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SOFTWARE FOR SIMPLE SCHEDULING RULES APPLICATION ON A FLEXIBLE MANUFACTURING SYSTEM – part II –

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Keywords: simple scheduling rules, the flexible manufacturing system, Gantt chart.

Summary: The aim of this paper is to present the simple scheduling rules application on the flexible manufacturing system presented in paragraph 1. For this purpose a software was created using Borland Pascal which generates the task's succession and the visualization chart. The received data should be processed and sorted using specific criteria.

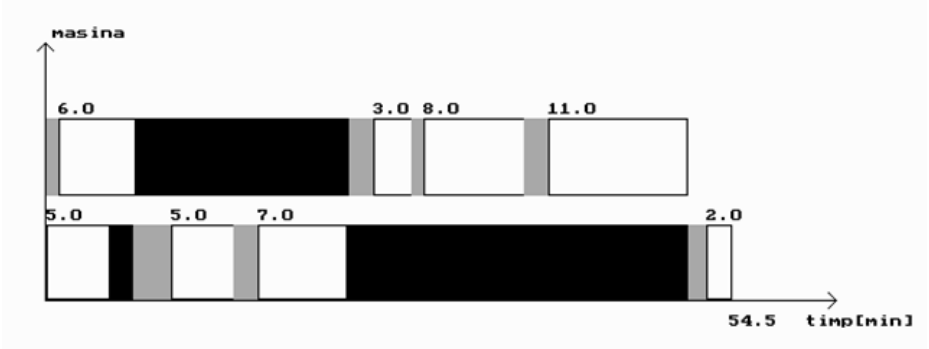
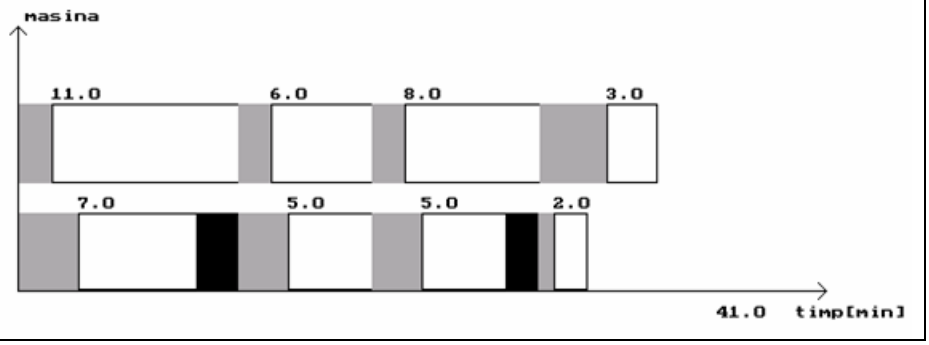
1. THE RESULTS OF SIMPLE SCHEDULING RULES APPLIED ON FMS

