The result of simulation has proved that using static preset intensity parameters based on mean intensity during the specific time period differs from the dynamic one. Although the test run with dynamic intensity was done with only one intensity being changed periodically during the run, it had great impact on the fitness function. Currently there are not many devices that could provide scientists with the information about road section situation therefore only one dynamic parameter was involved. Having stated that, installation of more facilities on intersections leading to getting more parameters, including intensity, for the system to work properly is considered to be a matter of great importance.

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UDC 519.876.5

MODELING OF A QUEUING SYSTEM BASED ON CEN NETWORK IN GPSS WORLD SOFTWARE ENVIRONMENT

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A queuing system (QMS) is any system in which the flow of requirements meets the limited possibilities of their processing [1]. The QMS can perform certain operations on the requirements coming into the system. An element of the system that performs operations on requirements is called a service device or simply a device. Queues may arise within the QMS system. A queue is a set of requests waiting to be serviced when the device is already busy servicing a previous request.

Consider the process of modeling a queuing system based on the task. Suppose we need to simulate the operation of a small system that has one

Control E-Network (CEN), designed for control and management of data (transitions, etc.), and one device that takes the value obtained after that. To simulate the operation of this system, you can take such a unit as a millisecond (ms). This choice was made for clarity and correctness of the results.

We need to define the parameters of the system:
- CEN network load factor;
- device load factor;
- maximum, average and current number of data in each queue;
- average service time (control and management);
- the average time of data in each queue, etc.

Consider the process of building a simulation model of the simplest QMS system by creating and executing simulation models in the GPSS World [2] environment. To facilitate the construction of the simulation model, the process of functioning will take place in a single-channel open system.

Receipt of requirements to the QMS system is modeled by the operator GENERATE, which in the task can be written as: GENERATE (Exponential (1,0,190)).

The field of operand A determines the time interval between the arrival of two requests coming one after another to the service channel. This program uses the built-in exponential distribution function. The average request arrival time is 190 ms, which is the third argument of the Exponential function.

The request is queued for processing. This can be simulated by the QUEUE operator, which only in conjunction with the corresponding DEPART operator collects statistical information about the queue. In the program, the QUEUE statement will look like this: QUEUE CHERGA_NET.

The field of operand A is given the symbolic or numeric name of the queue. This queue task is named CHERGA_NET. This name reflects the essence of the described element of the system - the queue for data to the CEN network [3].

Following the logic of the process, the request can be queued only when the service channel is released. To do this, enter the SEIZE operator, which determines the occupancy of the service channel, and when you release the last request, which is ahead, leaves the queue and goes to the service channel. This will be modeled as: SEIZE NETWORK.

In the field of operand A is given the symbolic or numerical name of the service channel. The channel program is named NETWORK. The output of the product from the service queue is fixed by the DEPART operator with the corresponding queue name: DEPART CHERGA_NET. Next, the maintenance time of the device is simulated. To model this process, the operator is used: ADVANCE (Exponential (1,0,150)).

The field of operand A indicates the exponential distribution with an average service time of the requirement of 150 ms. After processing the request, a message about the release of the service channel must be sent. This is done using the operator: RELEASE NETWORK. After maintenance, the requirement leaves the system. This action is modeled by the operator: TERMINATE 1. The number of requirements that have been serviced in our system will be equal to 10000.

To build a histogram of the time spent in the queue, add to the program the first operator QTABLE: t_cherga QTABLE CHERGA_NET, 1,1,250. Here in the field of operand A of the histogram T_cherga the name of the queue CHERGA_NM is indicated, operand B is the end of the first interval, operand C is the width of the intervals, operand D is the number of intervals of the histogram.

