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William James PORTERFIELD

A PRODUCTION PLANNING SYSTEM FOR PLASTIC FOOTWEAR

IN A SEASONAL MARKET

Doctor of Philosophy
University of Aston in Birmingham

September 1976

Volume II
APPENDIX 1  ANALYSIS OF THE OUTPUT STATISTICS

The data

Diagram 1 shows a typical piece of data showing the output by machine for one shift and giving a detailed analysis of the downtime. Table 1 shows the coded information for one week of fifteen shifts as input to the computer.

The data was then normalised into production for a full 8 hour shift with an average gang size. The downtime was treated similarly. The mould loading details were entered as the capacities of each mould in the machine. Multiple regression analyses were performed on the data, the principal independent variables were the largest mould capacity, the mean capacity and various measures of size-mix.

Typical measures of size-mix were $R_1$, the sum of the differences in capacity from the largest mould; $R_2$, the sum of the squares of the above differences; $R_3$, the sum of the squares of the differences from the mean mould capacity; and similarly $L_1$, $L_2$ and $L_3$ which are the same measures using the logarithms of the mould capacities instead of the actual capacities.

Table 2 shows selected correlations for the second set of data on the large protective machines. It is very interesting comparing the correlations in the first two columns. In the latter column the effect of the largest mould size on the production has been eliminated (almost); as a result the correlations associated with measures of size-mix fall while the effect of machine age is greatly increased.
### Copy of a Downtime Analysis Sheet

<table>
<thead>
<tr>
<th>Machine</th>
<th>Output</th>
<th>Running Time</th>
<th>Downtime</th>
<th>Mech &amp; Elec</th>
<th>Linings &amp; PVC</th>
<th>Mould Clean</th>
<th>Mould Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL 1</td>
<td>1881</td>
<td>1440</td>
<td>245</td>
<td>135</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>PL 2</td>
<td>1262</td>
<td>1440</td>
<td>420</td>
<td>42</td>
<td>190</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>PL 3</td>
<td>1816</td>
<td>1440</td>
<td>238</td>
<td>88</td>
<td>109</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>PL 4</td>
<td>1142</td>
<td>1440</td>
<td>720</td>
<td>645</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>PS 1</td>
<td>2007</td>
<td>1440</td>
<td>374</td>
<td>70</td>
<td>95</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>G 1</td>
<td>1581</td>
<td>1165</td>
<td>22</td>
<td>105</td>
<td>66</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>G 2</td>
<td>2256</td>
<td>1440</td>
<td>244</td>
<td>80</td>
<td>20</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>G 3</td>
<td>376</td>
<td>260</td>
<td>59</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Date:** 13/9/74
Table 1  Typical Input Data for one week on one machine

<table>
<thead>
<tr>
<th>Machine</th>
<th>Moulds</th>
<th>Prd$^n$</th>
<th>Cycle</th>
<th>Downtime</th>
<th>Hours</th>
<th>Man hours</th>
<th>Shift Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>959 1148 1159 1230 1313</td>
<td>428</td>
<td>261</td>
<td>130</td>
<td>8</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>524</td>
<td>502</td>
<td>482</td>
<td>518</td>
<td>510</td>
<td>504</td>
<td>523</td>
<td>495</td>
</tr>
<tr>
<td>259</td>
<td>259</td>
<td>259</td>
<td>258</td>
<td>257</td>
<td>258</td>
<td>258</td>
<td>258</td>
</tr>
<tr>
<td>42</td>
<td>42</td>
<td>81</td>
<td>45</td>
<td>67</td>
<td>120</td>
<td>35</td>
<td>64</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>16</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The corrected production is the production adjusted for the assumed effect of the largest...
Table 2  Selected correlations for the second data set on large protective machines

<table>
<thead>
<tr>
<th></th>
<th>Prod^n</th>
<th>Corr^d prod</th>
<th>Cycle Time</th>
<th>Downtime</th>
<th>Gang Size</th>
<th>Largest Mould</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prod^n</td>
<td>1.000</td>
<td>.817</td>
<td>-.444</td>
<td>-.612</td>
<td>.238</td>
<td>-.591</td>
<td>-.336</td>
<td>-.313</td>
</tr>
<tr>
<td>Corr^d prod</td>
<td>.817</td>
<td>1.000</td>
<td>-.203</td>
<td>-.538</td>
<td>.107</td>
<td>-.016</td>
<td>-.126</td>
<td>-.128</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>-.444</td>
<td>-.203</td>
<td>1.000</td>
<td>-.085</td>
<td>-.094</td>
<td>.485</td>
<td>.170</td>
<td>.162</td>
</tr>
<tr>
<td>Downtime</td>
<td>-.612</td>
<td>-.538</td>
<td>-.085</td>
<td>1.000</td>
<td>-.209</td>
<td>-.308</td>
<td>.402</td>
<td>.411</td>
</tr>
<tr>
<td>Gang Size</td>
<td>.238</td>
<td>.107</td>
<td>-.094</td>
<td>-.209</td>
<td>1.000</td>
<td>-.262</td>
<td>-.194</td>
<td>-.233</td>
</tr>
<tr>
<td>Largest mould</td>
<td>-.591</td>
<td>-.016</td>
<td>.485</td>
<td>-.308</td>
<td>-.262</td>
<td>1.000</td>
<td>.406</td>
<td>.363</td>
</tr>
<tr>
<td>R1</td>
<td>-.336</td>
<td>-.126</td>
<td>.170</td>
<td>.402</td>
<td>-.194</td>
<td>.406</td>
<td>1.000</td>
<td>.971</td>
</tr>
<tr>
<td>R2</td>
<td>-.313</td>
<td>-.128</td>
<td>.162</td>
<td>.411</td>
<td>-.233</td>
<td>.363</td>
<td>.971</td>
<td>1.000</td>
</tr>
<tr>
<td>R3</td>
<td>-.359</td>
<td>-.126</td>
<td>.206</td>
<td>.411</td>
<td>-.389</td>
<td>.446</td>
<td>.863</td>
<td>.911</td>
</tr>
<tr>
<td>L1</td>
<td>-.017</td>
<td>-.077</td>
<td>-.141</td>
<td>.409</td>
<td>-.051</td>
<td>-.077</td>
<td>.867</td>
<td>.833</td>
</tr>
<tr>
<td>L2</td>
<td>-.094</td>
<td>-.055</td>
<td>-.138</td>
<td>.269</td>
<td>-.405</td>
<td>.086</td>
<td>.563</td>
<td>.611</td>
</tr>
<tr>
<td>L3</td>
<td>-.100</td>
<td>-.061</td>
<td>-.078</td>
<td>.323</td>
<td>-.268</td>
<td>.087</td>
<td>.821</td>
<td>.861</td>
</tr>
<tr>
<td>Machine Age</td>
<td>.097</td>
<td>.342</td>
<td>.289</td>
<td>-.453</td>
<td>.557</td>
<td>.309</td>
<td>-.316</td>
<td>-.397</td>
</tr>
</tbody>
</table>

* The corrected production is the production adjusted for the assumed effect of the largest mould.
Distribution of the data by machine type and size range

