

FOR REFERENCE

IMPLEMENTATION OF JOB-SHOP SCHEDULING RULES IN
BE TAKEN FROM THIS ROOM

TEXTILE INDUSTRY

by

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IMPLEMENTATION OF JOB-SHOP SCHEDULING RULES IN
TEXTILE INDUSTRY

ABSTRACT

The work on machine scheduling problem of a large textile mill is reported in this thesis. Scheduling programs are prepared daily and present orders are taken into consideration. We can look at this problem as a static job-shop problem.

Main objectives of this research are to study the minimization of the average tardiness of orders, the variance of tardiness and the work-in-process inventory of the factory. For this purpose, Shortest-Processing-Time Rule with Truncation Process has been chosen as the best rule in meeting the main objectives, in the light of previous researches.

Series of interactive programs have been written in order to update the necessary changes in the status of orders and machines, easily. After a short education, users will be able to use this program, efficiently.

TEZGAH YÜKLEME KURALLARININ TEKSTİL ENDÜSTRİSİNE UYARLANMASI

ÖZET

Bu tezde büyük bir tekstil fabrikasının tezgah yükleme problemi üzerinde çalışılmıştır. Yükleme programları günlük olarak ve o andaki siparişler düşünülerek yapılmaktadır. Bu özelliği ile probleme statik tezgah yükleme problemi olarak bakabiliriz.

Yapılan çalışma, işletme içindeki yarı-mamul stok miktarını, siparişlerdeki ortalama gecikmeyi ve gecikmenin variansını enküçüklemeyi hedef almıştır. Bu amaçla daha önce yapılan araştırmalar da gözönünde tutularak, En Kısa İşlem Zamanı ve İşlem Başına Serbest Zaman kurallarının kombinasyonu (SPT/T), hedefleri en iyi sağlayan kural olarak seçilmiştir.

Siparişlerin ve makinelerin durumlarındaki değişikliklerin en kolay biçimde bilgisayara girilebilmesi için etkileşimli programlar dizisi yazılmıştır. Planlama personeli kısa bir eğitim sonucu programı kullanabilmektedir.

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I. INTRODUCTION

Scheduling problems occur, whenever there is a choice as to the order in which a number of tasks can be performed. The accepted definition of scheduling problem is given by Conway, Maxwell and Miller (1), as the simultaneous and synchronized sequencing of jobs on several machines.

Scheduling problems can be divided into two main groups:

- i. Flow-shop scheduling
- ii. Job-shop scheduling.

In the flow-shop case, there is a natural ordering of machines in a shop. There are two or more machines, and at least some of the jobs have a sequence of such cases the collection of machines is said to constitute a flow-shop if the machines are numbered in such a way that, for every job to be considered, operation K is performed on a higher-numbered machine than operation J, if $J > K$. Workflow in a flow-shop is unidirectional. The classical job-shop scheduling problem differs from the flow-shop problem in one important respect, the flow of work is not unidirectional. The elements of a problem are a set of machines and a collection of jobs to be scheduled. There is no initial machine that performs the first operation, nor a terminal

machine that performs the last operation of a job, contrary to flow-shop problem.

In the following chapters, we will only deal with job-shop scheduling problem.

The jobs entering a work-shop must leave the shop as soon as possible and they are subject to due-date constraints. Dispatching procedures can be easily adopted to real life problems by considering, the aims of the firm. One main objective is to decrease the average tardiness and average flow-time of jobs.

The following chapters contain, the theory and literature survey of dispatching procedures and possible solution techniques of job-shop scheduling problems, a consideration of a real life problem and the result of the applied algorithm to that problem.

II. JOB-SHOP SCHEDULING PROBLEM

The basic unit of the job-shop process is the operation. It has three primary attributes that are given below.

- i. A symbol identifying the operation of a particular job.
- ii. A symbol identifying the operation with a particular machine.
- iii. A real number representing the processing time of the operation.

Each job consists of several operations with a specific precedence structure. A job may require processing by the same machine more than once in its operation sequencing. Because the workflow in a job-shop is not unidirectional, each machine in the shop can be characterized by the input and output flows of work shown in Figure 2.1.

Scheduling a job-shop process is the task of assigning each operation to a specific position on the time scale of the specified machine.

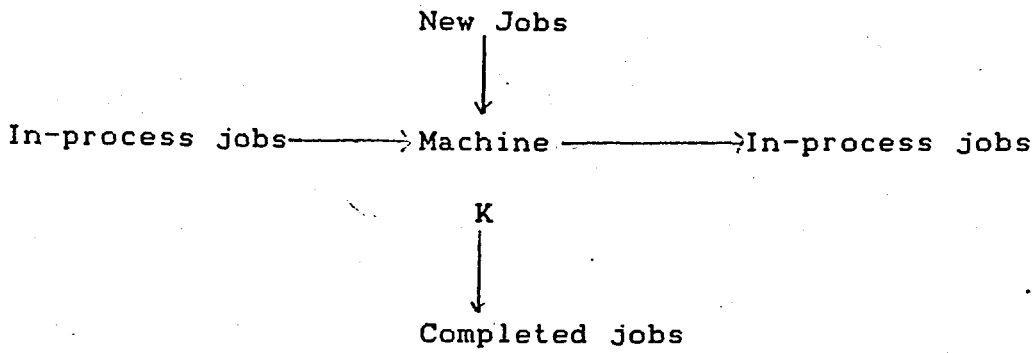


Figure 2.1 Job-Shop Process

2.1. Definition Of Shop

The job-shop process definition starts with the shop. It is described by giving the number of machines. The general function of shop could be best defined by the phrase of "m-machine shop". Existence of parallel machines and the possibility of performing an operation on the alternative one, construct the characteristics of shop.

2.2. Definition Of Job

Each job consists of g_i type of operations, and each operation is performed on a specific machine in a specific processing time. Let i show the job number and j be the operation number, then m_{ij} shows the machine number and p_{ij} shows the processing time of the j^{th} operation of the

i^{th} job. The number of data for a specific job must be $2 * g_i$.

Some of the operations can be performed on an alternate machine with a different processing time according to the characteristics of the job-shop.

2.3. The Formal Definition Of The Job-Shop Scheduling Problem

A scheduling problem has several concepts that determine the characteristics of the system. The most important variables of a job are as follows:

d_i is the due-date of the i^{th} job,

r_i is the arrival date of the i^{th} job,

$a_i = d_i - r_i$, is the total allowance for the i^{th} job,

W_{ij} is the waiting time of the j^{th} operation of the i^{th} job,

S_{ij} is the set-up time for the j^{th} operation of the i^{th} job,

C_i is the completion time of the i^{th} job.

$$C_i = r_i + \sum_j p_{ij} + \sum_j W_{ij} + \sum_j S_{ij}$$

Solution will determine an answer to our question which is "when and on what machine each operation of each job should be performed".

The result of the scheduling process introduces many other variables for compactness of notation. Some of them are as follows.

$F_i = C_i - r_i$, is the flow time of job i ,

$L_i = C_i - d_i$, is the lateness of job i ,

$T_i = \max(0, L_i)$, is the tardiness of job i .

In most of the cases, we use the above as measures of performance.

2.4. Dispatching or Scheduling Rules

The rule that specifies when and which job must be assigned to a specific machine is called a dispatching or a scheduling rule. The rule that will be used in scheduling, is selected according to the desired criteria of measure of performance. There are different kinds of scheduling rules that are used for different purposes. Only two of them will be explained here, because the experiments show that, in most of the cases they have the same properties. The selected two rules are most suitable rules for the desired criteria of performance in this case.

2.4.1 S/OPN Type Scheduling Rule

This is the least-slack-time-per-operation remaining rule. This rule gives the highest priority to the waiting operation corresponding to the job with the minimum ratio of slack time to remaining operations. The slack time of a job is the difference between the due-date and the total processing time of that job, at time t .

Example : Suppose that there are two jobs, X and Y, that are waiting for a specific machine. They have two and three operations respectively. The operation times are as follows.

$$P_{x1} = 10$$

$$P_{x2} = 20$$

$$P_{y1} = 10$$

$$P_{y2} = 15$$

$$P_{y3} = 11$$

If total processing times of X and Y are 30 and 36 and the due-dates are 40 and 48, respectively. Therefore the slack times per remaining operations are as follows.

$$S/OPN \text{ of X} = \frac{40 - 30}{2} = 5 \text{ unit,}$$

$$S/OPN \text{ of } Y = \frac{48 - 36}{3} = 4 \text{ unit.}$$

At that time, job Y has the minimum slack-time to operation remaining operation ratio and it should be processed first.

This rule shows a high performance with respect to meeting the due-dates, but, on the other hand, in minimizing the flow times of jobs, it does not give a better result like SPT and SPT/T rules.

2.4.2. Shortest Processing Time Rule With Truncation

Process (SPT/T)

This rule is a combination of the shortest processing time and slack time per operation remaining rules. As it is mentioned above, S/OPN rule prevents tardiness of jobs, but, average flow time gets longer when it is compared to SPT. SPT is one of the best for minimization of:

- i. Number of jobs in the shop,
- ii. Average tardiness of jobs,
- iii. Mean completion time of jobs,
- iv. Mean waiting time of jobs in the shop,
- v. Number of tardy job.

The main disadvantage of this rule is that, it generally produces a great tardiness in a job with a very long processing time, since it always gives high priority to the job with the shorter processing time. This is due to the fact that this rule never takes the due dates of jobs into consideration.

Combination of these two rule gives a better result by decreasing the deviations from the mean. SPT/T rule is defined as follows,

$$\text{Min}_i^{(k)} \min (E_i + r, Q_i) \text{ for } i \in I$$

E_i : the processing time of the next immediate operation of job i .

Q_i : the slack-time per operation remaining for job i .

r : a parameter, from minus infinity to infinity.

I : the set of jobs waiting at a machine center.

According to SPT/T rule, for jobs waiting at a machine center, k^{th} priority is given to the job with the k^{th} minimum of $\min (E_i + r, Q_i)$, where $k=1,2,\dots,n$ and n is the number of jobs in I .

