Mechanical Testing and Diagnosis
ISSN 2247 – 9635, 2014 (IV), Volume 3, pp. 13-20

SCHEDULING PROBLEMS FOR JOBS AND DIFFERENT MACHINES WITH MAKE SPAN CRITERION AND LEFT TIME ALIGNMENT

Daniel REZMIRES*, Alfredo MONFARDINI, Cezar RACOCEA*****

*S.C. SIRCA S.A, Piatra Neamt, ROMANIA,
** RIMA Spa, Italy,
*** "Gheorghe Asachi" Technical University of Iasi, Romania

drezmir@hotmail.com

ABSTRACT

This paper focuses on operations scheduling, which involves assigning jobs to workstations or employees to jobs for specified time period. The scheduling techniques we discuss in this paper are similar with Gantt method type and serv various process types in manufacturing process. There are companies which have to deliver many types of different products in a specified time, as, for example, a slewing ring factory, which has to sell a large variety of products (taking into account dimensions and configurations), in the same time.

Keywords: scheduling, make span, left time alignment, Gantt, CIM, FMS

1. INTRODUCTION

Literature presents the main terms associated to Gantt method and scheduling time. Scheduling is the allocation of shared resources over time to competing activities and it has been the subject of a significant amount of literature in the operations research field. The main term is makespan and it represents the total amount of time required to complete a group of jobs [1, 2]. Modern production process requirements ask for developing and implementing Computer Integrated Manufacturing (CIM) [3]. The eficency of CIM is dependent on the scheduling of Flexible Manufacturing System (FMS). Machine idle time can be decreased by sorting the make span, which results in the improvement in CIM productivity. This paper presents the problem of a flow shop scheduling with the objective of minimizing the make span. FMS [3] Scheduling system is one of the most important information-processing subsystems of CIM system. Sequencing is a technique to order the jobs in a particular sequence. By scheduling, we assign a particular time for completing a particular job. The main objective of scheduling is to arrive at a position where we will get the minimum processing time.

According to literature [3, 4, 5], sequencing and scheduling are types of decision-making activities that play a crucial role in manufacturing and service industries. Makespan minimization supports the competitive priorities of cost and time. In this paper, our discussion of the operations scheduling techniques has application for line processes in the manufacturing process. This case is obviously for companies which have to deliver many type of different products, in a specific time. There are many cases when the transport number between successive operations needs to be also minimized, even if the local makespan is not a minimum for a specified sequence of operations. In reality, some compromises are, sometime, necessary and a combination between FIFO (first in first out) and a compacting time method (with minimum movements between successive jobs) is necessary.

2. MATHEMATICAL MODEL

In this paper, the objective is to minimize the makespan of the batch-processing machines, in a flow shop. The processing times and the sizes of the jobs are known and can be non-identical. A computer code was developed to solve that type of problem.

To describe the model, some parameters are defined as following:

GrupE, which represents the total number of different type of pieces.

In this case, we attach a parameter GrupA=1…GrupE for any GrupA; we attach N_P and N_OP parameters, where

N_P is the number of pieces of type GrupA

N_OP is the number of successive operations necessary to realize a single piece of GrupA type.

So, for any OP =1..N_OP, NU machines can be attached

NU=1… number of identical machines available for production.

For a specified GrupA at any OP, a TU parameter can be attached, where TU represents the necessary machine time to finalize the current operation (for a single piece).

To solve the problem and to find the optimum solution, an individual procedure was created to find the number of possible combinations among numbers of GrupE. For exemplification, in Table 1, the following number of possible combinations was identified.

Table1. Numer of possible combinations as function of GrupE

GrupE	Number of possible combinations
2	2
4	24
6	96
10	460
20	3820
30	13080
32	15904
36	22716

If, for example, GrupE=4 or GrupE=10, then the possible combinations are presented in Figure 1 and Figure 2, respectively.