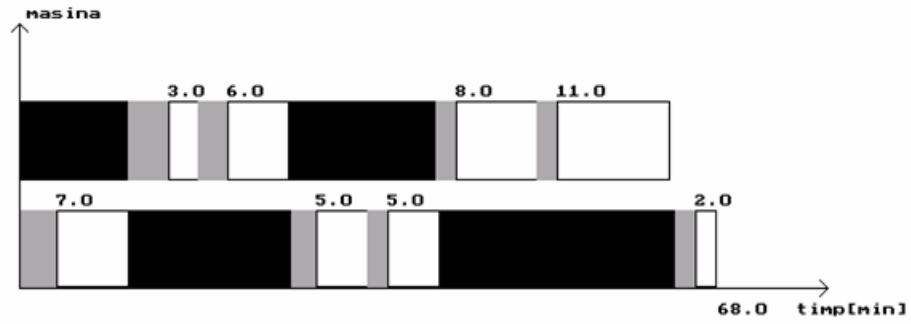
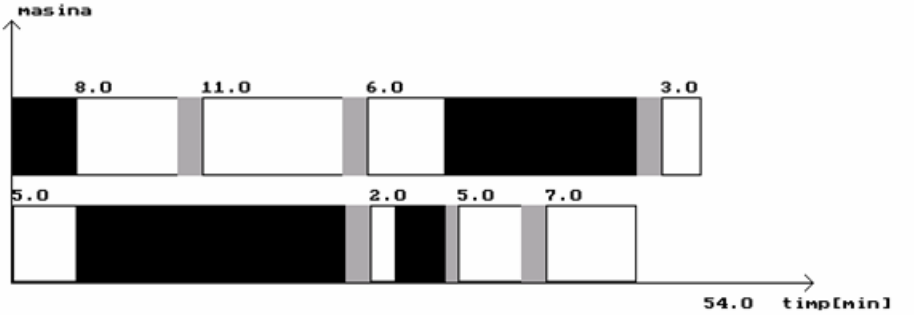
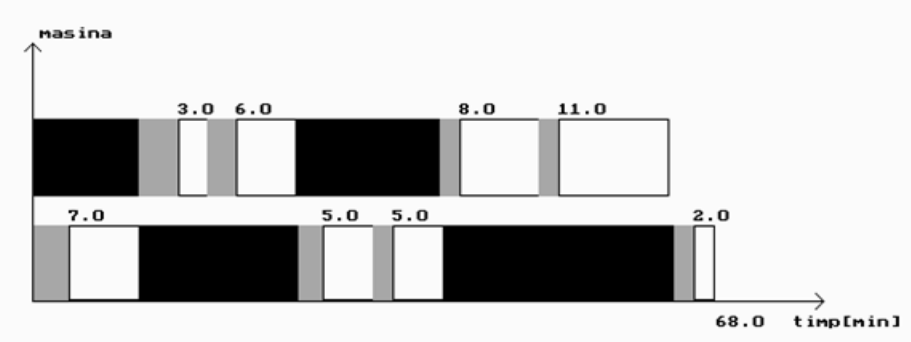
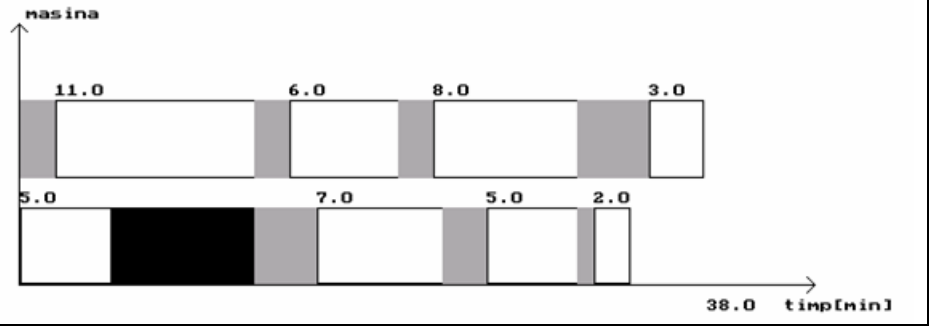
To see how the simple scheduling rules application on the flexible manufacturing system, presented in first part of the paper, a software was created using Borland Pascal which generates the task's succession and the Gantt chart. The received data should be processed and sorted using specific criteria.