That priority rule produce the best results for
job-shop scheduling with respect to:

- i. percentage of tardy jobs,
- ii. average tardiness,
- iii. variance of tardiness,
- iv. maximum tardiness.

It possibly improves

- i. to decrease the level of work-in-process inventory
- ii. to better utilize the machining and equipment,
- iii. to avoid slow moving items,
- iv. to better plan the production capacity,

2.5. Scheduling Techniques

This section is concerned with approximate solutions to the job-shop problem. Several algorithms have been developed by considering the characteristics of job-shop. Generally, they are effective for the small number of machines and jobs. If the size of the system increases, the effectiveness of the solution will decrease. For large size problems, the whole solution will take a long computer time but we need, generally, daily solutions. If we use those analytic techniques, we have to obtain the whole solution of the system. For those solutions, too much computer time is needed, and a very small change in the status of the machines or orders, causes the solution to go away from the optimal. We need daily solutions and, if we take the whole solution for each change in the system, it will not be effective. It is not practical for our case. We need a flexible and practical solution method, in order to make it possible for application. Commonly used scheduling techniques are stated below.

2.5.1. Integer Programming Formulation

The general job-shop problem can be modeled as an integer programming problem. There are a few type of formulation. The description here will follow Manne's model

(2). For simplicity of notation we assume that each job requires processing by each machine once and only once.

p_{ik} = the processing time of job i on machine k ,

r_{ijk} = 1 if the j^{th} operation of job i requires machine k ,

= 0 otherwise,

T_{ik} = the starting time of job i on machine k .

From the requirement that only one job may be in process on a machine at any instant of time, we have for two jobs, I and J , either

$$T_{ik} - T_{jk} \geq p_{jk} \quad \text{or} \quad T_{jk} - T_{ik} \geq p_{jk}$$

Simply stated, either job J precedes job I or else job I precedes job J .

Let Y_{ijk} = 1 if job I precedes job J on machine K ;

Y_{ijk} = 0 otherwise.

$$(M + p_{jk})Y_{ijk} + (T_{ik} - T_{jk}) \geq p_{jk}$$

$$(M + p_{ik})(1 - Y_{ijk}) + (T_{jk} - T_{ik}) \geq p_{ik}$$

The M is constant and is chosen sufficiently large so that only one of the above constraints are handled by noting

that $\sum_K r_{i,j+1,k} T_{ik}$ is the starting time of the j^{th}

operation of job i . For all but the last operation of a job, one must have,

$$\sum_k r_{ijk} (T_{ik} + p_{ik}) \leq \sum_k r_{i,j+1,k} T_{ik}$$

The complete formulation in order to minimize the meanflow time is:

$$\text{Min } \sum_i \sum_k r_{imk} T_{ik}$$

$$\sum_k r_{ijk} (T_{ik} + p_{ik}) \leq \sum_k r_{i,j+1,k} T_{ik}$$

$$(M + p_{jk}) Y_{ijk} + (T_{ik} - T_{jk}) \geq p_{jk}$$

$$(M + p_{ik})(1 - Y_{ijk}) + (T_{jk} - T_{ik}) \geq p_{ik}$$

with variables $T_{ik} > 0$, $Y_{ijk} = 0$ or 1

Apparently the size of the resultant integer programming problem, the time consuming and often erratic behaviour of existing integer programming computer codes, and the limited availability of such codes have discouraged other investigators from employing this approach. As an example, if there are four machines and ten jobs, there will be 220 variables and 390 constraints, in the formulation

2.5.2. Branch And Bound Approach

Branch and Bound technique is a solution method for the job-shop scheduling problem. An approach has been given by Brooks and White (3).

In this approach, each node represents an active schedule for a particular subset of the operations, and a point in time at which there is more than one operation which could be scheduled next on the particular machine chosen. Selection of a particular branch is based on determining the minimum value of a lower bound on the maximum flow time for each possible branch. The power of the procedure depends heavily on the quality of the lower bounds.

1. Construct any complete schedule starting from the partial schedule in-hand using one of the simple dispatching procedures discussed in the previous sections. Take as a bound the maximum flow time for this complete schedule.
2. For each job, find the earliest time at which it could possibly start on its next unscheduled operation. Add to this sum of the processing-times of all the unscheduled operations of the job. Take as a lower bound, the maximum of these quantities. This bound is good if there are several jobs whose remaining processing time requirements are large

relative to the others.

3. For each machine find the minimum time at which an unscheduled operations which require this machine. Take as a lower bound the maximum of these quantities. This bound is reasonably good if there are a few machines whose workload is considerably higher than others.

Brooks and White (3) conclude that the procedure is computationally prohibitive for problems of practical dimension, but it could be nevertheless be an attractive alternative to integer programming for solution of small problems.

III. STATEMENT OF THE PROBLEM

3.1. Description Of The System

The factory is a textile factory that produces different kinds of fabric. The factory is composed of two parts. In the first part, there are textile machinery producing cloth from cotton. In the second part, the cloth goes through several chemical processes. The number of chemical processes varies from five to 15, following a specific order according to its type.

We will deal with the second part of the factory. The fabric comes to the second part from the first part and enters the queue of the appropriate machine.

There are almost 40 machines and 40 different types of fabric available in the system. Average number of existing orders in the system changes between 40 and 50, and if it is taken into consideration that each has to go through approximately 10 different processes complexity in scheduling of machines appears to be a major problem.

Another complexity is the dynamics of the system. Since the efficiency of each machine depends on the previous

one, a breakdown or a problem in one of them will effect the others as well.

Generally there is no set-up time in loading operations. They attach the new fabric, to the end of the fabric whose process has just finished. That operation lasts a few minutes. Some of them need set-up time that does not take, too long. In general, the set-up times are a small percentage of the processing times.

Transfer of fabric between machines takes a few minutes. In other words, instantaneous transfer can be assumed for the items.

Some of the operations of jobs can be performed in an alternate machine if the original machine is down. The alternate machine, generally does not perform as well as the original machine. They are used for important jobs, such as exported fabric. Finishing the exported fabric by their due-dates is very important, for otherwise, indemnities are paid to the customer.

3.2. Criteria For Scheduling Of A Job-order

Job orders are scheduled according to the following rules.

- i. Once an operation is started on a machine it must be finished.
- ii. If the machine is not down, the job order that is waiting for that machine cannot be performed on the alternate machine, unless the job order is critical.

Schedule is prepared each morning and it is not changed unless a specific condition occurs (e.g. machine fails, defects in fabric etc.).

3.2.1. Case Of Machines Under Repair

The schedule is prepared assuming the available machines will work properly. When a machine breaks down, important job orders are performed on the alternate one, if it exists. Although more than one machine can be used for the same purpose, their performance may differ. Each can complete the same job at different time periods. That's why job orders are performed on the alternative machine if it is a very important order for the factory (i.e. exports). In

preparing a new schedule, the repair time of the machine that is down must be taken into consideration.

3.2.2. Case Of Changing A Job-order

During the process of an order one of the machines may break-down. In that case, the specific process of the order is partly completed. If the order is important for the factory, the next operation of the completed part can be performed in alternative machines. In other words, the job order is divided into two parts. They move differently in the factory.

Any unordered job may be still in the production process but whenever a non-expected order comes up on that job its production will be accelerated. The opposite of that case is also possible. Whenever an order is cancelled its production will also slow-down. Those kind of events also changes schedule of the machines.

3.3. Desired Criterion of Performance

The jobs entering the work-shop under consideration are subject to due-date constraints. Currently, due to lack of scheduling policy, most of the jobs are completed after their due dates. This causes friction between the factory and

work-shop leading to managerial problems. In order to alleviate these problems, the management wants to establish a scheduling policy that will minimize the tardiness of jobs.

The tardiness is important in export. If there is a tardiness, they have to pay indemnities to the customers. This causes important problems between their planning and management departments of the factory. The performance of the factory is measured with the amount of finish product during the day. That means, a job-order that comes into factory, must leave as soon as possible. They want to avoid slow-moving items. It is important to minimize the work-in-process inventory since it affects the amount of finished product during the day.

IV. APPLIED SOLUTION TO THE PROBLEM

The main menu is composed of two parts. Database editing and the main program. The first part is prepared for the editing of the changes in the system. The data file structures are as follows.

4.1. Data-Base Construction

There are mainly 4 files that contain the information about the state of the factory.

i. Machine master file: It contains the name of all machines that are available in the factory and their status. A machine may be either free or down for an unknown time period or down for a specific length of time. Fields are as follows:

Machine code

Time at which the machine becomes free

ii. Job master file: It contains master information about the jobs. The fields are as follows.

Job code

Job name

Specification

For each operation of that job:

Operation number

Operation name

Machine code of the operation on which the
operation will be performed

Standart processing time of the operation

iii. Job-order master file: The information about the
job-orders that enters the factory is written on that file.

The fields are as follows:

Production order number(that is given by the
planning department),

Job code

Order number(that is given by the marketting
department

Pattern number

Due-date of the order

Starting time of the job-order

Ordered quantity

Number of completed operations

Total number of operations

For each operation

Operation number that is selected for that
job-order

Each job-order record contains the job code field.

Generally job-orders are usually passed through all the processes that belong to that job, but some customers may want an extra process or to cancel some of them. In that case, the job master file may not contain the true information for that job-order. In order to avoid such problems, all possible processes have been written on the job master file, and then, the job-order file will contain only the process numbers that are selected by the customer. This gives a flexibility in job-orders.

iv. Machine file: That file contains the information about the job-orders that are waiting for the machines. The fields are as follows.

Machine code

Production order no

Process number of the job-order

Alternative machine code

Standard processing time for the alternate
machine.

The scheduling program will be used by the planning department of the factory. According to the changes in position of job-orders, machines, job-types the information will be edited by them. The usage of the edit part of the program is very easy. The detailed information is given below.