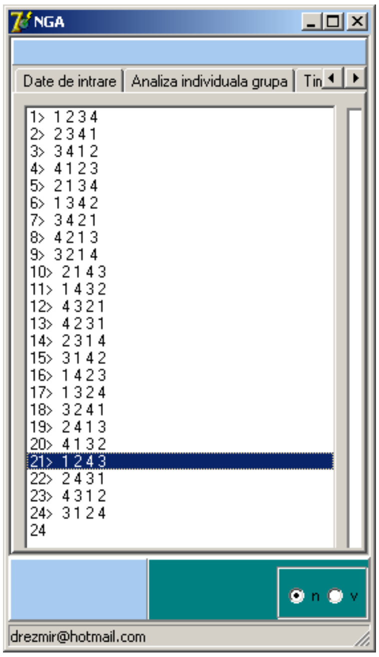

Fig. 1. The 24 possible combinations if GrupE=4

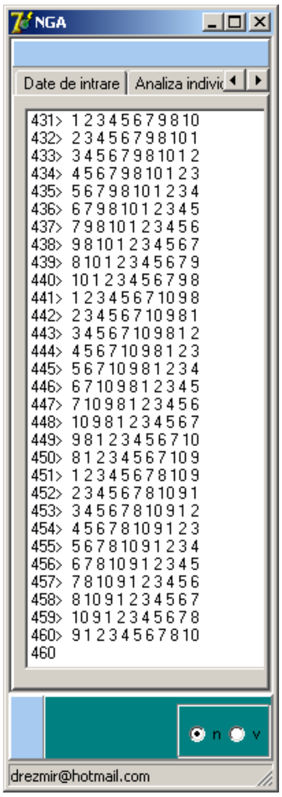

Fig. 2. A part of possible combinations if GrupE=10

3. PROGRAM EXEMPLIFICATION

The main data are inserted in the main panel of the program, as shown in Fig. 3. A dynamic allocation of memory is associated and some initial matrixes were created.

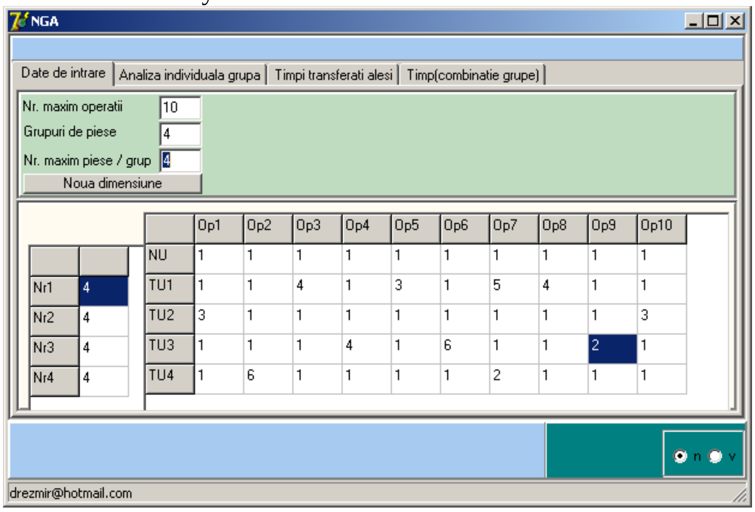

Fig. 3. Input data area

For any individual string of input data, an individual optimization of the time repartition was realized, as presented in Figures 4a, 4b, 4c and 4d.