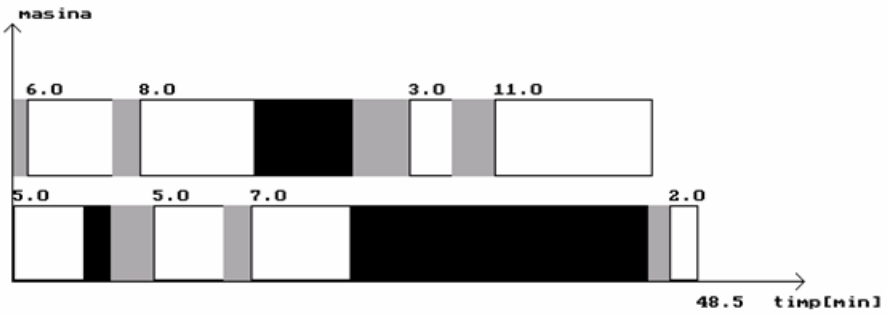
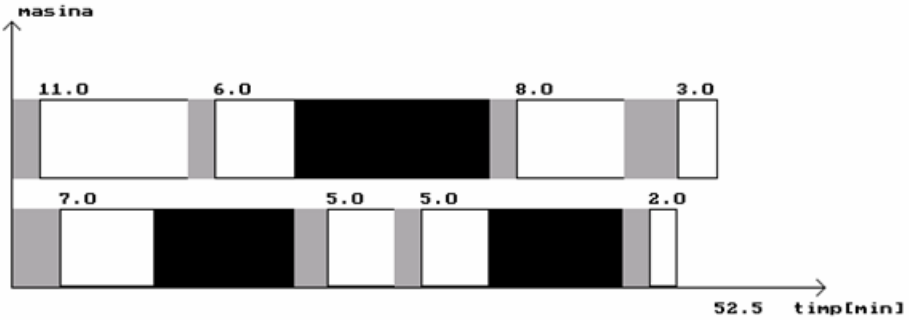
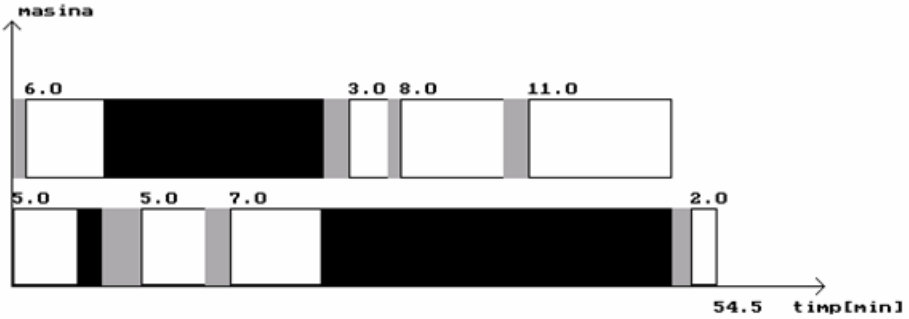
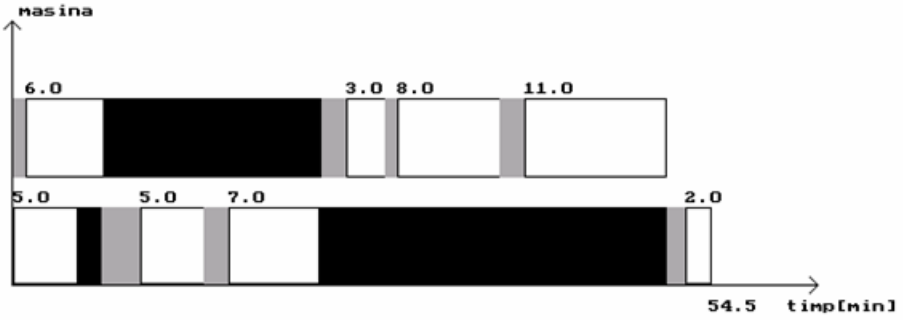
This is the wide scale used representation which illustrates the principles of simple rules use presented in this paper. The chosen simple scheduling rules are applied to the current flexible system.

Using the data inputs presented in previous paper, the FMS Gantt charts when the simple scheduling rules were selected are presented in table 1.

Table 1.

No.	Simple scheduling rule	Gantt chart
1	SIO	
2	LIO	

No.	Simple scheduling rule	Gantt chart
3	SPT	
4	LPT	
5	SRPT	
6	LRPT	

No.	Simple scheduling rule	Gantt chart
7	SDT	
8	LDT	
9	SMT	
10	LMT	

Using the same data inputs presented in previous paper, the achieved results when the simple scheduling rules were selected are presented in table 2.