4.2.1. Editing The Jobs

The menu of it, contains five choices, as seen in Figure 4.1. The first choice is about entering new job to the system. It is used only when a new type of job comes into the production process for the first time. If you use a job code that exist in the system, it will give the message "Duplicate job code", to you or if you enter a wrong machine code, it will not accept the data that you have entered. The screen that you will see is in Figure 4.2. The second choice is the update choice. Using that option, you can update the information about any jobtype. You can update the information by moving up or down, on the same screen, you can go to the next page or return to the previous page etc. If you press the ENTER key, the information on the screen will be permanent. The screen is on Figure 4.3.

JOB INFORMATION

CF1..MENU

G:NEW JOB D:UPDATE I:DELETE L:LIST K:ALL JOBS

Menu of Job-Type Option.

NEW JOB

100.1

CF2..CANCEL REQUEST
ENTER..NEXT PAGE
CF6..NEW JOB ADDED

ATION

P R O C E S S

| NO | NAME | MACHINE-NO | ST.PROC.TIME |
|----|------|------------|--------------|
| 01 | | | 000 |
| 02 | | | 000 |
| 03 | | | 000 |
| 04 | | | 000 |
| 05 | | | 000 |
| 06 | | | 000 |
| 07 | | | 000 |
| 08 | | | 000 |
| 09 | | | 000 |
| 10 | | | 000 |

New Information Screen.

J O B U P D A T E

ODE 165.4

CF2..CANCEL REQUEST
 ENTER..NEXT PAGE
 CF6..UPDATE JOB

AME COTTON CLOTH
 FICATION WHITE

P R O C E S S

| NO | NAME | MACHINE-NO | ST.PROC.TIM |
|----|------------|------------|-------------|
| 01 | CHEM.HARD. | STORK | 165 |
| 02 | EMULATION | G30-SIL | 150 |
| 03 | HAIRING | F.MULLER | 36 |
| 04 | ROLLING | S.BRUSH | 70 |
| 05 | EGALIZING | RAMOZ-2 | 100 |
| 06 | ENRICHMENT | SETTI | 12 |
| 07 | | | |
| 08 | | | |
| 09 | | | |
| 10 | | | |

4.3. Update Screen of Jobs.

L I S T O F J O B S

| JOB-CODE | CLOTH-NAME | SPECIFICATION |
|----------|--------------|---------------|
| 125.3 | COLLAR 2/50 | WHITE |
| 161.2 | SHEET 140 | REAC.PRINT |
| 165.4 | COTTON CLOTH | WHITE |
| .181.2 | FLANEL 158 | PIGMENT |
| 1125.2 | ORD.COT. 140 | PIGMENT |
| 1138.0 | ORD.COT. 172 | REAC.PRINT |

ENTER..NEXT PAGE
 CF2..CANCEL REQUEST

4.4. List of Jobs.

The third choice is to delete the job information from the system. If they decide not to produce a job type, anymore, then that job-type is deleted and any job-orders cannot be taken of that job type. The screen is almost the same as the update or new information screen.

The fourth choice is used to get existing information about job codes only. Any addition of new, update or delete is not accepted in this screen.

The fifth choice helps the user, in finding the job code that he or she looks for. It gives a list of jobs that exist in the system with some extra information. The screen is in Figure 4.4.

4.2.2. Editing Job-orders

The menu contains four choices. In editing job-orders, there are there are mainly two screens. The first one is master information screen, the other is operation information screen. As a first hand master information comes to screen according to the job code that is used in the first field, related fields such as operation names, name of the machines, comes into screen.

In the first and second choice (new information or update information), there is a field at the beginning of

each operation information. If you enter 1 for that field, it shows that, the operation will be performed for this job-order.

The screens for new information and update information are in Figures 4.5 and 4.6. If you enter a job code that does not exist in the system, it will not be accepted.

The third one is the delete option. It is used in order to discard a job-order from the system.

Job-order editing option is used when a new job-order comes or in case of missused information. Any update in one of these three editing options will cause to edit the information in machine file. The related fields in machine file will be automaticly updated as a result of any change in one of these three editing options.

The fourth choice gives the list of job-orders that exist in the system. The screen is in Figure 4.7.

4.2.3. Editing Machine Master

The existing machines are written to the machine master file. By choosing the last option you can see the list

LE UPDATE

ENTER..UPDATE ORDER
CF2..CANCEL REQUEST

| | | | |
|--------------|-----------|---------------|----------|
| ORDER NO | 158.0 | | |
| DE | 1125.2 | | |
| NO | 160 | | |
| ATION | AVUSTURYA | | |
| N NO | 4320 | | |
| ICATION | WHITE | | |
| TE | DD/MM/YY | | DD/MM/YY |
| | 08/09/86 | STARTING-TIME | 05/07/86 |
| QUANTITY | 12000 | | |
| OF COMP.OPR. | | | |
| MBER OF OPR. | 10 | | |

.5. Update of Orders (Master Information).

| | | | | | |
|----------|---|-------------|----------|---|---------------------|
| ORDER NO | : | 158.0 | ORDER NO | : | 160 |
| | : | 1125.2 | | : | |
| | : | ORD.COT 140 | | : | CF2..CANCEL REQUEST |
| ATION | : | PIGMENT | | : | ENTER..END-OF-UPD |

PUT 1 IN FRONT OF THE SELECTED OPERATIONS

| PROCESS-NO | PROCESS-NAME | MACHINE-NAME | STD.PROCESS-TIME |
|------------|-------------------|--------------|------------------|
| 01 | BURNING | PAREX | 100 |
| 02 | CHEM.HARDEN. | STORK | 85 |
| 03 | DRYING | CYLINDER 30 | 100 |
| 04 | BRUSHING | B.BRUSH | 90 |
| 05 | EGALIZING | E.RAMOZ | 100 |
| 06 | PAINTING | RAMOZ-2 | 100 |
| 07 | PRINTING | FD/ROT | 90 |
| 08 | CONDENSING | ARTHOS HF2 | 50 |
| 09 | APRE | RAMOZ-2 | 60 |
| 10 | CHEM.PAINT TREAT. | BRIEM | 48 |

.6. Update of Orders (Operational Information).

L I S T O F O R D E R S

ENTER..NEXT PAGE
CF2.. MENU

| SECTION: | | | | | ORDER |
|----------|-------------|----------|--------|----------|----------|
| ORDER NO | EXPLANATION | JOB-CODE | SPECS. | DUE-DATE | QUANTITY |
| 5.0 | AD.K | 1138.0 | | 27 8 86 | 7500 |
| 1.0 | HECK | 181.2 | | 20 8 86 | 27400 |
| 0.0 | AD.K | 161.2 | | 22 8 86 | 29000 |
| 2.0 | ADIK | 161.2 | | 23 8 86 | 14800 |
| 5.0 | DIERIG | 181.2 | | 23 8 86 | 6000 |
| 3.0 | AUSTRIA | 1125.2 | | 8 9 86 | 12000 |
| 5.0 | AD.KAP | 1125.2 | | 27 8 86 | 5300 |
| 5.0 | HECKIN | 1125.2 | | 27 8 86 | 15000 |
| 0.0 | IBENA | 181.2 | | 29 8 86 | 10000 |

4.7. List of Orders.

of machines in the factory. There is a second field that is the time of machine becomes free. If it is zero that means, the machine is free. If it has the highest value (99999999); that shows the machine is under repair. If it has a value between them, that value is the repair time in minute, after the simulation is started. As an example; its value is 600, the machine will be ready ten hours later. At that time, the program can make a schedule for that machine.

Four options are available for machine editing, too. Entering a new machine, update, delete the machine and list of machines.

In the case of break-down of a machine, the update option will be selected and the field will be changed (for unknown time: 99999999, known time: repair time in minute as shown in Figure 4.8. The screen for the fourth choice is in Figure 4.9.

4.2.4. Editing The Last Positions Of Job-orders And Machines

When you enter the information about job-orders, each selected operation is placed into related machine record in the machine file. The file is sorted according to the machine code.

FILE UPDATE

ENTER...UPDATE
CF2..CANCEL REQ.

CODE : BRIEM

PERIOD :

SKIP THE SECOND FIELD FOR IDLE MACHINE
PUT 99999999 FOR DOWN MACHINE

4.8. Update of Machine File.

L I S T O F M A C H I N E S

ENTER...NEXT PAGE
CF2..MENU

| CODE | IDLE-TIME |
|------|-----------|
| HF1 | |
| HF2 | |
| R | 125 |
| | 99999999 |

IC

4.9. List of Machines.

In that option of the main menu, three choices are available. The first one gives the information about orders in front of a specific machine. That option is for the user to see the amount of work in front of the specific machine.

The second choice, includes all machines. All available operations that wait for machines are listed on the screen. The list is sorted in descending order according to the machine code. The screen of second choice is in Figure 4.10.

The last choice is used to give the last status of the factory to the computer. The changes in the system will be given to the computer by using this option.

The program that prepares the schedule of the machines, is used after that option is executed, in order to obtain the right schedule. In the factory, schedule is prepared in mornings. By entering the positions of machines and orders, using that option, the data in the files are changed with the actual data.

It is used for three purposes:

- i. The alternate machine for any operation is given.

There is a field at the beginning of each record, field X.