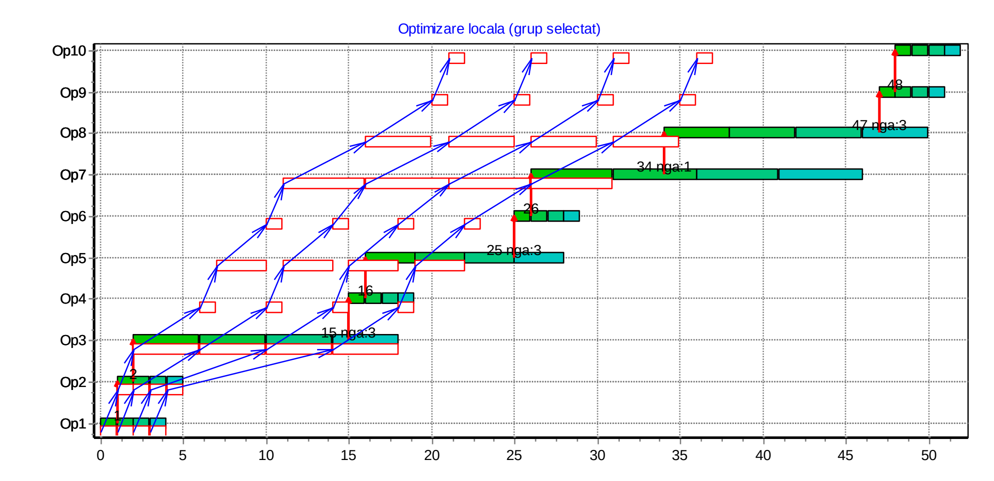

Fig. 4.a. Local optimizations for GrupA=Nr1 data components

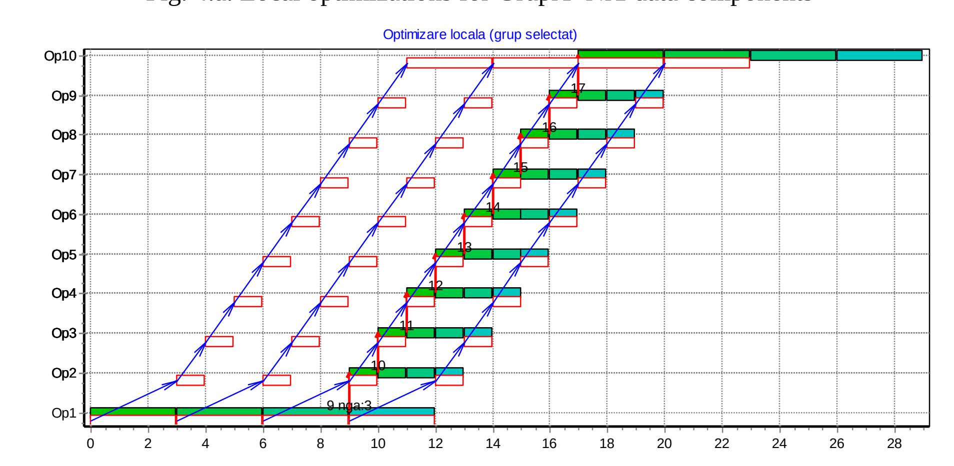

Fig. 4.b. Local optimizations for GrupA=Nr2 data components

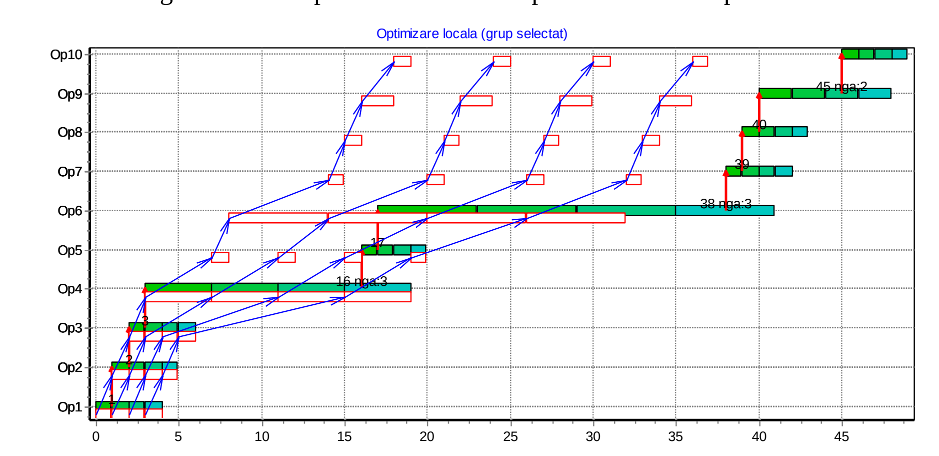

Fig. 4.c. Local optimizations for GrupA=Nr3 data components

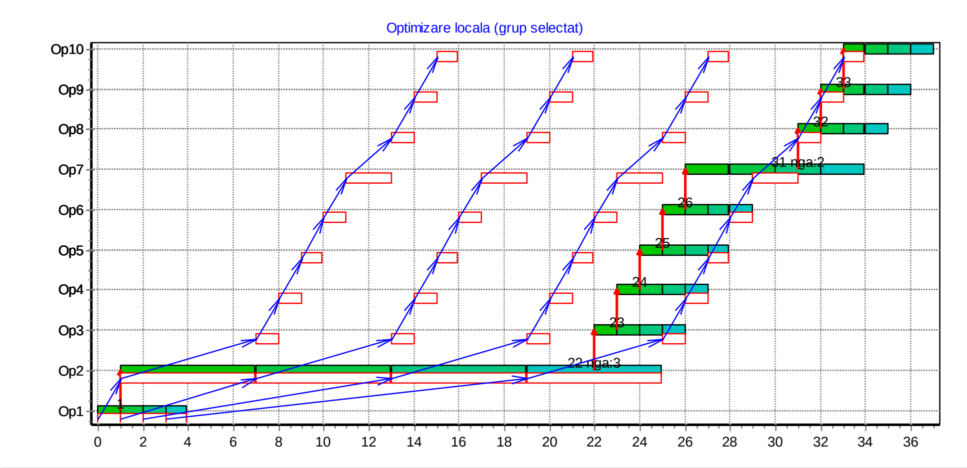

Fig. 4.d. Local optimizations for GrupA=Nr4 data components