As stated in 8.7 it is extremely difficult to isolate the effect of the largest mould from the effect of the machine age. This is because most of the readings on each machine were made while it was producing the same range of products. Table 3 shows the distribution of the first set of data for the protective machines while table 4 gives similar details for the second set. Both tables also show the mean output per shift (adjusted for security). Note that only machine 1 has really covered all size ranges in its mould loading.
<table>
<thead>
<tr>
<th>Size Range</th>
<th>Machine No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child's: Shifts</td>
<td>34</td>
<td>152</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>186</td>
</tr>
<tr>
<td>Mean output</td>
<td>481</td>
<td>561</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>546</td>
</tr>
<tr>
<td>Juvenile's: Shifts</td>
<td>-</td>
<td>-</td>
<td>139</td>
<td>-</td>
<td>-</td>
<td>139</td>
</tr>
<tr>
<td>Mean output</td>
<td>-</td>
<td>-</td>
<td>591</td>
<td>-</td>
<td>-</td>
<td>591</td>
</tr>
<tr>
<td>Women's: Shifts</td>
<td>162</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>177</td>
<td>343</td>
</tr>
<tr>
<td>Mean output</td>
<td>483</td>
<td>398</td>
<td>-</td>
<td>-</td>
<td>544</td>
<td>513</td>
</tr>
<tr>
<td>All: Shifts</td>
<td>196</td>
<td>156</td>
<td>139</td>
<td>177</td>
<td>-</td>
<td>668</td>
</tr>
<tr>
<td>Mean output</td>
<td>483</td>
<td>557</td>
<td>591</td>
<td>544</td>
<td>-</td>
<td>537</td>
</tr>
</tbody>
</table>
Table 4  Distribution of the second set of data

<table>
<thead>
<tr>
<th>Size Range</th>
<th>Machine No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child's:</td>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Weeks</td>
<td>Mean output</td>
<td>587</td>
<td>592</td>
<td></td>
<td></td>
<td>590</td>
</tr>
<tr>
<td>Juvenile's:</td>
<td></td>
<td>5</td>
<td></td>
<td>15</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Weeks</td>
<td>Mean output</td>
<td>494</td>
<td></td>
<td>557</td>
<td></td>
<td>541</td>
</tr>
<tr>
<td>Women's:</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Weeks</td>
<td>Mean output</td>
<td>497</td>
<td></td>
<td></td>
<td>517</td>
<td>511</td>
</tr>
<tr>
<td>All:</td>
<td></td>
<td>13</td>
<td>3</td>
<td>15</td>
<td>13</td>
<td>44</td>
</tr>
<tr>
<td>Weeks</td>
<td>Mean output per shift</td>
<td>517</td>
<td>554</td>
<td>557</td>
<td>517</td>
<td>534</td>
</tr>
</tbody>
</table>
APPENDIX 2  MOULD SCHEDULING TESTS

Two tests were prepared for the mould scheduling to see how well it performed with simple problems. The first test covers a 13 week schedule with machine changes at the start and finish of the period. The second test covers 20 weeks of a theoretically infinite schedule.

Both problems use one brand with 14 sizes and correspondingly 14 moulds (with two sets of moulds for each size). The weekly demand for each mould is the same in each problem, but the initial stocks differ. Full details are given in the accompanying table.

The objective of each problem is to minimise the number of mould changes during the schedule while satisfying all demand on time. In problem 2, this is subject to the schedule continuing normally outside this period.
The production rate from each mould is ten 1000 parts per week.

<table>
<thead>
<tr>
<th>Machine Empty for Problem 1</th>
<th>x</th>
<th>x</th>
<th>x</th>
<th>x</th>
</tr>
</thead>
</table>

Problem 1: 1628 1692 1653 357 307 2469 2299 1928 2269 1768 1368 261 1096
Problem 2: 357 307 2469 2299 1928 2269 1768 1368 261 1096

Weekly Stock

<table>
<thead>
<tr>
<th>Initial Machine Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 300 500 650 750 950</td>
</tr>
<tr>
<td>200 300 500 650 750 950</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 300 500 650 750 950</td>
</tr>
<tr>
<td>200 300 500 650 750 950</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sydney's Sizes Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 13 14 15 16 17 18</td>
</tr>
<tr>
<td>2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sydney's Sizes Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 13 14 15 16 17 18</td>
</tr>
<tr>
<td>2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
## CONTROLLER'S MANUAL

### CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Purpose of the System.</td>
</tr>
<tr>
<td>2.</td>
<td>Controlling the Scheduling System.</td>
</tr>
<tr>
<td>4.</td>
<td>Completing the Cards.</td>
</tr>
<tr>
<td>5.</td>
<td>Running the Scheduling System on the Computer.</td>
</tr>
<tr>
<td>6.</td>
<td>Use of the diagnostic printouts.</td>
</tr>
<tr>
<td>7.</td>
<td>Detecting errors in the FORTRAN programs.</td>
</tr>
</tbody>
</table>
THE I M F SCHEDULING SYSTEM (Outline)

SECTION 1

PURPOSE OF THE SYSTEM

The I M F Scheduling System provides mould loading schedules for the Injection Moulded Footwear Department. Each week, the Senior Planner (IMF) issues these schedules, with slight modifications, to the IMF and the engineers to specify what changes should be made in the following week.

The schedules are also used to determine future raw materials requirements (using the ICL 'PRIME' system) and are sent to the Sales Department as an indication of future supplies to the warehouse.

The objectives of the system are to satisfy the demand and to provide a reasonable cover against fluctuations in demand. Within this and other constraints, the system aims to minimise production costs. During the selling season, the system should keep the unbalanced stocks low with short production runs, while there will be longer runs when overall stocks are high.

...
THEORY

The company sells many styles of footwear with one or more size ranges for each. To retain goodwill, it is necessary to stock all the sizes of each style so that orders can be completely satisfied. It is thus necessary to estimate the demand by size for each style until the scheduling horizon. The Sales Department supplies estimates of the future demand by list number for each month. The requirements for each size are interpreted as the released orders for that size plus an appropriate percentage of the remaining requirements based on the size roll of recent sales.

The initial stocks and the machine loading enable the stocks at any future time to be estimated. These stocks are split between a production buffer stock, used to keep down production costs; and a sales cover stock which provides against fluctuations in demand by maintaining a balanced supply of each list number to meet peak demand.

A revised set of requirements for each size are obtained by adding the sales cover stocks to the demand. The system schedules to meet the requirements wherever possible, and uses the production buffer stock to make the best quantity in each batch and minimise production costs.

The scheduling is done one week at a time by giving each mould a priority and scheduling the moulds in order of priority. The highest priority is given to meeting the requirements; other priorities are set so that once a mould is started it should remain in production until the optimal batch quantity has been moulded. This is based on the theory of the Economic Batch Quantity - a standard theory in Operations Research.
SECTION 2
CONTROLLING THE SCHEDULING SYSTEM (Outline)

SUMMARY

The stages in controlling the scheduling system are:

1. Gathering the data
2. Completing the cards
3. Running the system on the computer
4. Checking and issuing the schedule

In addition, the scheduling system produces diagnostic printouts which provide some information of general use and some specifically for detecting and clearing errors that arise in running the computer programs.

The remainder of this manual covers these matters in turn; the bulk of the manual concerns completing the cards.

SEQUENCE OF EVENTS

The time between collecting the initial information for a schedule run and issuing that schedule is about ten days.

1. The first stage is to collect the requirements from the Sales Department, the manufacturing group schedule from the Planning Manager, and the proposed production and machine loading from the planner.

2. Check then that the basic file of data for each list number and manufacturing group contains currently valid information; if not, amend it.