Put 2 into that field then write the code of alternate

M A C H I N E I N F O R M A T I O N

ENTER..NEXT PAGE

CF2..CANCEL REQ.

| PROD. | ORDER NO | EXPLANATION | ORDER QUANTITY | P R O C E S S NAME | NO | ALTERNATE MACHINE | STD.F TIM |
|-------|----------|-------------|----------------|--------------------|----|-------------------|-----------|
| HF2 | 142.0 | ADIK | 14800 | CONDENSE | 8 | | 000 |
| HF2 | 140.0 | AD.K | 29000 | CONDENSE | 8 | | 000 |
| HF2 | 165.0 | AD.KAP | 5300 | CONDENSE | 8 | | 000 |
| HF2 | 166.0 | HECKIN | 15000 | CONDENSE | 8 | | 000 |
| HF2 | 158.0 | AUSTRIA | 12000 | CONDENSE | 8 | | 000 |
| | 142.0 | ADIK | 14800 | CH.PT.TRT. | 10 | | 000 |
| | 140.0 | AD.K | 29000 | CH.PT.TRT. | 10 | | 000 |
| | 165.0 | AD.KAP | 5300 | CH.PT.TRT. | 10 | | 000 |
| | 166.0 | HECKIN | 15000 | CH.PT.TRT. | 10 | | 000 |
| | 158.0 | AUSTRIA | 12000 | CH.PT.TRT. | 10 | | 000 |
| | 146.0 | DIERIG | 6000 | EGALIZING | 6 | | 000 |
| | 170.0 | IBENA | 10000 | EGALIZING | 6 | | 000 |
| | 131.0 | HECK | 27400 | EGALIZING | 6 | | 000 |
| | 165.0 | AD.KAP | 5300 | EGALIZING | 5 | | 000 |
| | 166.0 | HECKIN | 15000 | EGALIZING | 5 | | 000 |

4.10. List of Jobs That Are Waiting for Machines.

machine and the standard processing time for that operation. So the operation will be performed on the alternate one.

ii. If any machine breaks down while an order was completed partly in that machine the next operation cannot start. But using this option you can apart the finished part from the remaining one, so the finished part may go on although the remaining part waits for the previous machine. Put 2 into field X, write the completed amount to the field then you will see that the order is divided into two part by starting from the next operation. The order number of the second part is increased by 0.1 unit. That case is shown in Figures 4.11 and 4.12.

iii. The finished operations are given to the computer by using that option. If you put 1 into the field X and leave the field amount completed as it is; it means that operation is finished. If you write anything to that field, that value is taken as the completed amount and files are updated using the remaining value as the new amount.

4.3. Scheduling

The solution for the problem is a heuristic approach using the dispatching rules that are stated in Section II.

M A C H I N E I N F O R M A T I O N

ENTER..NEXT PAGE
CF2..END-OF-UPDATEFOR PARTLY OR FULLY COMPLETED OPERATIONS
FOR ALTERNATE MACHINE OR PARTITION OF ORDER

| PROD. | ORDER-NO | EXPLANATION | COMP.ORD. | Q U A N T I T Y | P R O C E S S | ALTERNATE | STD.P |
|-------|----------|-------------|-----------|-----------------|---------------|---------------|---------|
| | | | | | N A M E | N O | T I M E |
| | | | | | | M A C H I N E | |
| | 131.0 | HECK | | 27400 | HAIRING | 4 | |
| | 131.0 | HECK | | 10000 | CHEM.HARD. | 1 | |
| | 16.0 | AD.K | | 7500 | CHEM.HARD. | 2 | |
| ER 30 | 16.0 | AD.K | | 7500 | DRYING | 10 | |

11. Updating Status of Machines.

M A C H I N E I N F O R M A T I O N

ENTER..NEXT PAGE
CF2..END-OF-UPDATEFOR PARTLY OR FULLY COMPLETED OPERATIONS
FOR ALTERNATE MACHINE OR PARTITION OF ORDER

| PROD. | ORDER-NO | EXPLANATION | COMP.ORD. | Q U A N T I T Y | P R O C E S S | ALTERNATE | STD.P |
|-------|----------|-------------|-----------|-----------------|---------------|---------------|---------|
| | | | | | N A M E | N O | T I M E |
| | | | | | | M A C H I N E | |
| | 131.0 | HECK | | 17400 | EMULATION | 3 | |
| | 131.0 | HECK | | 10000 | EMULATION | 3 | |
| | 131.0 | HECK | | 10000 | APRE | 9 | |
| | 131.0 | HECK | | 17400 | HAIRING | 4 | |
| | 131.0 | HECK | | 10000 | HAIRING | 4 | |
| | 131.0 | HECK | | 17400 | CHEM.HARD. | 1 | |
| | 16.0 | AD.K | | 7500 | CHEM.HARD. | 2 | |
| ER 30 | 16.0 | AD.K | | 7500 | DRYING | 10 | |

12. Updating Status of Machines.

The assumptions made for the system are summarized below.

4.3.1. Assumptions For The Problem .

Some assumptions were made about the system in order to make it more clear but the real structure of it and appropriateness to the practise are protected. The assumptions are:

- i. Preemption is not allowed, i.e. once an operation is started on a machine, it must be completed before another operation can begin on that machine,
- ii. The processing times of successive operations of a particular job cannot be overlapped, i.e. physicaly each job moves through the job-shop as a single unit,
- iii. Set-up times of machines are neglected,
- iv. Instantaneous transfer to the next machine center is assumed,
- v. Unavailability of machines due to break-down or electric-shortage after simulation is started, is considered (If the machine is in maintainence for a specific time or unknown time, that information can be given to the computer).

4.3.2. Algorithm Used For The Scheduling

The schedule is prepared, by selecting the option CF5 in the main menu. That program prepares the schedule for machines for the specific time that is decided by the user, as you see in Figure 4.13. It uses the shortest-processing-time with truncation as dispatching rule.

As mentioned in previous sections, the file structure and usage of this language is different from others and you can reach any record with different keyword or keylist, by using logical files. Search and sort techniques are not needed because, the logical files make those operations automatically.

Down machines are also taken into consideration, in the program. If a machine is down for a specific time, it is activated at the repair time of it.

Input for that program are given or changed by using options previously explained. After the completion of updating of data, that part can be executed to get the schedule of machines, using the information about the last positions of machines.

All the programs except, the preparation of schedule are executed interactively. Preparation of schedule takes a

CF1..MENU

S C H E D U L I N G T I M E

STARTING TIME : DD MM YY HH MM
 26 9 86 10 30

SIMULATION TIME : DD HH MM
 1 2

13. Prompt of the Scheduling Program.

ORDER NO : 131.0 ENTER..NEXT PAGE
 ON : HECK CF2..END-OF-SESS
 DD MM YY HH MM DD MM YY
 TIME : 26 09 86 10 30 DUE-DATE : 20 08 86
 ORDER QUANTITY : 17400

| E S S | MACHINE | COMPLETED | REMAINING |
|-------|-----------|-----------|-----------|
| NO | NAME | QUANTITY | QUANTITY |
| 1 | STORK | 17400 | |
| 2 | G30-SIL | 17400 | |
| 3 | RAMOZ-2 | 17400 | |
| 4 | SCHOLAERT | 17400 | |
| 9 | RAMOZ-2 | | 17400 |

14. The Result According to The Orders.

long time with respect to the other programs and if we execute it interactively, the whole system slows down. That's why we execute it in batch and at the end of execution, a message comes to screen. Using the next option in menu, we can see the results of schedule in machine and order base with the collected statistics.

The program stops if the current time is greater than or equal to the simulation time, or all orders in the system are completed.

Step 1. Initialize the data and give the simulation time,

Step 2. If there is any down-machine, change the machine code of the operations that is waiting for it with the alternative machine code,

Step 3. If the current time is greater than simulation time go to Step 12,

Step 4. Search the machine master file for a free machine, if not found go to Step 11,

Step 5. Read an operation, that is waiting for that machine, if no job in front of the machine go to Step 4; If there is no job in the system, go to Step 12,

Step 6. If the previous operations of the job-order are completed then continue; otherwise go to Step 5,

Step 7. Calculate the priority for that order and write it to the file CIZELGE,

Step 8. If there are other job-orders waiting for that machine, go to Step 5,

Step 9. Chain the CIZELGE file by key priority. This order is the one that has the minimum priority. Update that record with the starting time of the operation,

Step 10. Update machine master file with the completion time of operation plus current time. Go to Step 4,

Step 11. Chain the machine master file with key time of machine becomes free. This record belongs to the machine that will be free before others. Then the current time is incremented to that time. Go to Step 3,

Step 12. End of simulation is reached. Find the completed amount of jobs, on the machines. Stop.

4.4. The Report

Last part of the program contains three choices. That part can be used after the message of the scheduling program that shows completion of it.

4.4.1. According To Orders

In the first choice, you can get a report, according to the orders. You can completed and incompletd amount of operations of the order, at the end of the simulation time. The screen is in Figure 4.14.

4.4.2. According To Machines

In the second choice, the schedule of machines are listed. The list is in machine base, it is sorted according to the machine codes and starting time of the operations. You can see the screen in the Figure 4.15.

4.4.3. Statistics

The third choice is the statistics that is collected during the simulation. Flow times and tardiness of jobs are listed for each completed order and the average of them is calculated.