When all individual processes are optimized, then a global optimization is done taking into account the number of possible combinations as a function of GrupE parameter. The time for any individual combination is computed and results are presented in Figure 5a and 5b, as following.

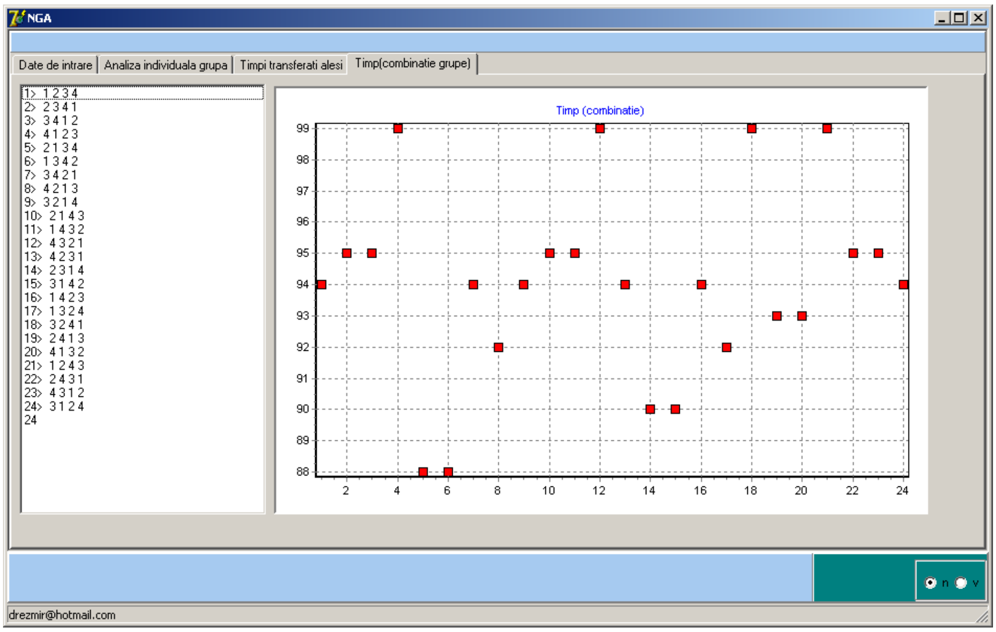

Fig. 5a. Time vs possible variants – with internal delay time and partial left alignment