3. Check to see if there are any unusual circumstances applying to the proposed schedule; decide how to implement these if there are.

4. Write out all the data onto data sheets and send these to be punched. If stocks information is to be obtained from computer files, request that the appropriate STOCK-EXECUTE tape be saved.

5. Assemble the data into a card pack, and present it for the first scheduling run.

6. The data is vetted on the computer and errors or warnings issued.
7. Check through the schedule printout and clear any errors. Note that there may be errors although all cards are valid.

8. Proceed with the scheduling run, restarting if there were errors. The controller collects all the computer printouts.

9. The controller examines the printouts and issues the schedule if acceptable.

If the system breaks down during a scheduling run, the controller first attempts to discover and cure the error; if unsuccessful he calls in the Computer Department.
GATHERING THE DATA

Most of the data is gathered by the Controller himself or provided by three other people - the Planning Manager, the Senior Planner DMF or the Supplies Executive UK.

Information from the Planning Manager

The Planning Manager supplies the machine loading or manufacturing group schedule. This is written out on a special form which states the manufacturing group to use in each machine each week and any special instructions for that week, e.g. to make colour white or to run for only ten shifts.

Information from the Senior Planner DMF

The controller determines the stock date and the schedule start date. He requests details from the Senior Planner of the expected production in the intervening period, which may be four weeks long. This information will come from the current schedule or its latest revision. It enables the stock position at the schedule start to be realistically estimated.

The Senior Planner also specifies the expected machine loading at the end of the week before the schedule starts. This is input as the initial machine loading. The computer program may request mould changes at that weekend, so the first week's program will differ from the initial machine loading.

Information from the Supplies Executive UK

The Supplies Executive specifies the requirements for each list number as monthly demand estimates. Generally, the requirements will equal the forecast sales in the month.

The scheduling system plans to meet all demand evenly and will be uniformly ahead or behind on each list number in the same manufacturing group. One may wish to favour certain brands, particularly if the overall demand cannot be met; in this case, a priority allocation should be made. This will ensure that this brand is in better supply than other brands.

For example, B.S.C. is a favoured customer. If the total production is only sufficient to meet demand for the previous month, i.e. there is a four week shortfall in saleable supplies, then a priority allocation
GATHERING THE DATA (contd)

of five weeks' demand to B.S.C. products will ensure their requirements can be met from stock. The latter part is a series of articles.

Other information

Details on how to obtain other information are supplied in Section 4 on 'Completing the Cards'.
SECTION 4

COMPLETING THE CARDS

The first part of this section details how to enter the information for each card type on to data sheets. The latter part is a series of notes on special circumstances that may arise.

### SUMMARY OF CARD TYPES

<table>
<thead>
<tr>
<th>Card Type</th>
<th>Purpose</th>
<th>One card for each</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESC</td>
<td>Description</td>
<td>List no./size range</td>
</tr>
<tr>
<td>SZRL</td>
<td>Sizerolls</td>
<td>&quot;</td>
</tr>
<tr>
<td>STKS</td>
<td>Stocks</td>
<td>&quot;</td>
</tr>
<tr>
<td>PROD</td>
<td>Production before schedule</td>
<td>&quot;</td>
</tr>
<tr>
<td>MATS</td>
<td>Material availability</td>
<td>&quot;</td>
</tr>
<tr>
<td>REQS</td>
<td>Requirements</td>
<td>List no. Size Mould type</td>
</tr>
<tr>
<td>MOLD</td>
<td>Machine loading</td>
<td>&quot;</td>
</tr>
<tr>
<td>MLDS</td>
<td>Mould availability</td>
<td>&quot;</td>
</tr>
<tr>
<td>FORC</td>
<td>Forces mould into particular machine</td>
<td>&quot;</td>
</tr>
<tr>
<td>MCDA</td>
<td>Machine Data - Production rate and scheduling parameters</td>
<td>&quot;</td>
</tr>
<tr>
<td>RAWS</td>
<td>Expediting costs by week</td>
<td>&quot;</td>
</tr>
<tr>
<td>CHRT</td>
<td>Charts manufacturing group schedule</td>
<td>Mach. Type/Machine No.</td>
</tr>
<tr>
<td>WEEK</td>
<td>Working days in week</td>
<td>One only</td>
</tr>
<tr>
<td>SYNC</td>
<td>Synchronises dates</td>
<td>&quot;</td>
</tr>
<tr>
<td>CAL</td>
<td>Calendar card</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
DATES

All cards have a date attached. This is merely informative on DESC, SZRL, MLDS, MODA, MCID, MATS and FORC cards, and the current date should be used. On all other cards it is used for a specific purpose.

The most important dates are given on the SYNC card (and again on the CAL card).

These are the schedule start date, the schedule finish date and the stock date; except where specifically stated otherwise, weeks are given relative to the schedule start date which starts Week 1.

The dates on STMS and PROD cards must be the stock date.

The dates on the WEEK, CHRT and CHOV cards should be the starting date of the manufacturing group schedule, which will generally be a month before the schedule start date.

The requirements (REQS) are specified monthly with the first month given by the starting date. It will generally be convenient to set the day as 01, the first.

The weeks on the raw material availability card, RAWS, are given relative to the date on that card. It will generally be convenient to set this as the schedule start date, or the man. group schedule start date.
PRODUCT DESCRIPTIONS

The Reference Numbers

Each brand sold by Dunlop Footwear has a unique reference number, a list number, which identifies it. We give the brand another set of reference numbers for the IMF Scheduling system. These identify the machine it is made on and the other products which can be made with it, as well as giving it a unique reference.

The computer programs work with these internal reference numbers, but the input and output are performed using the list numbers.

Each list no. is indexed by the type of machine it is made on (603, 606, 609 or 704); the manufacturing group it belongs to; and within the manufacturing group it is given a unique reference number between 1 and 9.

Example - Red Flash, List No.1547, is 704/2/1.

INTRODUCING A NEW BRAND

When a new brand is introduced to the product range it must be given a suitable reference number. If it uses existing moulds or new, but compatible moulds, the brand will belong to an existing manufacturing group and should be given the next brand number in sequence.

If the brand uses distinct moulds which must run separately, a new manufacturing group must be created (see separate sheets), and the brands will number from one in this group.
COMPLETING THE DESCRIPTION CARD

One description card is completed for each size range (C, J, W or M) of each list number. It contains the following information:

<table>
<thead>
<tr>
<th>Col.</th>
<th>Content</th>
<th>Correct values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>DESC</td>
</tr>
<tr>
<td>5-10</td>
<td>Creation date</td>
<td>Current date</td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td>603, 606, 609 or 704</td>
</tr>
<tr>
<td>14-15</td>
<td>Manufacturing Group</td>
<td>01 to 05</td>
</tr>
<tr>
<td>16-17</td>
<td>Brand Number (Internal Ref.No.)</td>
<td>01 to 09</td>
</tr>
<tr>
<td>19-22</td>
<td>List number</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Size Range</td>
<td>C, J, W or M</td>
</tr>
<tr>
<td>24</td>
<td>Type of mould used</td>
<td>B for Bright, D for Dull space ((\checkmark)) normally.</td>
</tr>
<tr>
<td>25-30</td>
<td>Major moulding colour</td>
<td>Black, brown, red, green, blue, yellow or white.</td>
</tr>
<tr>
<td>31-45</td>
<td>Description for printing</td>
<td>Anything</td>
</tr>
<tr>
<td>46-80</td>
<td>Not used</td>
<td>Anything</td>
</tr>
</tbody>
</table>

Note: Two brands in the same manufacturing group with the same moulding colour will be planned together. Brands with different moulding colours will be planned for different days or weeks.
THE SIZEROLLS

Purpose - The Sizeroll card specifies the future sales likely of each size of a brand to per thousand pairs sold of that brand. After meeting immediate commitments, the stock is built up using this sizeroll as a guide.