| MACHINE CODE | RANK NO | DAY | MONTH | YEAR | HOUR | MIN. | EXPLANATION | COMPLETED AMOUNT | PRODUCTION ORDER NO | P R O C E S S NAME | NO |
|--------------|---------|-----|-------|------|------|------|----------------|------------------|---------------------|--------------------|----|
| ARTHOS HF2 | 1 | 11 | 9 | 86 | 18 | 48 | AD.KAP | 54000 | 165.0 | CONDENSING | 8 |
| BRIEM | 1 | 12 | 9 | 86 | 12 | 48 | AD.KAP | 54000 | 165.0 | CHEM.PAINT.TREAT. | 10 |
| E.RAMOZ | 1 | 10 | 9 | 86 | 9 | 57 | BENLI TIC. | 500 | 203.0 | EGALIZING | 2 |
| E.RAMOZ | 2 | 10 | 9 | 86 | 13 | 48 | FARMA TIC. | 23000 | 301.0 | EGALIZING | 6 |
| E.RAMOZ | 3 | 10 | 9 | 86 | 23 | 48 | AD.KAP | 54000 | 165.0 | EGALIZING | 5 |
| E.RAMOZ | 4 | 11 | 9 | 86 | 8 | 48 | BAYRAKTAR TIC. | 5000 | 201.0 | EGALIZING | 2 |
| E.RAMOZ | 5 | 12 | 9 | 86 | 1 | 28 | FAMATEX | 50000 | 300.0 | EGALIZING | 6 |
| E.RAMOZ | 6 | 12 | 9 | 86 | 21 | | YANIK MEN. | 10000 | 200.0 | EGALIZING | 2 |
| E.RAMOZ | 7 | 14 | 9 | 86 | 6 | 20 | SANCAK | 10000 | 202.0 | EGALIZING | 2 |
| FAMATEX | 1 | 11 | 9 | 86 | 10 | 35 | HECK | 17000 | 131.0 | CONDENSING | 8 |
| FD/ROT | 1 | 11 | 9 | 86 | 8 | 48 | AD.KAP | 54000 | 165.0 | PRINTING | 7 |
| FD/ROT | 2 | 12 | 9 | 86 | 9 | 48 | FAMATEX | 50000 | 300.0 | PRINTING | 7 |
| FD/ROT | 3 | 14 | 9 | 86 | 20 | 14 | AD.K | 75000 | 16.0 | PRINTING | 7 |
| L.BRUSH | 1 | 10 | 9 | 86 | 8 | 20 | FARMA TIC. | 23000 | 301.0 | ROLLING | 5 |
| L.BRUSH | 2 | 10 | 9 | 86 | 13 | 48 | AD.KAP | 54000 | 165.0 | BRUSHING | 4 |
| GERBER | 1 | 15 | 9 | 86 | 8 | 44 | AD.K | 75000 | 16.0 | VAPORIZING | 8 |
| G30-SIL | 1 | 10 | 9 | 86 | 5 | 15 | FARMA TIC. | 23000 | 301.0 | DRYING | 2 |
| G30-SIL | 2 | 10 | 9 | 86 | 9 | 7 | HECK | 17000 | 131.0 | DRYING | 2 |
| G30-SIL | 3 | 14 | 9 | 86 | | 5 | AD.K | 75000 | 16.0 | DRYING | 5 |
| KUSTERS | 1 | 11 | 9 | 86 | 13 | 6 | FAMATEX | 50000 | 300.0 | SQUEEZING | 3 |
| KUSTERS | 2 | 12 | 9 | 86 | 4 | 20 | AD.K | 75000 | 16.0 | SQUEEZING | 3 |
| MAXGOLLER | 1 | 12 | 9 | 86 | 16 | 50 | AD.K | 75000 | 16.0 | MERSERIZE | 4 |
| MEZERA | 1 | 16 | 9 | 86 | 21 | 29 | AD.K | 75000 | 16.0 | WASHING | 9 |
| OSTOF | 1 | 10 | 9 | 86 | | | FAMATEX | 50000 | 300.0 | BURNING | 1 |
| PAREX | 1 | 10 | 9 | 86 | | | AD.KAP | 54000 | 165.0 | BURNING | 1 |
| RAMOZ-1 | 1 | 10 | 9 | 86 | 20 | 17 | VERTA TIC. | 2000 | 212.0 | EGALAZING | 3 |
| RAMOZ-2 | 1 | 10 | 9 | 86 | 11 | 24 | HECK | 17000 | 131.0 | EMULATION | 3 |
| RAMOZ-2 | 2 | 10 | 9 | 86 | 18 | 51 | FARMA TIC. | 23000 | 301.0 | APRE | 9 |
| RAMOZ-2 | 3 | 11 | 9 | 86 | 15 | 49 | HECK | 17000 | 131.0 | APRE | 9 |
| SCHOLAERT | 1 | 10 | 9 | 86 | 18 | 51 | HECK | 17000 | 131.0 | HAIRING | 4 |
| SETTI | 1 | 10 | 9 | 86 | 11 | 57 | YILDIRIM TIC. | 600 | 207.0 | ENRICHMENT | 2 |
| SETTI | 2 | 10 | 9 | 86 | 18 | 37 | VERTA TIC. | 2000 | 212.0 | ENRICHMENT | 2 |
| SETTI | 3 | 14 | 9 | 86 | 9 | 40 | CANER TIC. | 6000 | 205.0 | ENRICHMENT | 2 |
| SETTI | 4 | 15 | 9 | 86 | 22 | 20 | GUNAYLAR | 11000 | 204.0 | ENRICHMENT | 2 |
| SETTI | 5 | 17 | 9 | 86 | 11 | | EGINLI TIC. | 11000 | 206.0 | ENRICHMENT | 2 |
| STORK | 1 | 10 | 9 | 86 | | | FARMA TIC. | 23000 | 301.0 | CHEM.HARD. | 1 |
| STORK | 2 | 10 | 9 | 86 | 5 | 15 | HECK | 17000 | 131.0 | CHEM.HARD. | 1 |
| STORK | 3 | 10 | 9 | 86 | 9 | 7 | BENLI TIC. | 500 | 203.0 | CHEM.HARD. | 1 |
| STORK | 4 | 10 | 9 | 86 | 9 | 57 | YILDIRIM TIC. | 600 | 207.0 | CHEM.HARD. | 1 |
| STORK | 5 | 10 | 9 | 86 | 11 | 57 | VERTA TIC. | 2000 | 212.0 | CHEM.HARD. | 1 |

The most important statistics are those values because they want to minimize the flow times and tardiness of jobs. The screen is in Figure 4.16.

S T A T I S T I C S

AVERAGE TARDINESS : 1709
 AVERAGE FLOW TIME : 9108

ENTER..NEXT PAGE
 CF2..END-OF-SESSI

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8873 | 7433 |
| 140.0 | 3898 | 0 |
| 165.0 | 6403 | 0 |
| 210.0 | 13672 | 0 |
| 211.0 | 19672 | 0 |
| 212.0 | 19872 | 0 |
| 300.0 | 6612 | 0 |
| 301.0 | 3136 | 6016 |
| 302.0 | 7444 | 0 |
| 303.0 | 8345 | 0 |
| 304.0 | 7340 | 5900 |
| 305.0 | 4040 | 1160 |

re 4.16. Statistics.

V. RESULTS AND CONCLUSION

5.1. Computational Results

The experiments that are made show that SPT/T rule is better for our case, because it decreases the flow-times of orders which are related to the work-in-process inventory level. You can see below average flow times and average tardiness in SPT/T and S/OPN rules which are obtained for five different data samples. You can see the detailed result in Appendix C.

| Average Tardiness | | Average Flow-time | |
|-------------------|--------------|-------------------|--------------|
| <u>SPT/T</u> | <u>S/OPN</u> | <u>SPT/T</u> | <u>S/OPN</u> |
| 1866 | 1887 | 7729 | 10354 |
| 1671 | 1709 | 7372 | 9108 |
| 212 | 254 | 5766 | 10958 |
| 1221 | 1202 | 7045 | 10590 |
| 1005 | 986 | 8051 | 13309 |

5.2. Implication Of Results

The characteristics of the job-orders affect the selection of priority rule that will be used in the program.

The level of shop load, The manner in which due-dates are set, and the tightness of the due-dates, are very critical in selecting the best rule, especially if one of the performance measures is tardiness. A complete set of reliable data has not been obtained yet. However, there are many experiments based on priority rule using a lot of set of samples. General results have been obtained by Conway (1) about the effects of the priority rules to the different kinds of measure of performances. If the main objectives of the factory like minimizing work-in-process inventory and the tardiness are taken into consideration, the best rule that shows the best performance on those measure is SPT/T which is the combination of SPT and S/OPR rules. In the meanwhile, the experiments that are performed using the actual data show that SPT/T rule causes a less average flow-time and tardiness if it is compared with the S/OPR rule.

Considering the schedule of the machines is prepared daily, the real positions of the machines at the preperation time, must be represented in the computer. Two of the most important features of that program are that it can be used by anyone who has no experience and status of the system can be updated by the user in a few minutes. The information in the computer always shows the last position of the factory since it is day-to-day updated.

The program helps the planning department in following respects:

- i. It enables user to update the related changes in a shorter time period,
- ii. Scheduling program of the whole factory can be prepared in thirty minutes without any effort.

5.3. Extension Of Research

An extension of the research may be to apply the program to the data samples in the factory and to observe the percent usage of SPT and S/OPN rules and to decide the value of r which is a parameter that gives different performance according to the different characteristics of shop. That may also help to decide a strategy in determining due-dates.

APPENDIX A COMPUTER SYSTEM

The computer system of the factory is IBM-System/38. The only available language is the RPG III. The file usage of it makes it a very powerful language in business. The attractive properties of it are as follows:

i. There are two types of data files, physical files and logical files. Firstly, physical file is constructed with a specific key or a composite key. That physical file is sorted automatically in descending or ascending order, according to the key or keylist. If you want to reach the data with a different keyfield, then you will construct a logical file on that physical file with a different field as a key. If you take the list of that logical file, the list is sorted according to the key of logical file. You may construct as many logical files as you want, on the physical data. Logical files does not contain physical data but it contains, logical record number which is in physical file.

ii. Use of subfiles: You can enter, or update the same type of data as you use a note-book. You can go anywhere on the screen, you can see the next page , or previous page, you can update any field on the screen, then you press the ENTER key in order to make the information permanent. It brings a simplicity in editing the files.