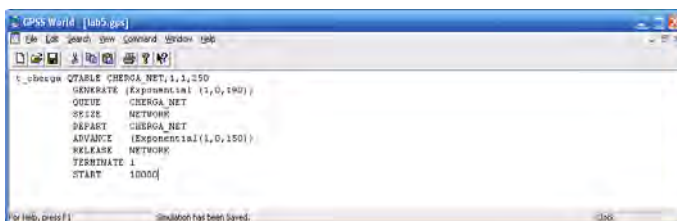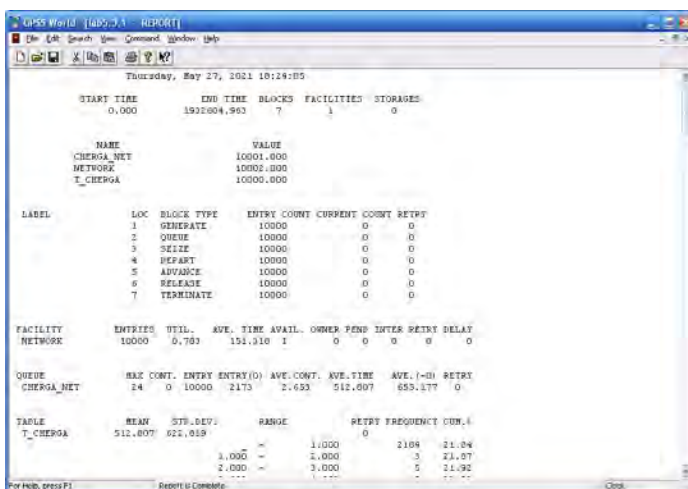Finally, the GPSS program will look like shown in Fig. 1.

Fig. 1. Window with the model of the simplest QMS

Fragments of the REPORT window with simulation results for this model are presented in Fig. 2.
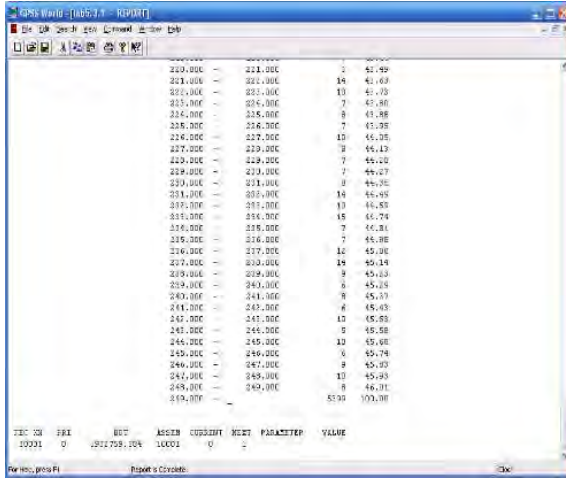

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Fig. 2. Fragments of the REPORT window with simulation results

The data in turn have the following values: MAX (Maximum length) - 24; CONT. (Current length) - 0; ENTRY (Number of inputs) - 10000; ENTRY (O) (Number of inputs with zero time) - 2173; AVE.CONT. (Average number of entrances) - 2,653; AVE.TIME (Average time in the queue) - 512,807; AVE. (Average time without zero inputs-O) - 655.177; RETRY (Number of detainees in case of queue status) - 0.

In addition to the above table, as a result of the model, a histogram of the values of the time of the requirements in the queue was constructed. To view this histogram, it was necessary to open the graph of the histogram T_CHERGA, the window of which is shown in Fig. 3.

Fig. 3. The window of the histogram of the time spent in the queue

As can be seen from Fig. 3, the average time in the queue (Mean) coincides with the value of the same parameter (Ave.Time), presented in the REPORT window, and is equal to 512,807 ms. In addition, from the histogram you can get an additional value of the standard deviation (S.D.) of this parameter (queue time), which is not given in the table.

The value of the average queue length obtained by means of the simulation model, which is equal to 2,653, can be compared with the value calculated for the simplest QMS. With the specified parameters, the load factor will be equal to:

$$\lambda = \frac{1}{190}; \mu = \frac{1}{150}; \rho = \frac{\lambda}{\mu} = \frac{150}{190} = 0.7895 \tag{1}$$

Then the average length of the queue will be equal to:

$$l = \frac{\rho^2}{1-\rho} = \frac{0.5584}{0.2105} \approx 2.653 \tag{2}$$

Therefore, the GPSS World software environment is ideal for creating and executing simulation models. The simulation model of the simplest queuing system was investigated and a comparison with analytical solutions was successfully made.

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