Source - The most reliable guide to future sales should be used to give the sizeroll. Generally past sales provide this, but future commitments should be better when many forward orders have been placed. The Supplies Executive may provide the sizeroll to use.

The appropriate information can be obtained from the CRC3 printout.

The sizeroll is calculated as the actual sales of a size divided by the total sales in thousands over all size ranges.

Frequency - The sizerolls should be revised every six months, or if a change in the demand is detected by the Supplies Executive.
COMPLETING THE SIZEROLL CARD

One sizeroll card is completed for each size range of each list no. Hence there is one for each description card.

<table>
<thead>
<tr>
<th>Cols.</th>
<th>Content</th>
<th>Correct Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>SZRL</td>
</tr>
<tr>
<td>5-10</td>
<td>Creation date</td>
<td>Current date</td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td>May both be left blank</td>
</tr>
<tr>
<td>14</td>
<td>Manufacturing group</td>
<td></td>
</tr>
<tr>
<td>15-16</td>
<td>First valid week</td>
<td>Generally blank</td>
</tr>
<tr>
<td>18-21</td>
<td>List number</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Size range</td>
<td>C, J, W or M</td>
</tr>
<tr>
<td>23</td>
<td>Type of mould used</td>
<td>Leave blank</td>
</tr>
<tr>
<td>24-28</td>
<td>Sizeroll for first size in range</td>
<td></td>
</tr>
<tr>
<td>5 cols. at time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59-63</td>
<td>Sizeroll for eighth size in range</td>
<td></td>
</tr>
<tr>
<td>64-69</td>
<td>Total sizeroll for size range</td>
<td></td>
</tr>
<tr>
<td>70-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>

Notes: If the sizeroll for any size is below 1 in 1000 set it as 1.

Due to rounding errors, the total overall ranges may not equal 1000; any value between 990 and 1010 is acceptable.

* See separate sheet on exceptional circumstances.
THE MOULDS CARD

Purpose
- To specify the mould availability for each size so that a mould will not be requested if it is not available.

Source
- The engineers or MF planner should inform the Controller of any change in the mould availability. It is, in any case, desirable to check this at least once a year.

COMPLETING THE MOULDS CARD

One moulds card is required for each size range of each type of mould used. Normally there is only one type of mould for each manufacturing group, and the mould type is left blank. For Wellingtons there are bright and dull moulds, referred to as B and D respectively.

<table>
<thead>
<tr>
<th>Col(s.)</th>
<th>Content</th>
<th>Correct Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>MLD5</td>
</tr>
<tr>
<td>5-10</td>
<td>Creation date</td>
<td></td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Manufacturing group</td>
<td></td>
</tr>
<tr>
<td>15-16</td>
<td>First valid week *</td>
<td>603, 606, 609 or 704</td>
</tr>
<tr>
<td>18-21</td>
<td>List number</td>
<td>1 to 5</td>
</tr>
<tr>
<td>22</td>
<td>Size range</td>
<td>Generally blank</td>
</tr>
<tr>
<td>23</td>
<td>Type of mould used</td>
<td>Blank</td>
</tr>
<tr>
<td>28</td>
<td>No. of moulds for first series in range</td>
<td>C, D, W or M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B, D, or space</td>
</tr>
<tr>
<td></td>
<td>* See exceptional circumstances</td>
<td>Up to 3</td>
</tr>
<tr>
<td>Every 5th column</td>
<td>No. of moulds for eight size in range</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64-69</td>
<td>Total number of moulds</td>
<td></td>
</tr>
<tr>
<td>70-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>

* See exceptional circumstances
THE STOCKS

Purpose

The stocks card specifies the net current stocks after meeting immediate commitments. Future commitments are assumed balanced according to the ziseroll.

Comment

This information can be obtained directly from the computer. Only in special circumstances should card input be required.

Source

The information can be obtained from the CRCS printout. The stocks at Freestock-2 should be used. The cumulative releases are the total over relevant sizes of all forward orders released for the current or future months, but not past months, plus daily orders awaiting despatch (and export orders).
COMPLETING THE STOCK CARD

One stock card is completed for each size range of the list no.
Where no input is present, the date will be picked up from the
computer.

<table>
<thead>
<tr>
<th>Col.</th>
<th>Content</th>
<th>Correct Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>Stocks date</td>
<td>See note. As on SYNC card</td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td>Leave blank</td>
</tr>
<tr>
<td>14</td>
<td>Manufacturing group</td>
<td>&quot;</td>
</tr>
<tr>
<td>15-16</td>
<td>Reference week</td>
<td>&quot;</td>
</tr>
<tr>
<td>18-21</td>
<td>List number</td>
<td>&quot;</td>
</tr>
<tr>
<td>22</td>
<td>Size range</td>
<td>C, J, W or M</td>
</tr>
<tr>
<td>23</td>
<td>Type of mould used</td>
<td>Leave blank</td>
</tr>
<tr>
<td>24-28</td>
<td>Net stocks for first size in range</td>
<td></td>
</tr>
<tr>
<td>5 cols. at time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59-63</td>
<td>Net stock for eighth size in range</td>
<td></td>
</tr>
<tr>
<td>64-69</td>
<td>Total stock for size range</td>
<td></td>
</tr>
<tr>
<td>70-75</td>
<td>Cumulative released orders</td>
<td></td>
</tr>
<tr>
<td>76-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The stocks date is the last date for which transactions have been processed. It will be a couple of days before the date on the CRO8. If net stocks are negative, place minus sign in the first column of the field.
<table>
<thead>
<tr>
<th><strong>THE PRODUCTION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td><strong>Source</strong></td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
</tr>
</tbody>
</table>
COMPLETING THE PRODUCTION CARD

There are no bounds on the number of production cards. There may be none for a size range and list no., or, alternatively, several.

<table>
<thead>
<tr>
<th>Cols.</th>
<th>Content</th>
<th>Correct Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>PROD</td>
</tr>
<tr>
<td>5-10</td>
<td>Stocks date</td>
<td>As on SYNC and STKS cards</td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td>Can leave blank</td>
</tr>
<tr>
<td>14</td>
<td>Manufacturing group</td>
<td>Leave blank</td>
</tr>
<tr>
<td>15-16</td>
<td>Reference week</td>
<td>Leave blank</td>
</tr>
<tr>
<td>18-21</td>
<td>List number</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Size range</td>
<td>C, J, W or M</td>
</tr>
<tr>
<td>23</td>
<td>Type of mould used</td>
<td>Leave blank</td>
</tr>
<tr>
<td>24-28</td>
<td>Production for first size in range</td>
<td>Production for eighth size in range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total production over size range</td>
</tr>
<tr>
<td></td>
<td>5 cols. at time</td>
<td>Not used</td>
</tr>
<tr>
<td>59-63</td>
<td>Production for eighth size in range</td>
<td></td>
</tr>
<tr>
<td>64-69</td>
<td>Total production over size range</td>
<td></td>
</tr>
<tr>
<td>70-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>
THE MACHINE LOADING CARD

Purpose
The machine loading cards state the machine loading expected at the end of the previous schedule. This ensures that the schedules 'marry' up. A machine loading card can also be used to encourage the loading of a particular mould in a later week. It cannot force that loading though.