APPENDIX B

LIST OF THE COMPUTER PROGRAM

SOURCE FILE: BAKIM.BAKIM

MEMBER: SIMSRPG

SEQNBR#... 1 ... 2 ... 3 ... 4 ... 5 ... 6 ...

```

100 FSIPAR1B UF E K DISK
200 FSIPAR1P IF E K DISK
300 FSIPAR2B UF E K DISK
400 FKALIT2P IF E K DISK
500 FMACHIN3 UF E K DISK A
600 FMACHINL UF E K DISK
700 FGE'IMAKB UF E K DISK
800 FCIZELGE UF E K DISK A
900 FCIZEL1L UF E K DISK A
1000 FGECIC IF E K DISK
1100 FISTATIS O E K DISK A
1200 FGENMAKL UF E K DISK
1300 C** KEYLISTLERIN TANIMLANMASI
1400 C KAKO KLIST
1500 C KFLD KAKODR
1600 C KFLD ISNOK2
1700 C PROCS KLIST
1800 C KFLD USINS2
1900 C KFLD ISNOS2
2000 C MACKE KLIST
2100 C KFLD MCHCOR
2200 C KFLD USNOR
2300 C KFLD ISLNOR
2400 C** DATALARIN INITIALIZE EDILMESI VE SIMULASYON SURESI PROMPT
2500 C BASLA TAG
2600 C MOVE 1 BB
2700 C DB CHAINGECICI - 61
2800 C 61 SETON LR
2900 C CALL 'INITIALP'
3000 C EXSR SUBR3
3100 C BEGIN TAG
3200 C Z-ADDD SIMZAM 80
3300 C G4 MULT 24 ZAMAN 80
3400 C ADD H4 ZAMAN
3500 C MULT 60 ZAMAN
3600 C ADD '4 ZAMAN
3700 C Z-ADDD X 10
3800 C** SURE KONTROLU
3900 C YENIBA TAG
4000 C SIMZAM COMP ZAMAN 78 78
4100 C 78 GOTO LIST
4200 C MOVE #LOVAL MCHCOR
4300 C MCHCOR SETLLGENMAKG
4400 C SETOF 21
4500 C** BOS MAKINE ARAMASI*****
4600 C TEKRAR TAG
4700 C READ GENMAKG 65
4800 C 65N21 Z-ADD1 X
4900 C 65N21 GOTO LIST
5000 C 65 GOTO LAB5
5100 C BOZZAR CARNEO TTT
5200 C GOTO TTT1
5300 C TTT TAG
    
```

SOURCE FILE: DAKIM.BAKIM MEMBER: SIM5RPG 51
SEQNBR#... 1 ... 2 ... 3 ... 4 ... 5 ... 6 ...

| | | | | | | |
|-------|-----|---------------------------------|----------------------------------|--------|----|----|
| 5400 | C | | SETON | | | 21 |
| 5500 | C | | GOTO TEKRAR | | | |
| 5600 | C | TTT1 | TAG | | | |
| 5700 | C | MCHCOR | SETLLMACHING | | | 61 |
| 5800 | C | N61 | GOTO TEKRAR | | | |
| 5900 | C | | SETON | | | 21 |
| 6000 | C** | MAKINEDEKI SIPARISLER IN | OKUNMAST***** | | | |
| 6100 | C | NEXTSI | TAG | | | |
| 6200 | C | MCHCOR | READEMACHING | | | 62 |
| 6300 | C | | MOVE MCHCOR | MCH1 | 10 | |
| 6400 | C | 62 | GOTO LAB4 | | | |
| 6500 | C | | MOVE USNOR | USINS2 | | |
| 6600 | C | | MOVE #LOVAL | ISNOS2 | | |
| 6700 | C** | ISLEMIN ILK ISLEM | OLUP OLMADIGININ SAPTANMASI***** | | | |
| 6800 | C | USINS2 | SETLLSIPAR2G | | | 63 |
| 6900 | C | N63 | SETON | | | 58 |
| 7000 | C | N63 | GOTO LIST | | | |
| 7100 | C | 63 | READ SIPAR2G | | | 41 |
| 7200 | C | 41 | SETON | | | 58 |
| 7300 | C | 41 | GOTO LIST | | | |
| 7400 | C | ISLNOR | CABNEISNOS2 | NEXTSI | | |
| 7500 | C | | MOVE USNOR | USINS1 | | |
| 7600 | C | USINS1 | CHAINSIPAR1G | | | 64 |
| 7700 | C | 64 | SETON | | | 42 |
| 7800 | C | 64 | GOTO LIST | | | |
| 7900 | C | | MOVE KAKODR | KAKOK2 | | |
| 8000 | C | | Z-ADDO | TOPISZ | 80 | |
| 8100 | C | | MOVE ISLNOR | ISNOK2 | | |
| 8200 | C** | KALAN ISLEMLERININ TOPLAM ISLEM | ZAMANLARININ BULUNMASI***** | | | |
| 8300 | C | | SETOF | | | 41 |
| 8400 | C | LAB1 | TAG | | | |
| 8500 | C | MCHCOR | COMP MCHCOA | | | 31 |
| 8600 | C | 31 | DO | | | |
| 8700 | C | | MOVE STANDA | STAZAR | | |
| 8800 | C | | GOTO LAB1A | | | |
| 8900 | C | | END | | | |
| 9000 | C | KAKO | CHAINKALIT2R | | | 61 |
| 9100 | C | 61 | SETON | | | 43 |
| 9200 | C | LAB1A | TAG | | | |
| 9300 | C | SIPMIK | DIV STAZAR | PROZAM | 30 | |
| 9400 | C | N41 | MOVE PROZAM | ENKIZA | 30 | |
| 9500 | C | | ADD PROZAM | TOPISZ | | |
| 9600 | C | USINS2 | READESIPAR2G | | | 66 |
| 9700 | C | 66 | GOTO LAB2 | | | |
| 9800 | C | | SETON | | | 41 |
| 9900 | C | | MOVE ISNOS2 | ISNOK2 | | |
| 10000 | C | | GOTO LAB1 | | | |
| 10100 | C** | PRIORITY HESAPLAMA***** | | | | |
| 10200 | C | LAB2 | TAG | | | |
| 10300 | C | | EXSR SUBR1 | | | |
| 10400 | C | TERMIN | SUB TOPISZ | PRIORR | | |
| 10500 | C | | DIV TOPISR | PRIORR | | |
| 10600 | C | PRIORR | COMP ENKIZA | | | 42 |

SOURCE FILE: DAKIM.BAKIM

MEMBER: SIM5RPG

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SEQ#BR#... 1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7

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10700 C 42 Z-ADDNKIZA PRIORR
10800 C*# CIZELGE DOSYASINA YAZILMASI*****
10900 C LAB3 TAG
11000 C WRITECIZELGER
11100 C MOVE MCHI MCHCOR
11200 C*# MCHCOR SETGMACHING
11300 C GOTO NEXTSI
11400 C*# MAKINE DOSYASINDAN SILME*****
11500 C LAB4 TAG
11600 C MOVE #LOVAL PRIORR
11700 C MCHCOR SETLLCIZELGER 70
11800 C 70 READ CIZELGER 80
11900 C 80 SETON 51
12000 C 80 GOTO LIST
12100 C N70 GOTO TEKRAR
12200 C LABL8 TAG
12300 C MACKE CHAINMACHINI 61
12400 C 61 DO
12500 C MCHCOR READECIZELGER 81
12600 C N81 GOTO LABL8
12700 C 81 GOTO TEKRAR
12800 C END
12900 C N61 DO
13000 C MOVE SIMZAM CONVZA 80
13100 C EXSR SUBR2
13200 C WRITECIZI1111
13300 C DELETMACHINI
13400 C END
13500 C*# ISLEMIN BITIS TARİHI HESABI VE GENEL MAKINE DOSYASI UPDATE*
13600 C MOVE USNOR USINSI
13700 C USINSI CHAINSIPARIG 72
13800 C 72 SETON 52
13900 C 72 GOTO LIST
14000 C MOVE KAKOR KAKOK2
14100 C MOVE ISLOR ISNOK2
14200 C MCHCOR COMP MCHCOA 31
14300 C 31 DO
14400 C MOVE STANDA STAZAR
14500 C GOTO LAB4A
14600 C END
14700 C KAKO CHAINKALIT2R 61
14800 C 61 SETON 53
14900 C 61 GOTO LIST
15000 C LAB4A TAG
15100 C SIPMIK DIV STAZAR PROTİM 80
15200 C***** MCHCOR CHAINGENMAKG 61
15300 C ADD SIMZAM PROTİM
15400 C MOVE PROTİM BOZZAR
15500 C UPDATGENMAKG
15600 C GOTO YENİBA
15700 C*# MAKİNELER DOLDU EN YAKIN ZAMANA GİT*****
15800 C LAB5 TAG
15900 C Z-ADD1 BOZZAR

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SOURCE FILE: BAKIM.DAKIM

MEMBER: SIM5RPG

SEQNBR#... 1 ... 2 ... 3 ... 4 ... 5 ... 6 ...

| | | | | | | | |
|-------|---|-----|--------|---------------|--------|----|----|
| 16000 | C | | BOZZAR | SETLLGENMAKK | | | |
| 16100 | C | | | READ GENMAKK | | | 69 |
| 16200 | C | 68 | | SETON | | 55 | |
| 16300 | C | 68 | | GOTO LIST | | | |
| 16400 | C | | BOZZAR | COMP #HIVAL | | | 19 |
| 16500 | C | 19 | | Z-ADD1 | X | 10 | |
| 16600 | C | 19 | | GOTO LIST | | | |
| 16700 | C | | | Z-ADDBOZZAR | SIMZAM | | |
| 16800 | C | | LABL7 | TAG | | | |
| 16900 | C | | | Z-ADDBOZZAR | BOZZAM | 80 | |
| 17000 | C | | | MOVE MCHCOR | MACBOZ | 10 | |
| 17100 | C | | | Z-ADDO | BOZZAR | | |
| 17200 | C | | | UPDATGENMAKK | | | |
| 17300 | C | | | MOVE #LOVAL | PRIORR | | |
| 17400 | C | | MCHCOR | SETLLCIZELGER | | | 70 |
| 17500 | C | N70 | | SETON | | 56 | |
| 17600 | C | N70 | | GOTO LIST | | | |
| 17700 | C | | LABL9 | TAG | | | |
| 17800 | C | 70 | MCHCOR | READCIZELGER | | | 80 |
| 17900 | C | 80 | | GOTO LABL6 | | | |
| 18000 | C | | | MOVE USNOR | USINS2 | | |
| 18100 | C | | | MOVE ISLNOR | ISNOS2 | | |
| 18200 | C | | PROCS | CHAINSHIPAR2G | | | 67 |
| 18300 | C | 67 | | GOTO LABL9 | | | |
| 18400 | C | N67 | | DELETSIPAR2G | | | |
| 18500 | C | | | MOVE USNOR | USINS2 | | |
| 18600 | C | | | MOVE USNOR | USINS1 | | |
| 18700 | C | | USINS1 | CHAINSHIPARIG | | | 77 |
| 18800 | C | N77 | | SUB 1 | TOPISR | | |
| 18900 | C | N77 | | UPDATSIPARIG | | | |
| 19000 | C | | | MOVE #LOVAL | ISNOS2 | | |
| 19100 | C | | USINS2 | SETLLSIPAR2G | | | 70 |
| 19200 | C | 70 | | GOTO LABL6 | | | |
| 19300 | C | N70 | | DO | | | |
| 19400 | C | | | MOVE USNOR | USINS1 | | |
| 19500 | C | | USINS1 | CHAINSHIPARIG | | | 69 |
| 19600 | C | N69 | | DELETSIPARIG | | | |
| 19700 | C | | | EXSR SUBR1 | | | |
| 19800 | C | | | MOVE TERMIN | TERMI | 80 | |
| 19900 | C | | | MOVE Y7 | Y2 | | |
| 20000 | C | | | MOVE A7 | A2 | | |
| 20100 | C | | | MOVE G7 | G2 | | |
| 20200 | C | | | EXSR SUBR1 | | | |
| 20300 | C | | SIMZAM | SUB TERMIN | FLOW | | |
| 20400 | C | | SIMZAM | SUB TERMI | COMPTI | | |
| 20500 | C | | COMPTI | COMP 0 | | | 24 |
| 20600 | C | 24 | | Z-ADDO | COMPTI | | |
| 20700 | C | | | WRITEI STAT | | | |
| 20800 | C | | | END | | | |
| 20900 | C | | LABL6 | TAG | | | |
| 21000 | C | | | MOVE SIMZAM | BOZZAR | | |
| 21100 | C | | BOZZAR | CHAINGENMAKK | | | 29 |
| 21200 | C | N29 | | GOTO LABL7 | | | |

