выбран вариант реализации группировки, для которой производится моделирование. Также задано число реализаций процесса моделирования и коэффициент, задающий диапазон варьирования лимита расходования ресурса объектов (в процентах). В каждой итерации имитируется процесс ПРВР объектов і-го типа на заданном интервале прогнозирования

Ключевые слова: сложные объекты военной техники, процесс расходования и восполнения ресурса, режим нормативного планирования.