Source
The IMF planner will provide this information which should generally come from the previous schedule.

Frequency
New machine loading cards are needed for each schedule.
Completing a Machine Loading Card

There will usually be 5 machine loading cards for each machine. None are necessary if the whole machine is to be changed.

<table>
<thead>
<tr>
<th>Col.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 4</td>
<td>Card Type</td>
<td>MCLD</td>
</tr>
<tr>
<td>5 - 10</td>
<td>Current date</td>
<td></td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td>603, 606, 609 or 704</td>
</tr>
<tr>
<td>14</td>
<td>Manufacturing group</td>
<td>1 to 5</td>
</tr>
<tr>
<td>15</td>
<td>Machine number</td>
<td>1 to 5</td>
</tr>
<tr>
<td>16-17</td>
<td>Relevant week</td>
<td>Generally blank or 01</td>
</tr>
<tr>
<td>18</td>
<td>Size range</td>
<td>C, J, W or M</td>
</tr>
<tr>
<td>19-20</td>
<td>Size</td>
<td></td>
</tr>
<tr>
<td>21-22</td>
<td>Type of mould loaded</td>
<td>B or D</td>
</tr>
<tr>
<td>23-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>

Note: Columns 21 and 22 indicate the loading. Generally one mould is used and D should be entered for a dull mould, B otherwise. If two moulds are in use, the entry should be BB etc.
**THE REQUIREMENTS CARD**

**Purpose**
- The requirements card specifies monthly forecasts of demand for each list number. The demand is assumed to be split between the sizes according to the sizerrll.

**Source**
- The supplies executive will supply this information, using information about known orders.

**Note**
- To permit a list number to be given priority, a priority allocation can be made. This will increase the supply of that list number appropriately, to the detriment of other brands in that manufacturing group.

**Frequency**
- The requirements should be revised whenever new information becomes available, at least quarterly.
# Completing the Requirements Card

One requirements card, with possible continuation cards, is needed for list number.

<table>
<thead>
<tr>
<th>Col.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>REQS</td>
</tr>
<tr>
<td>5-10</td>
<td>Starting date</td>
<td>1, 2 or 3</td>
</tr>
<tr>
<td>11</td>
<td>Part</td>
<td></td>
</tr>
<tr>
<td>13-16</td>
<td>List number</td>
<td>1, 2 or 3</td>
</tr>
<tr>
<td>17-22</td>
<td>Priority allocation (Frs)</td>
<td>Part 1 only,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Generally blank</td>
</tr>
<tr>
<td>23-28</td>
<td>Requirements for starting month (10th/19th)</td>
<td></td>
</tr>
<tr>
<td>29-34</td>
<td>Requirements for second month (11th/20th)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71-76</td>
<td>Requirements for ninth month (18th/27th)</td>
<td></td>
</tr>
<tr>
<td>77-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>
SYNCHRONISATION

Purpose
To specify the start and end dates of the schedule and also the stock date. All other information is synchronised to these dates.

Source
The Controller determines the dates. There is one SYNC card per run.

Completing the SYNC card

<table>
<thead>
<tr>
<th>Cols.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card type</td>
<td>SYNC</td>
</tr>
<tr>
<td>5-10</td>
<td>Schedule start date</td>
<td>A Monday</td>
</tr>
<tr>
<td>11-16</td>
<td>Schedule finish date</td>
<td>As on STKS and PROC cards.</td>
</tr>
<tr>
<td>17-22</td>
<td>Stocks date</td>
<td></td>
</tr>
<tr>
<td>23-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>
### The Calendar Card

**Purpose**
- To specify the schedule start and finish dates for the printout and for the PROMPT BREAKDOWN tape.

**Source**
- The Controller determines these dates as for the SYNC card.

**Note**
- The Calendar Card is used in M50 and not in M10 and M20.

### Completing the CAL Card

<table>
<thead>
<tr>
<th>Column</th>
<th>Content</th>
<th>Correct Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Card type</td>
<td>CAL</td>
</tr>
<tr>
<td>4-9</td>
<td>Schedule starting date</td>
<td>As SYNC card</td>
</tr>
<tr>
<td>10-15</td>
<td>Schedule finish date</td>
<td>&quot;&quot; &quot;&quot; &quot;&quot;</td>
</tr>
<tr>
<td>16-21</td>
<td>Excluded date</td>
<td>Not normally used</td>
</tr>
<tr>
<td>22-27</td>
<td>Excluded date</td>
<td>&quot;&quot;</td>
</tr>
<tr>
<td>...</td>
<td>&quot;PROMPT&quot; week for schedule start</td>
<td>52 assumed if blank</td>
</tr>
<tr>
<td>78-79</td>
<td>Weeks in current 'Prompt' year</td>
<td>(\checkmark) if weekly schedule</td>
</tr>
<tr>
<td>.80</td>
<td>Day Indicator</td>
<td>1 if daily schedule</td>
</tr>
</tbody>
</table>
THE MANUFACTURING GROUP SCHEDULE

Purpose
The manufacturing group schedule states which manufacturing group is to be made on each machine during each week. It also specifies any special conditions for that week.

Normal Conditions
The normal conditions are that the machine is running with 5 moulds for 3 shifts a day with the moulding colour unspecified.

Source
The manufacturing group schedule is prepared by the Planning Manager shortly before starting each scheduling run.

Coding
The information is presented to the computer on three types of card: WEEK, CHRT and CHOV. The WEEK card specifies the number of working days each week. The CHRT cards specify the manufacturing groups to be in each machine. The CHOV (Chart override) cards give any special conditions for any set of weeks.
## Completing the WEEK and CHRT Cards

There is one WEEK card per run, and one CHRT card per machine!

<table>
<thead>
<tr>
<th>Col.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>WEEK</td>
</tr>
<tr>
<td>5-10</td>
<td>Start date of manufacturing group schedule</td>
<td>A Monday</td>
</tr>
<tr>
<td>11-20</td>
<td>Unused</td>
<td>Blank</td>
</tr>
<tr>
<td>21-80</td>
<td>Working days in week</td>
<td>0 to 7</td>
</tr>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>CHRT</td>
</tr>
<tr>
<td>5-10</td>
<td>Start date of manufacturing group schedule</td>
<td>As WEEK card</td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td>603, 605, 609 or 704</td>
</tr>
<tr>
<td>14</td>
<td>Machine Number</td>
<td>1 to 5</td>
</tr>
<tr>
<td>15-20</td>
<td>Unused</td>
<td>Blank</td>
</tr>
<tr>
<td>21-80</td>
<td>Manufacturing group loaded</td>
<td>0 to 5</td>
</tr>
</tbody>
</table>

**Notes:**

Columns 21 to 80 refer respectively to the first to sixtieth week of the manufacturing group schedule. Thus column 32 is the 12th week.

A space on the WEEK card is interpreted as a normal 5-day week.

A zero on a CHRT card indicates the machine should only be used as a reserve machine in that week. Spaces should only occur on this card after the end of the manufacturing group schedule.
COMPLETING THE CHART OVERRIDE CARDS

A CHOV card (Chart override) is completed for each case in which special circumstances apply. It can cover any number of consecutive weeks.