SOURCE FILE: BAKIM.BAKIM

MEMBER: SIM5RPG

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SEQNBR#... 1'... 2 ... 3 ... 4 ... 5 ... 6 ... 7

| | | | | | | | | |
|-------|---|------|------|------------|--------------|--------|----|--------|
| 21300 | C | | | GOTO | YENIBA | | | |
| 21400 | C | | LIST | TAG | | | | |
| 21500 | C | | X | COMP | 1 | | | 97 |
| 21600 | C | N87 | | EXSR | SUBR4 | | | |
| 21700 | C | | | SETON | | | LR | |
| 21800 | C | | | RETRN | | | | |
| 21900 | C | **** | | SUBROUTINE | ZAMAN HESABI | | | |
| 22000 | C | | | SUBR1 | BEGSR | | | |
| 22100 | C | | | BEG11 | TAG | | | |
| 22200 | C | | | SETOF | | | | 111213 |
| 22300 | C | | | SETOF | | | | 141516 |
| 22400 | C | | | SETOF | | | | 1719 |
| 22500 | C | | Y2 | SUB | Y1 | YY | 40 | |
| 22600 | C | | YY | COMP | 0 | | | 111213 |
| 22700 | C | 13 | | DO | | | | |
| 22800 | C | | A2 | SUB | A1 | AA | 40 | |
| 22900 | C | | AA | COMP | 0 | | | 141516 |
| 23000 | C | | | END | | | | |
| 23100 | C | 11 | | DO | | | | |
| 23200 | C | | | SUB | 1 | YY | | |
| 23300 | C | | YY | MULT | 12 | YY | | |
| 23400 | C | | 12 | SUB | A1 | AA | | |
| 23500 | C | | | ADD | A2 | AA | | |
| 23600 | C | | | ADD | YY | AA | | |
| 23700 | C | | | SETON | | | | 14 |
| 23800 | C | | | END | | | | |
| 23900 | C | 12 | | DO | | | | |
| 24000 | C | | | ADD | 1 | YY | | |
| 24100 | C | | | MULT | 12 | YY | | |
| 24200 | C | | 12 | SUB | A2 | AA | | |
| 24300 | C | | | ADD | A1 | AA | | |
| 24400 | C | | YY | SUB | 4A | AA | | |
| 24500 | C | | | SETON | | | | 15 |
| 24600 | C | | | END | | | | |
| 24700 | C | 16 | | DO | | | | |
| 24800 | C | | G2 | SUB | G1 | GG | 40 | |
| 24900 | C | | GG | COMP | 0 | | | 171719 |
| 25000 | C | 17 | | Z-ADD0 | | TERMIN | 30 | |
| 25100 | C | | GG | MULT | 1440 | TERMIN | | |
| 25200 | C | | | END | | | | |
| 25300 | C | 14 | | DO | | | | |
| 25400 | C | | | SUB | 1 | AA | | |
| 25500 | C | | AA | MULT | 30 | AA | | |
| 25600 | C | | 30 | SUB | G1 | GG | | |
| 25700 | C | | | ADD | G2 | GG | | |
| 25800 | C | | | ADD | AA | GG | | |
| 25900 | C | | GG | MULT | 1440 | TERMIN | | |
| 26000 | C | | | END | | | | |
| 26100 | C | 15 | | DO | | | | |
| 26200 | C | | | ADD | 1 | AA | | |
| 26300 | C | | | MULT | 30 | AA | | |
| 26400 | C | | 30 | SUB | G2 | GG | | |
| 26500 | C | | | ADD | G1 | GG | | |

SOURCE FILE: BAKIM.BAKIM

MEMBER: SIM5RPG

SEQNBR#... 1 ... 2 ... 3 ... 4 ... 5 ... 6 ...

| | | | | | | |
|-------|---|-------|---------------------------------|--------------|-----------|----|
| 26600 | C | | SUB GG | AA | | |
| 26700 | C | AA | MULT 1440 | TERMIN | | |
| 26800 | C | | END | | | |
| 26900 | C | | ENDSR | | | |
| 27000 | C | **** | SUBROUTINE ZAMAN HESABI II***** | | | |
| 27100 | C | | SUBR2 | BEGSR | | |
| 27200 | C | | CONVZA | DIV 519400 | KAL | 20 |
| 27300 | C | | MVR | | ART | 80 |
| 27400 | C | Y1 | ADD KAL | | Y3 | 20 |
| 27500 | C | | MOVE ART | | CONVZA | |
| 27600 | C | | CONVZA | DIV 43200 | KAL | |
| 27700 | C | | MVR | | ART | |
| 27800 | C | A1 | ADD KAL | | A3 | 20 |
| 27900 | C | | MOVE ART | | CONVZA | |
| 28000 | C | | CONVZA | DIV 1440 | KAL | |
| 28100 | C | | MVR | | ART | |
| 28200 | C | G1 | ADD KAL | | G3 | |
| 28300 | C | | MOVE ART | | CONVZA | |
| 28400 | C | | CONVZA | DIV 60 | KAL | |
| 28500 | C | | MVR | | ART | |
| 28600 | C | H1 | ADD KAL | | H3 | |
| 28700 | C | H1 | ADD ART | | M6G | 30 |
| 28800 | C | | M6G | COMP 59 | | 12 |
| 28900 | C | 12 | | DO | | |
| 29000 | C | | M6G | SUB 60 | M3 | |
| 29100 | C | | | ADD 1 | H3 | |
| 29200 | C | | | END | | |
| 29300 | C | N12 | | MOVE M6G | M3 | |
| 29400 | C | | H3 | COMP 23 | | 13 |
| 29500 | C | 13 | | DO | | |
| 29600 | C | | | SUB 24 | H3 | |
| 29700 | C | | | ADD 1 | G3 | |
| 29800 | C | | | END | | |
| 29900 | C | | G3 | COMP 30 | | 11 |
| 30000 | C | 11 | | DO | | |
| 30100 | C | | | SUB 30 | G3 | |
| 30200 | C | | | ADD 1 | A3 | |
| 30300 | C | | | END | | |
| 30400 | C | | A3 | COMP 29 | | 14 |
| 30500 | C | 14 | | DO | | |
| 30600 | C | | | SUB 12 | A3 | |
| 30700 | C | | | ADD 1 | Y3 | |
| 30800 | C | | | END | | |
| 30900 | C | | | ENDSR | | |
| 31000 | C | ***** | SUBROUTINE 3 ***** | | | |
| 31100 | C | | SUBR3 | BEGSR | | |
| 31200 | C | | | MOVE *HIVAL | BOZZAR | |
| 31300 | C | | BOZZAR | SETLLGENMAKK | | 18 |
| 31400 | C | N18 | | GOTO BASL2 | | |
| 31500 | C | | BASL1 | TAG | | |
| 31600 | C | | BOZZAR | READEGENMAKK | | 19 |
| 31700 | C | | | MOVE MCHCOR | MCH111 10 | |
| 31800 | C | 19 | | GOTO BASL2 | | |