Table 2

No	Simple sche-duling rules	The task se-quence	Total manu-facturing time	Total task execu-tion time	Total make-ready time	Total delay time	First compo-nent delay time	Second compo-nent delay time	Third compo-nent delay time	Fourth compo-nent delay time	Total delay time
1	SIO	S1-S8-S7-S3-S4-S2-S6-S5	54,5	47	12,5	46	23	17	47,5	3	90,5
2	LIO	S3-S6-S8-S1-S2-S7-S4-S5	41	47	20,5	4,5	19	29	30	5	83
3	SPT	S3-S4-S8-S7-S1-S2-S6-S5	68	47	21	64	36	5,5	56	22	119,5
4	LPT	S1-S2-S6-S5-S8-S7-S3-S4	54	47	11	45	0	42	23	28	93
5	SRPT	S3-S4-S8-S7-S1-S2-S6-S5	68	47	21	64	36	5,5	61	22	124,5
6	LRPT	S1-S6-S8-S3-S2-S7-S4-S5	38	47	17	8	16	26	27	19	88
7	SDT	S1-S8-S7-S2-S3-S4-S6-S5	48	47	16,5	30	2	18,5	41	3	64,5
8	LDT	S3-S6-S8-S7-S1-S2-S4-S5	52,5	47	20	34,5	30,5	36	42,5	16,5	125,5
9	SMT	S1-S8-S7-S3-S4-S2-S6-S5	54,5	47	12,5	46	23	17	47,5	3	90,5
10	LMT	S3-S6-S8-S1-S2-S7-S4-S5	41	47	20,5	4,5	19	29	30	21	99

The program orders the simple scheduling rules after the one of the following rule efficiency:

- the total processing time (table 3);
- the total make-ready time (table 4);
- the total waiting time (table 5);
- the total delaying time of the component 1 (table 6);
- the total delaying time of the component 2 (table7);
- the total delaying time of the component 3 (table8);
- the total delaying time of the component 4 (table9);
- the total delaying time (table10);

Table 3. Rules efficiency regarding the total processing time

Pos	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	LRPT	38	17	8	16	26	27	19	88
2.	LIO	41	20.5	4.5	19	29	30	5	83
3.	LMT	41	20.5	4.5	19	29	30	21	99
4.	SDT	48	16.5	30	2	18.2	41	3	64.5
5.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5
6.	LPT	54	11	45	0	42	23	28	93
7.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
8.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
9.	SPT	68	21	64	36	5.5	56	22	119.5
10.	SRPT	68	21	64	36	3.5	61	22	124.5

Table 4. Rules efficiency regarding the total make-ready time

Pos	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	LPT	54	11	45	0	42	23	28	93
2.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
3.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
4.	SDT	48	16.5	30	2	18.2	41	3	64.5
5.	LRPT	38	17	8	16	26	27	19	88
6.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5
7.	LIO	41	20.5	4.5	19	29	30	5	83
8.	LMT	41	20.5	4.5	19	29	30	21	99
9.	SPT	68	21	64	36	5.5	56	22	119.5
10.	SRPT	68	21	64	36	3.5	61	22	124.5

Table 5. Rules efficiency regarding the total waiting time

Pos	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	LIO	41	20.5	4.5	19	29	30	5	83
2.	LMT	41	20.5	4.5	19	29	30	21	99
3.	LRPT	38	17	8	16	26	27	19	88
4.	SDT	48	16.5	30	2	18.2	41	3	64.5
5.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5
6.	LPT	54	11	45	0	42	23	28	93
7.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
8.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
9.	SPT	68	21	64	36	5.5	56	22	119.5
10.	SRPT	68	21	64	36	3.5	61	22	124.5

Table 6. Rules efficiency regarding the total delaying time of the component 1

Pos.	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	LPT	54	11	45	0	42	23	28	93
2.	SDT	48	16.5	30	2	18.2	41	3	64.5
3.	LRPT	38	17	8	16	26	27	19	88
4.	LIO	41	20.5	4.5	19	29	30	5	83
5.	LMT	41	20.5	4.5	19	29	30	21	99
6.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
7.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
8.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5
9.	SPT	68	21	64	36	5.5	56	22	119.5
10.	SRPT	68	21	64	36	3.5	61	22	124.5

Table 7. Rules efficiency regarding the total delaying time of the component 2

Pos.	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	SRPT	68	21	64	36	3.5	61	22	124.5
2.	SPT	68	21	64	36	5.5	56	22	119.5
3.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
4.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
5.	SDT	48	16.5	30	2	18.2	41	3	64.5
6	LRPT	38	17	8	16	26	27	19	88
7.	LIO	41	20.5	4.5	19	29	30	5	83
8.	LMT	41	20.5	4.5	19	29	30	21	99
9.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5
10.	LPT	54	11	45	0	42	23	28	93