<table>
<thead>
<tr>
<th>Cols.</th>
<th>Content</th>
<th>Correct Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- 4</td>
<td>Card Type</td>
<td>CHOV</td>
</tr>
<tr>
<td>5-10</td>
<td>Start date of manufacturing group schedule</td>
<td>As WEEK card</td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td>603, 606, 609 or 704</td>
</tr>
<tr>
<td>14</td>
<td>Machine number</td>
<td>1 to 5</td>
</tr>
<tr>
<td>15</td>
<td>Manufacturing group</td>
<td>1 to 5</td>
</tr>
<tr>
<td>16-17</td>
<td>First relevant week</td>
<td></td>
</tr>
<tr>
<td>18-19</td>
<td>Last relevant week</td>
<td></td>
</tr>
<tr>
<td>20-21</td>
<td>Number of moulds</td>
<td>Normally 05</td>
</tr>
<tr>
<td>22-23</td>
<td>Number of shifts</td>
<td></td>
</tr>
<tr>
<td>24-29</td>
<td>Moulding colour</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The weeks are specified relative to the manufacturing group schedule start date. The moulding colour corresponds to that on the description card; if this is left blank, the colour will be chosen in the scheduling process.
**MACHINE DATA**

**Purpose**
- To supply information about the machinery while it is producing a specific manufacturing group. There are two types of information - production details go on one card and scheduling parameters on another.

**Source**
- Varied - mainly collected by the Controller.

**Frequency**
- Checked every six months or so.

**Details**
- See sheets on setting up a new manufacturing group and on adjustment of the scheduling parameters.
COMPLETING A PAIR OF MCDA CARDS

There is one pair of MCDA cards for each manufacturing group. The first card gives production information, the second scheduling parameters.

<table>
<thead>
<tr>
<th>Cols.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>MCDA</td>
</tr>
<tr>
<td>5-10</td>
<td>Current date</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Part</td>
<td>603, 606, 609 or 704</td>
</tr>
<tr>
<td>12-14</td>
<td>Machine Type</td>
<td>1 to 5</td>
</tr>
<tr>
<td>15</td>
<td>Manufacturing Group</td>
<td>Normally blank</td>
</tr>
<tr>
<td>16-17</td>
<td>Starting week</td>
<td>&quot;</td>
</tr>
<tr>
<td>18-19</td>
<td>End week</td>
<td>&quot;</td>
</tr>
<tr>
<td>20-23</td>
<td>Average production per full week</td>
<td>Prs. of bests</td>
</tr>
<tr>
<td>24-27</td>
<td>Weekly production on Machine 1</td>
<td></td>
</tr>
<tr>
<td>28-31</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>32-35</td>
<td>&quot;</td>
<td>3</td>
</tr>
<tr>
<td>36-39</td>
<td>&quot;</td>
<td>4</td>
</tr>
<tr>
<td>40-43</td>
<td>&quot;</td>
<td>5</td>
</tr>
<tr>
<td>44</td>
<td>Machine to take smallest sizes</td>
<td></td>
</tr>
<tr>
<td>:</td>
<td>Other machines in order</td>
<td></td>
</tr>
<tr>
<td>:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49-51</td>
<td>Typical large size for Machine 1</td>
<td>Eg. C09, M11.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Normally blank</td>
</tr>
<tr>
<td>61-63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64-69</td>
<td>Desired minimum freestock</td>
<td>Normally blank</td>
</tr>
<tr>
<td>70-79</td>
<td>Not used</td>
<td>D for daily</td>
</tr>
<tr>
<td>80</td>
<td>Day Indicator</td>
<td>W for weekly</td>
</tr>
<tr>
<td>Col.</td>
<td>Content</td>
<td>Correct value</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1- 4</td>
<td>Card Type</td>
<td>NCDA</td>
</tr>
<tr>
<td>5-10</td>
<td>Current date</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Part</td>
<td>603, 606, 609 or 704</td>
</tr>
<tr>
<td>12-14</td>
<td>Machine Type</td>
<td>1 to 5</td>
</tr>
<tr>
<td>15</td>
<td>Manufacturing Group</td>
<td>Normally blank</td>
</tr>
<tr>
<td>16-17</td>
<td>Starting week</td>
<td>£ per week's supply</td>
</tr>
<tr>
<td>18-20</td>
<td>Expediting cost</td>
<td>£</td>
</tr>
<tr>
<td>21-23</td>
<td>Set-up Cost</td>
<td>£</td>
</tr>
<tr>
<td>24-26</td>
<td>Colour change cost</td>
<td>£-mm per size difference</td>
</tr>
<tr>
<td>27-29</td>
<td>Size Scatter Cost</td>
<td>Often zero indicating</td>
</tr>
<tr>
<td>30-31</td>
<td>Maximum spread of sizes</td>
<td>unlimited</td>
</tr>
<tr>
<td>32-33</td>
<td>Mould change limit</td>
<td>Thousandths</td>
</tr>
<tr>
<td>34-37</td>
<td>Weighting factor</td>
<td>&quot;</td>
</tr>
<tr>
<td>38-41</td>
<td>Fraction saleable</td>
<td>Ø or ± 1</td>
</tr>
<tr>
<td>42-45</td>
<td>Indicator</td>
<td></td>
</tr>
</tbody>
</table>
SETTING UP A NEW MANUFACTURING GROUP

If a new set of brands is introduced, they will need a new manufacturing group if they are moulded separately from existing brands. Allocate these brands the next manufacturing group for the machine type they use, e.g. G03 group 3.

Production details

The average production rate from one mould in bests per full week can be obtained initially from the Planning Manager. Once the manufacturing group has run for a few weeks, actual production figures should be used.

Note that the figure for bests, not total output, should be used and that the output rate per mould will be a fifth of the machine output.

Production per machine

The production rates from each machine will generally be the same but if, for any reason, there are differences, these can be included.

Notes

At present, for the Bright and Dull wellingtons, the expected production per mould-week is 100 pairs higher on the child's or juveniles' machines than on the women's machines.

The production rate for the number 3 machine on Standard Sports should be the value for white sports. If black sports are in use, BM30 scales this figure down by 10% so no adjustment to the NESA card is needed.

Machines in smallest sizes sequence

All the machine numbers which could potentially be used to make this manufacturing group must be ranked in sequence. If several machines can be in use together, the first machine will take the smallest sizes, the second the middle sizes, etc. The ranking does not matter if only one machine is used at a time to make this manufacturing group. The suggested ranking is to put the most likely machine first.
A TYPICAL SIZE FOR EACH MACHINE

This is generally left blank and the scheduling routine determines these automatically. If these are specified they should be specified for all machines. The maximum possible size for a machine will generally be two sizes larger than this typical large size.

DESIRED PREELOG

Leave this blank except for exceptional circumstances explained in adjusting the parameters.

DAY INDICATOR

This determines whether daily or weekly schedules are issued. Generally, weekly schedules should be issued. Where a variety of colours are to be made in a short period, as with golf, daily schedules are appropriate.

SCHEDULING PARAMETERS

Costs - The expediting cost is an estimated cost for expediting a week's supply of linings. It is used only as a guide (see RAWS card) so need not be very accurate.

The set-up cost is the estimated cost of a mould change. It includes fitter's time, operative's time, value of scrap and value of lost output. It should be calculated for a weekend or midweek, whichever is more representative.