SOURCE FILE: BAKIM.BAKIM

MEMBER: SIM5RPG

SEQNUR#... 1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7

| | | | | | | |
|-------|---|-----|-------------------------|--------------|-----------|----|
| 31900 | C | | BASL4 | TAG | | |
| 32000 | C | | MCHCOR | SETLLMACHING | | 20 |
| 32100 | C | N20 | | GOTO BASL1 | | |
| 32200 | C | | BASL3 | TAG | | |
| 32300 | C | | MCHCOR | READMACHING | | 11 |
| 32400 | C | 11 | | GOTO BASL1 | | |
| 32500 | C | | MCHCOA | COMP #BLANK | | 12 |
| 32600 | C | 12 | | GOTO BASL3 | | |
| 32700 | C | | MCHCOR | DELETMACHING | | 92 |
| 32800 | C | | | MOVE MCHCOA | MCHCOR | |
| 32900 | C | | | WRITEMACHING | | |
| 33000 | C | | | MOVE MCH111 | MCHCOR | |
| 33100 | C | | | GOTO BASL4 | | |
| 33200 | C | | BASL2 | TAG | | |
| 33300 | C | | | ENDSR | | |
| 33400 | C | | *****SUBROUTINE 4 ***** | | | |
| 33500 | C | | SUBR4 | BEGSR | | |
| 33600 | C | | | MOVE 1 | BOZZAR | |
| 33700 | C | | BOZZAR | SETLLGENMAKK | | 17 |
| 33800 | C | 17 | | GOTO SONSB4 | | |
| 33900 | C | | TAG1 | TAG | | |
| 34000 | C | | | READ GENMAKK | | 23 |
| 34100 | C | 23 | | GOTO SONSB4 | | |
| 34200 | C | | #HIVAL | COMP BOZZAR | | 18 |
| 34300 | C | 18 | | GOTO SONSB4 | | |
| 34400 | C | | MCHCOR | SETGTCIZ1111 | | |
| 34500 | C | | | READPCIZ1111 | | 19 |
| 34600 | C | 19 | | GOTO SONSB4 | | |
| 34700 | C | | BOZZAR | SUB ZAMAN | KALZAM 80 | |
| 34800 | C | | | MOVE USNOR | USINS1 | |
| 34900 | C | | USINS1 | CHAINSIPAR1R | | 61 |
| 35000 | C | | | MOVE KAKODR | KAKOK2 | |
| 35100 | C | | | MOVE ISLNOR | ISNOK2 | |
| 35200 | C | | KAKO | CHAINKALIT2R | | 62 |
| 35300 | C | | STAZAR | MULT KALZAM | SIPMIL 70 | |
| 35400 | C | | SIPMIK | SUB SIPMIL | SIPMIK | |
| 35500 | C | | | UPDATCIZ1111 | | |
| 35600 | C | | | GOTO TAG1 | | |
| 35700 | C | | SONSB4 | TAG | | |
| 35800 | C | | | MOVE MACBOZ | MCHCOR | |
| 35900 | C | | | MOVE BOZZAM | BOZZAR | |
| 36000 | C | | MCHCOR | SETGTCIZ1111 | | |
| 36100 | C | | | READPCIZ1111 | | 19 |
| 36200 | C | 19 | | GOTO SONSB5 | | |
| 36300 | C | | BOZZAR | SUB ZAMAN | KALZAM 80 | |
| 36400 | C | | | MOVE USNOR | USINS1 | |
| 36500 | C | | USINS1 | CHAINSIPAR1R | | 61 |
| 36600 | C | | | MOVE KAKODR | KAKOK2 | |
| 36700 | C | | | MOVE ISLNOR | ISNOK2 | |
| 36800 | C | | KAKO | CHAINKALIT2R | | 62 |
| 36900 | C | | STAZAR | MULT KALZAM | SIPMIL 70 | |
| 37000 | C | | SIPMIK | SUB SIPMIL | SIPMIK | |
| 37100 | C | | | UPDATCIZ1111 | | |

5714UT1 R07M00 850913

SEU SOURCE LISTING

SOURCE FILE: BAKIM.DAKIM

MEMBER: SIMSRPG

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SEQNDR#... 1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7

| | | | |
|-------|---|--------|-------|
| 37200 | C | SONSB5 | TAG |
| 37300 | C | | ENDSR |

***** END OF SOURCE *****

APPENDIX C**COMPUTATIONAL RESULTS**

S T A T I S T I C S

GE TARDINESS : 986
 GE FLOW TIME : 13309

ENTER..NEXT PAGE
 CF2..END-OF-SESSIO

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8324 | 6884 |
| 131.0 | 5313 | 3873 |
| 165.0 | 6213 | 0 |
| 200.0 | 14710 | 0 |
| 201.0 | 15710 | 0 |
| 202.0 | 26180 | 0 |
| 203.0 | 14370 | 0 |
| 204.0 | 11370 | 0 |
| 205.0 | 13070 | 0 |
| 206.0 | 22840 | 0 |
| 207.0 | 13150 | 0 |
| 210.0 | 12570 | 0 |
| 211.0 | 23640 | 0 |
| 212.0 | 23840 | 0 |
| 300.0 | 5510 | 0 |

Group 1 with S/OPN

S T A T I S T I C S

E TARDINESS : 1005
 E FLOW TIME : 8051

ENTER..NEXT PAGE
 CF2..END-OF-SESSION

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8651 | 7211 |
| 131.0 | 5313 | 3873 |
| 165.0 | 6213 | 0 |
| 200.0 | 7580 | 0 |
| 201.0 | 4971 | 0 |
| 202.0 | 9580 | 0 |
| 203.0 | 2068 | 0 |
| 204.0 | 9640 | 0 |
| 205.0 | 6940 | 0 |
| 206.0 | 11840 | 0 |
| 207.0 | 1691 | 0 |
| 210.0 | 21240 | 0 |
| 211.0 | 27400 | 0 |
| 212.0 | 2331 | 0 |
| 300.0 | 6580 | 0 |

Group 1 with SPT/T

S T A T I S T I C S

E TARDINESS : 1202
 E FLOW TIME : 10590

ENTER..NEXT PAGE
 CF2..END-OF-SESSION

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8324 | 6884 |
| 131.0 | 5372 | 3932 |
| 165.0 | 6213 | 0 |
| 201.0 | 11694 | 0 |
| 203.0 | 10354 | 0 |
| 206.0 | 19124 | 0 |
| 207.0 | 10314 | 0 |
| 210.0 | 13254 | 0 |
| 211.0 | 19924 | 0 |
| 212.0 | 20124 | 0 |
| 300.0 | 6194 | 0 |
| 301.0 | 3136 | 6016 |
| 302.0 | 6317 | 0 |
| 303.0 | 7927 | 0 |

Group 2 with S/OPN

S T A T I S T I C S

E TARDINESS : 1221
 E FLOW TIME : 7045

ENTER..NEXT PAGE
 CF2..END-OF-SESSION

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8651 | 7211 |
| 131.0 | 5313 | 3873 |
| 165.0 | 6213 | 0 |
| 201.0 | 4971 | 0 |
| 203.0 | 2068 | 0 |
| 206.0 | 7124 | 0 |
| 207.0 | 1691 | 0 |
| 210.0 | 16524 | 0 |
| 211.0 | 22524 | 0 |
| 212.0 | 2331 | 0 |
| 300.0 | 6580 | 0 |
| 301.0 | 3136 | 6016 |
| 302.0 | 1854 | 0 |
| 303.0 | 9655 | 0 |

Group 2 with SPT/T

S T A T I S T I C S

E TARDINESS : 254
 E FLOW TIME : 10958

ENTER..NEXT PAGE
 CF2..END-OF-SESSION

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 11196 | 0 |
| 131.0 | 3986 | 2546 |
| 165.0 | 5925 | 0 |
| 200.0 | 13786 | 0 |
| 201.0 | 14786 | 0 |
| 203.0 | 13446 | 0 |
| 204.0 | 10446 | 0 |
| 205.0 | 12146 | 0 |
| 207.0 | 12226 | 0 |
| 210.0 | 11646 | 0 |

roup 3 with S/OPN.

S T A T I S T I C S

GE TARDINESS : 212
 GE FLOW TIME : 5766

ENTER..NEXT PAGE
 CF2..END-OF-SESSION

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 12266 | 0 |
| 131.0 | 3986 | 2546 |
| 165.0 | 5925 | 0 |
| 200.0 | 6656 | 0 |
| 201.0 | 4120 | 0 |
| 202.0 | 8656 | 0 |
| 203.0 | 882 | 0 |
| 204.0 | 8716 | 0 |
| 205.0 | 6016 | 0 |
| 206.0 | 10916 | 0 |
| 207.0 | 462 | 0 |
| 212.0 | 1102 | 0 |

Group 3 with SPT/T.

S T A T I S T I C S

SE TARDINESS : 1709
 SE FLOW TIME : 9108

ENTER..NEXT PAGE
 CF2..END-OF-SESSION

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8873 | 7433 |
| 140.0 | 3898 | 0 |
| 165.0 | 6403 | 0 |
| 210.0 | 13672 | 0 |
| 211.0 | 19672 | 0 |
| 212.0 | 19872 | 0 |
| 300.0 | 6612 | 0 |
| 301.0 | 3136 | 6016 |
| 302.0 | 7444 | 0 |
| 303.0 | 8345 | 0 |
| 304.0 | 7340 | 5900 |
| 305.0 | 4040 | 1160 |

Group 4 with S/OPN.

S T A T I S T I C S

AGE TARDINESS : 1671
 AGE FLOW TIME : 7372

ENTER..NEXT PAGE
 CF2..END-OF-SESSI

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8419 | 6979 |
| 140.0 | 3444 | 0 |
| 165.0 | 6425 | 0 |
| 210.0 | 14072 | 0 |
| 211.0 | 20072 | 0 |
| 212.0 | 2579 | 0 |
| 300.0 | 6328 | 0 |
| 301.0 | 3136 | 6016 |
| 302.0 | 2807 | 0 |
| 303.0 | 9812 | 0 |
| 304.0 | 7362 | 5922 |
| 305.0 | 4016 | 1136 |

Group 4 with SPT/T.

S T A T I S T I C S

AVERAGE TARDINESS : 1887
 AVERAGE FLOW TIME : 10354

ENTER..NEXT PAGE
 CF2..END-OF-SESSI

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8324 | 6884 |
| 131.0 | 6772 | 5332 |
| 165.0 | 6375 | 0 |
| 206.0 | 19224 | 0 |
| 207.0 | 10964 | 0 |
| 210.0 | 13904 | 0 |
| 211.0 | 20024 | 0 |
| 212.0 | 20224 | 0 |
| 300.0 | 7503 | 0 |
| 301.0 | 3136 | 6016 |
| 302.0 | 7416 | 0 |
| 303.0 | 8577 | 0 |
| 304.0 | 7312 | 5872 |
| 305.0 | 5206 | 2326 |

Group 5 with S/OPN.

S T A T I S T I C S

AVERAGE TARDINESS : 1866
 AVERAGE FLOW TIME : 7729

ENTER..NEXT PAGE
 CF2..END-OF-SESS

| PRODUCTION ORDER-NO | FLOW TIME (MIN) | TARDINESS (MIN) |
|------------------------|--------------------|--------------------|
| 16.0 | 8751 | 7311 |
| 131.0 | 5942 | 4502 |
| 165.0 | 6425 | 0 |
| 206.0 | 7224 | 0 |
| 207.0 | 2170 | 0 |
| 210.0 | 16624 | 0 |
| 211.0 | 22624 | 0 |
| 212.0 | 2931 | 0 |
| 300.0 | 6680 | 0 |
| 301.0 | 3136 | 6016 |
| 302.0 | 2807 | 0 |
| 303.0 | 10284 | 0 |
| 304.0 | 7362 | 5922 |
| 305.0 | 5256 | 2376 |

a Group 5 with SPT/T.

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