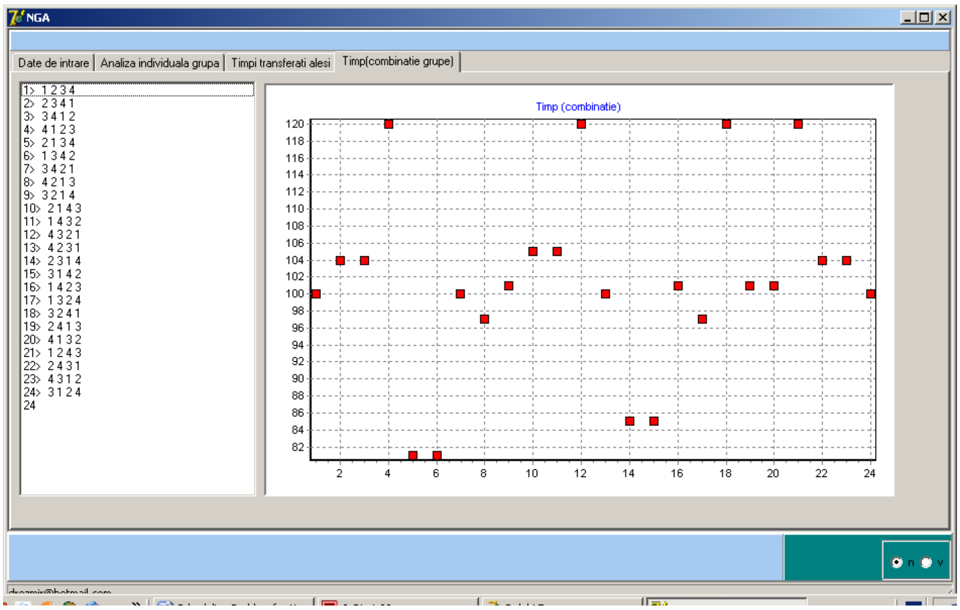

Fig. 5b. Time vs possible variants – without internal delay time and partial left alignment

With these data, the minimum value of time is selected and the Gantt representation is done, as in Figures 6a and 6b. The maximum time combination is also revealed in Figures 7a and 7b.