The colour change cost is the average cost of changing colour. Changes to a darker colour involve flushing the barrel and are cheap; changes to a lighter colour require a screw-clean. A weighted average of these costs should be used (say half and half).
The size scatter cost and maximum spread should be set to zero if there is only one size range or up to 10 sizes per machine in the manufacturing group. The weighting factor is, in this case, irrelevant and can be set to 1,000.

If the manufacturing group contains a wide range of sizes, as does Standard Sports, which it is undesirable to mould simultaneously, these two parameters should be set:

The size scatter cost should be set as 1/20 of the estimated loss per week, due to running a Juvenile's 10 with a Women's 7. The loss is the cost of the increased downtime plus the lost output.

The maximum spread of sizes should be set to the largest spread you are willing to allow. The average spread of sizes will be half of this (if half is above 5). Count the spread in shoe sizes, i.e. C9 to W8 is 12 sizes. An unnecessarily low value of 'max. spread' can significantly increase scheduling costs.

A suitable value for the weighting factor is .60; values between .25 and .5 give generally acceptable results. Lower values may be too sluggish to change and higher values too responsive to exceptional moulds.
THE MOULD CHANGE LIMIT

The Mould Change Limit should be set to the maximum allowable number of mould changes in a weekend for this manufacturing group, bearing in mind that there may also be machine changes taking place. Once the mould change limit has been reached in a week, no more mould changes will be scheduled unless it is physically impossible not to schedule more. For example, if the mould change limit is 2, it will still require 5 mould changes on start-up.

The Fraction Saleable

Up to the minimum requirements for effective production scheduling, all stock is allocated for production purposes and there will be no saleable stock. Above this minimum requirement, 'fraction' of the stock will be made saleable, the rest will contribute to decreasing production costs. Values between about .3 and .800 should be suitable and the suggested initial setting is .600.

Indicator

Set to zero for everything except S/Sports and Red Flash, where 1 should be set.
EXCEPTIONAL CIRCUMSTANCES

Use of the relevant week

On SZRL, MLDS, FCNC, MCDA, MATS and MCLD, there is a field 'week' or 'relevant week'. This is generally blank (or 01 on the MCLD card); however positive values are permissible.

Positive values indicate a change that is due to take place in a specified week after the schedule start date. Most commonly later weeks will be used on MATS or MCLD cards, but, for example, if a new mould will arrive during the schedule, a second set of MLDS cards will specify the change. Cards will only be output for these later weeks as a result of exceptional circumstances brought to the controller's attention.

Notes: If any new MLDS, FCNC or MCDA card is issued then all necessary parts for a complete record must be reissued, e.g. if a new Juvs. mould arrives, must reissue the old cards for C, W and M.

If any sizeroll is varied during the schedule, (unlikely) a new MCDA card must be issued from this week and the previous MCDA must finish in an earlier week. The sizeroll must be reissued for all size ranges.

The most likely reasons for issuing a second set of MCDA cards is if the production per mould or the ordering of the machines varies during the schedule, but even this will be rare.
OPTICAL CARDS

The optional cards indicate a limited raw material availability, RAWs and MATS, or restrict a certain mould to going in one particular machine only, FORC. For full details of their use, see the section on exceptional circumstances. The RAWs and MATS card are used together.

**Source**

These cards are used when exceptional circumstances are brought to the attention of the Controller. They should be infrequently required; when they are, the appropriate information may come from anywhere.

**Frequency**

Rarely used.

**Outline of Use**

- **MATS** - Indicates the number of pairs of each size that can be made without expediting.
- **RAWS** - Shows the expediting cost appropriate for each week.
- **FORC** - If not blank, specifies the only machine into which a specific size of mould may go.
USES OF MATS CARDS

The major use of MATS cards is when limited raw material availability restricts production of some sizes. They can also be used as artificial controls to prevent or force certain sizes into manufacture for other reasons.

If the material availability is positive, it is assumed that any quantity can be produced that week (generally one mould week's production). If the availability is zero or negative, the expediting cost must be paid to produce that product. In setting the availability, quantities should be rounded down to a whole number of weeks.

To prevent certain sizes from production, either enter no moulds or set unlimited availability on everything bar these sizes, and set the RAWS cost high. To force certain products in, set the availability at zero for all bar these products, which should have positive availability, and set a reasonably high RAWS cost.

As more material becomes available, further cards can be inserted for later weeks. The availability is additive and only relevant non-zero entries need be made.

A blank entry indicates 99,999 pairs, this can be counteracted by an entry of 99999 or R9999 which will reset the availability to zero.
**COMPLETING THE MATERIAL AVAILABILITY CARD**

There are no bounds on the number of material availability cards. There can be one for each size range of each brand in each week.

<table>
<thead>
<tr>
<th>Cols.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>MATS</td>
</tr>
<tr>
<td>5-10</td>
<td>Current date</td>
<td></td>
</tr>
<tr>
<td>11-13</td>
<td>Machine Type</td>
<td>Can leave blank</td>
</tr>
<tr>
<td></td>
<td>Manufacturing Group</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>15-16</td>
<td>Relevant week</td>
<td>Relative to schedule start date (Not Man. Group schedule)</td>
</tr>
<tr>
<td>17-21</td>
<td>List Number</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Size range</td>
<td>C, J, W or M</td>
</tr>
<tr>
<td>23</td>
<td>Type of mould</td>
<td>Leave blank</td>
</tr>
<tr>
<td>24-28</td>
<td>Material availability for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>first size in range.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59-63</td>
<td>Material availability for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>eighth size in range.</td>
<td></td>
</tr>
<tr>
<td>64-69</td>
<td>Total material availability</td>
<td></td>
</tr>
<tr>
<td>70-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The material availability is the number of pairs which can be produced without expediting. To signify that there is no limit, leave the field blank. If there is no material available, set the value to zero.
SETTING THE RAWS COSTS

If the material availability is limited, a RAWS card is needed. If expediting is possible, the cost should be set to the expediting cost (see NCDA Part 2), or a more appropriate value.

Otherwise, the cost is being used as a control variable. The table below shows its effect at various values. It operates by reducing the priority by this cost; furthermore, if the total extra cost exceeds 190, the priority is divided by 100.

<table>
<thead>
<tr>
<th>Cost</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 49</td>
<td>Includes this cost in calculating the mould priority.</td>
</tr>
<tr>
<td>50 to 100</td>
<td>Stops non-urgent products from being made, but not urgent products.</td>
</tr>
<tr>
<td>130 to 189</td>
<td>Stops most urgent products being made, but not extremely urgent.</td>
</tr>
<tr>
<td>190 to 480</td>
<td>Stops any expediting if any other products can be made.</td>
</tr>
<tr>
<td>510</td>
<td>Stops any expediting. Program halts if this is unavoidable.</td>
</tr>
</tbody>
</table>

Within any range, the effect of a change in value is low, i.e. a schedule with expediting cost 50 will resemble one with cost 100. Values between 100 and 130 and 480 to 510 are not recommended because they have inconsistent effects.

The major difference between a cost of 200 and 1,000 is that the scheduling will halt and proceed to the next group if expediting is required with a cost of 1000, whereas it will continue if the cost is 200. 1000 represents impossibility better, but makes re-scheduling necessary; generally a value below 480 will be preferable providing the schedule is then checked carefully.