Table 8. Rules efficiency regarding the total delaying time of the component 3

Pos.	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	LPT	54	11	45	0	42	23	28	93
2	LRPT	38	17	8	16	26	27	19	88
3.	LIO	41	20.5	4.5	19	29	30	5	83
4.	LMT	41	20.5	4.5	19	29	30	21	99
5.	SDT	48	16.5	30	2	18.2	41	3	64.5
6.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5
7.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
8.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
9.	SPT	68	21	64	36	5.5	56	22	119.5
10.	SRPT	68	21	64	36	3.5	61	22	124.5

Table 9. Rules efficiency regarding the total delaying time the component 4

Pos.	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
2.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
3.	SDT	48	16.5	30	2	18.2	41	3	64.5
4.	LIO	41	20.5	4.5	19	29	30	5	83
5.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5
6	LRPT	38	17	8	16	26	27	19	88
7.	LMT	41	20.5	4.5	19	29	30	21	99
8.	SRPT	68	21	64	36	3.5	61	22	124.5
9.	SPT	68	21	64	36	5.5	56	22	119.5
10.	LPT	54	11	45	0	42	23	28	93

Table 10. Rules efficiency regarding the total delaying time

Pos	Rule	Total duration			Delay				
		program	Prepare	Wait	component 1	component 2	component 3	component 4	total
1.	SDT	48	16.5	30	2	18.2	41	3	64.5
2.	LIO	41	20.5	4.5	19	29	30	5	83
3	LRPT	38	17	8	16	26	27	19	88
4.	SIO	54.5	12.5	46	23	17	47.5	3	90.5
5.	SMT	54.5	12.5	46	23	17	47.5	3	90.5
6.	LPT	54	11	45	0	42	23	28	93
7.	LMT	41	20.5	4.5	19	29	30	21	99
8.	SPT	68	21	64	36	5.5	56	22	119.5
9.	SRPT	68	21	64	36	3.5	61	22	124.5
10.	LDT	52.5	20	34.5	30.5	36	42.5	16.5	125.5

If we analyze the result presented in tables 3-10, we can conclude the following:

- from the point of view of rules efficiency regarding the total processing time (table 3), the order of the rules are LRPT, LIO, LMT, SDT, LDT, LPT, SIO, SMT, SPT, SRPT;
- from the point of view of rules efficiency regarding the total make-ready time (table 4) the order of the rules are LPT, SIO, SMT, SDT, LRPT, LDT, LIO, LMT, SPT, SRPT;
- from the point of view of rules efficiency regarding the total waiting time (table 5) the order of the rules are LIO, LMT, LRPT, SDT, LDT, LPT, SIO, SMT, SPT, SRPT;
- from the point of view of rules efficiency regarding the total delaying time of the component 1 (table 6) the order of the rules are LPT, SDT, LRPT, LIO, LMT, SIO, SMT, LDT, SPT, SRPT.
- from the point of view of rules efficiency regarding the total delaying time of the component 2 (table7) the order of the rules are SRPT, SPT, SIO, SMT, SDT, LRPT, LIO, LMT, LDT, LPT;
- from the point of view of rules efficiency regarding the total delaying time of the component 3 (table 8) the order of the rules are LPT, LRPT, LIO, LMT, SDT, LDT, SIO, SMT, SPT, SRPT;
- from the point of view of rules efficiency regarding the total delaying time of the component 4 (table9) the order of the rules are SIO, SMT, SDT, LIO, LDT, LRPT, LMT, SRPT, SPT, LPT;
- from the point of view of rules efficiency regarding the total delaying time (table10) the order of the rules are SDT, LRPT, SIO, SMT, LPT, LMT, SPT, SRPT, LDT.

2. CONCLUSIONS

The software developed by authors is a useful instrument in the performance evaluation of the fabrication systems. It offers valuable information in the real systems functioning optimisation process.

Using this software it is possible for a CAPS engineer to select for a similar flexible manufacturing system the appropriate simple scheduling rule for a requirement.

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