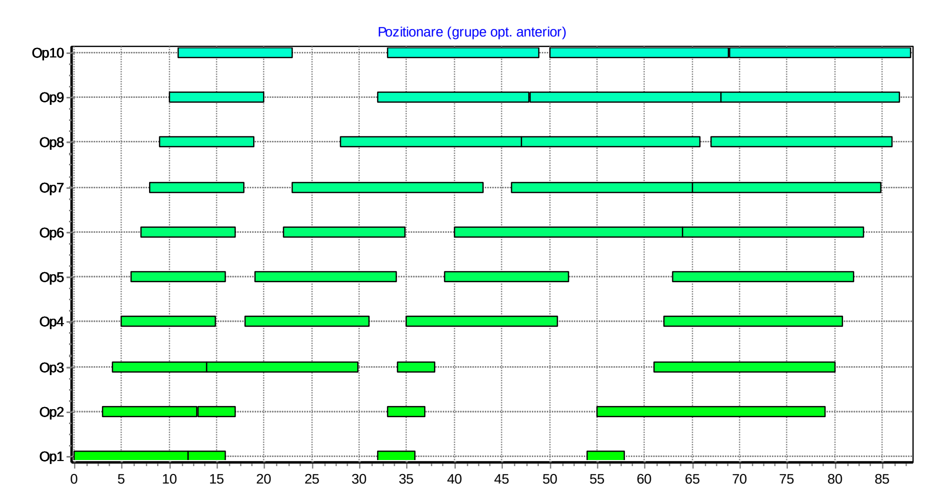

Fig. 6.a. Minimum Scheduling time - with internal delay time

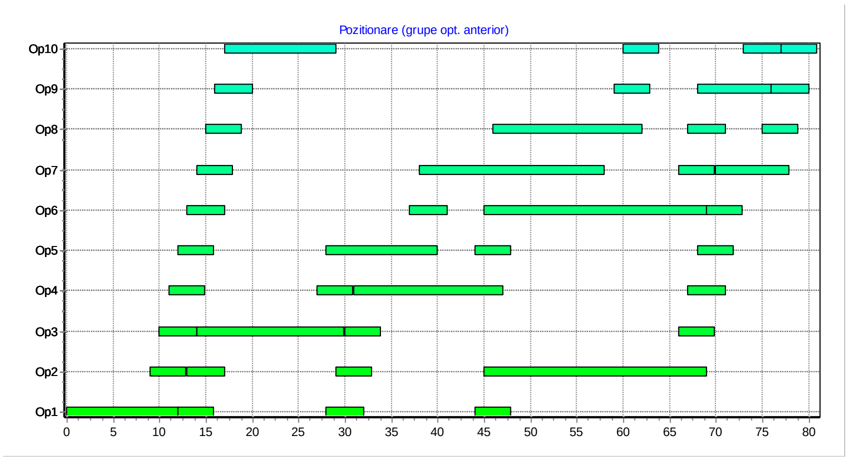

Fig. 6.b. Minimum Scheduling time - without internal delay time

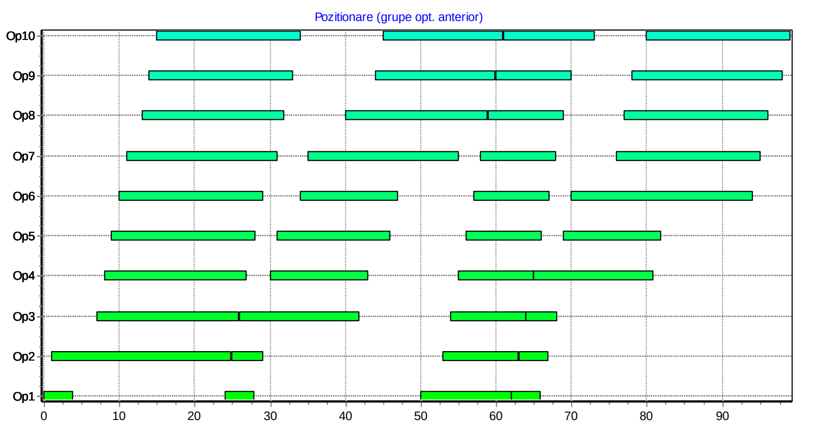

Fig. 7.a. Maximum Scheduling time - with internal delay time

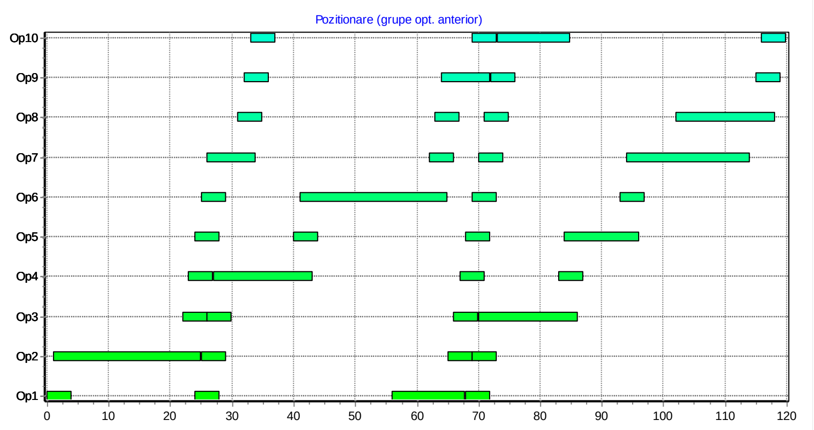

Fig. 7.b. Maximum Scheduling time - without internal delay time

Of course, the process can continue if a simultaneous left-right alignment is performed as is evidenced in Figures 8a and 8b for GrupA=Nr4 and GrupA=Nr3, respectively.

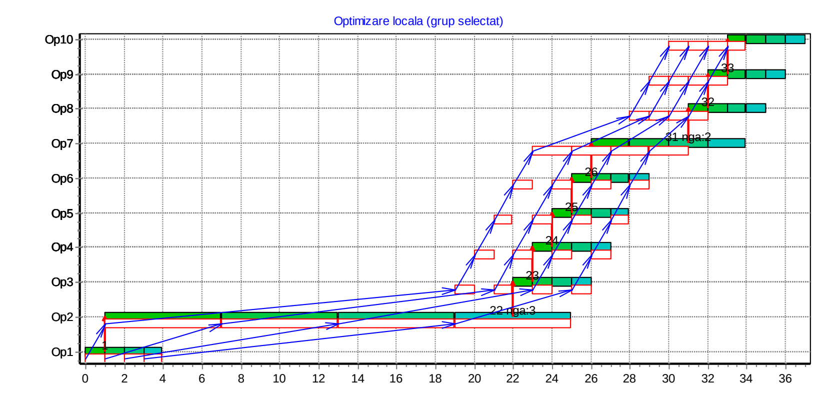

Fig. 8a. Left-Right alignment for Grupa=Nr4

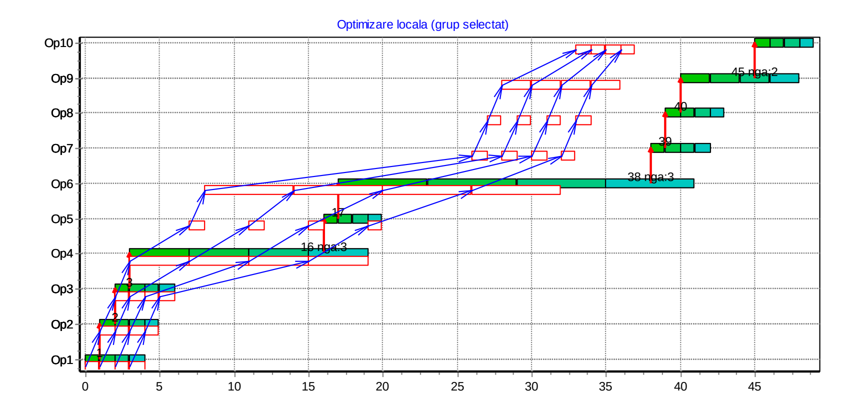

Fig. 8b. Left-Right alignment for Grupa=Nr3

4. CONCLUSIONS

The developed program assures a first approximation prediction time arrangement among different GrupE of the machined components. The program results have to be associated with a real case and a system manager has to decide if it is this individual solution fits to left alignment, left-right time alignment or if its individual process may have internal time delay.

REFERENCES

1. *** Operations Scheduling, (accessed December 2014) http://wps.prenhall.com/wps/media/objects/7117/7288732/krm9e_SuppJ.pdfm
2. Souza A., Advanced Algorithms: Design and Analysis, Lecture Notes, Spring Term 2014, University of Zurich, Chapter 9. Makespan Scheduling (accessed December 2014) http://www2.informatik.hu-berlin.de/alcox/lehre/lvws1011/coalg/makespan_scheduling.pdf
3. Kumar Agarwal, Rajiv Kumar, Neeraj Kumar, Flow Shop Scheduling Problem for 8-Jobs, 3-Machines with Make Span Criterion, Ajay International Journal of Applied Engineering Research, vol. 7, no.11, pp. 1757-1762, 2012, (accessed December 2014) http://www.ripublication.com/Volume/ijaerv7n11_spl..htm
4. Yamada T., Nakano R., Job-shop scheduling, Chapter 7. Job-shop scheduling (pp. 134–160), Genetic algorithms in engineering systems, Edited by A.M.S. Zalzala and P.J. Fleming IEE control engineering series 55, 1997, The Institution of Electrical Engineers.
5. Pinedo M. L., Scheduling, Theory, Algorithms, and Systems, 3rd Ed., Prentice-Hall, NJ, 2002.