**Warning:** Expediting may be requested to avoid violating the mould change limit.
COMPLETING THE RAWS CARD

A RAWS card is needed if any MATS cards are used for that manufacturing group. One card is generally sufficient, but the information can be continued on subsequent cards.

<table>
<thead>
<tr>
<th>Cols.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card type</td>
<td>RAWS</td>
</tr>
<tr>
<td>5-10</td>
<td>Starting date</td>
<td>Schedule start date</td>
</tr>
<tr>
<td>11</td>
<td>Part</td>
<td>1 to 4 in order</td>
</tr>
<tr>
<td>12-14</td>
<td>Machine type</td>
<td>603, 606, 609 or 704</td>
</tr>
<tr>
<td>15</td>
<td>Manufacturing group</td>
<td>1 to 5</td>
</tr>
<tr>
<td>16-17</td>
<td>First week</td>
<td>Generally 01</td>
</tr>
<tr>
<td>18-22</td>
<td>Expediting cost in this week</td>
<td>Relative to starting date on card</td>
</tr>
<tr>
<td>23-24</td>
<td>Next week</td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7 cols at time

| 72-73 | Week                                |                                    |
| 74-78 | Expediting cost in this week        |                                    |
| 79-80 | Not used                            |                                    |

Note: A new entry is made each week the expediting cost changes. The final entry, when the situation returns to normal, should have cost zero.
USE OF THE FORCE CARD

The FORCE card is not used to force a particular mould into a specified machine. It ensures that the mould will go into that machine if it is used, but the mould may not be required. It does not override a current machine loading, if the mould is loaded in another machine it will stay there.

A FORCE card may be desirable for keeping certain sizes out of a machine, for example, allow only dull moulds in No.4 609. It may also be used to force moulds which run in large batches into a machine which stays in use rather than one which will change manufacturing group shortly.
Completing a 'FORCE' Card

There can be a 'force' card for each size range of each type of mould used. Force cards can also be provided for later weeks.

<table>
<thead>
<tr>
<th>Col.</th>
<th>Content</th>
<th>Correct value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Card Type</td>
<td>FORCE</td>
</tr>
<tr>
<td>5-10</td>
<td>Current date</td>
<td></td>
</tr>
<tr>
<td>11-13</td>
<td>Machine type</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Manufacturing group</td>
<td>1 to 5</td>
</tr>
<tr>
<td>15-16</td>
<td>Relevant Week</td>
<td>Relative to schedule start date</td>
</tr>
<tr>
<td>18-21</td>
<td>List number</td>
<td>Leave blank</td>
</tr>
<tr>
<td>22</td>
<td>Size range</td>
<td>C, J, W or H</td>
</tr>
<tr>
<td>23</td>
<td>Type of mould used</td>
<td>B, D or space</td>
</tr>
<tr>
<td>28</td>
<td>Machine for first size in range</td>
<td>Space or 0 to 5</td>
</tr>
<tr>
<td></td>
<td>Every fifth column</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>Machine for eighth size in range</td>
<td></td>
</tr>
<tr>
<td>64-69</td>
<td>Total of entries</td>
<td></td>
</tr>
<tr>
<td>70-80</td>
<td>Not used</td>
<td></td>
</tr>
</tbody>
</table>
On the introduction of the 606 machine it was necessary to provide a schedule for an 8-week run of unbranded bright Wellingtons, 6201A. Several moulds were already in the machine for test purposes and these moulds were kept in for the first week of the programme. The only stock would be that produced during the first week (estimated at 1400 pairs per mould).

Since the product was replacing the unbranded wellingtons made on the 609 machines, its requirements were uncertain, but, due to the general shortage of stock, the stocks would be low and high requirements were assumed. The sizeroll was taken from the sales last year of unbranded wellingtons.

The machine information was estimated from the best available information. The main concern was the output per mould per week which was estimated at 1400 pairs of bests.

DATA NEEDED

The information input to the scheduling system is shown on the next page and explained here. Nineteen cards are necessary.

The first two cards provide a description (DESC) of the products, one card for each list no. and size range. This specifies that the product is made on the 606 machine and is the first brand in the first group with size ranges childs and juveniles.

The next two cards give the sizerolls (SZRL) by size and in total for each size range. Thus 43 pairs per thousand will be childs size 7 and 86 childs size 8, etc.

The two moulds cards (MILS) state the number of moulds available for each size and in total. In this case there is one mould for each size.

The stocks cards (STKS) give the stocks on the 10th March after one week's production. The zero indicates that no requirements have been taken into account.

The requirements card (REQS) states that the minimum stock-holding is zero and that fifteen thousand pairs are required in March with twenty-five thousand in April, May and June.
The first machine details card (MCDA) states that the average production and production from machine no. 1 are 1400 pairs per mould week. It also states that only machine 1 is used and schedules are produced weekly.

The second card provides some cost information and scheduling parameters. For example, the '3' specifies a limit of 3 mould changes a week.

The Week card (WEEK) specifies the number of working days in each week. This is five days a week except over Easter, when it is four.

The Chart card (CHRT) specifies the manufacturing group to be made on the first 6C6 machine. Group number 1 is to be made for 8 weeks and then Group 2 (Snobops).

The Synchronisation card (SYNC) states that the schedule is to run from 10th March to 12th May, with a stock date of 10th March.

Finally, the machine loading cards (MCLD) specify the sizes that are loaded at the start of the schedule. (Childs 9, Juveniles 11, 13, 1 & 2).
SECTION 5

RUNNING THE SCHEDULING SYSTEM ON THE COMPUTER

OUTLINE OF THE CONTROLLER'S RESPONSIBILITIES

1. The data is written out and punched on to cards.

2. The data cards are assembled with the standard information in front.

3. The first computer run is made (JM10 and JM20) (The Computer Department has detailed operating instructions).

4. The printouts are checked and the data corrected.

5. The second computer run is made. This time the full system is run. Any further errors are cleared on a re-run.

6. The schedules and schedule printouts are examined and issued.
OUTLINE OF THE COMPUTER SYSTEM

The IMF Scheduling is performed by a suite of 5 computer programs. The main processing is performed in the third and fourth programs, which are written in FORTRAN, a scientific programming language.

Since a single error can invalidate the schedule for a manufacturing group with no easy method of correction, it is important to check the date carefully. This is done by two COBOL programs. IM10 checks the validity of the data submitted; IM20 checks its completeness and consistency. The latter program also processes the data into a suitable form for the FORTRAN programs and provides a simple stock projection.

IM30 provides target levels of saleable stock for each list number each month. A sales cover stock, depending on the total available stock at that time, is added to the demand to give a revised set of requirements for each list number.

IM40 calculates the production schedules to meet the revised set of requirements for a given machine loading schedule. Within this constraint it aims to minimise production costs.

Finally, IM50, another COBOL program, prints out the schedules.
ASSEMBLING THE CARD PACK

The only rule about the card pack is that the Description Cards must come first with all description cards for one list number together.

It is convenient to keep the rest of the pack grouped into card types. Since the MLDS, NCDA and SZRL cards remain for several runs, these cards should come next. The other card types may appear in any convenient order. An end card (****) should appear at the end of the pack.

The Calendar Card (CAL) is kept separate for the second scheduling run.
THE FIRST SCHEDULING RUN

Object
- To vet the data and format it for easy checking. Also to produce an output tape for the scheduling programs.

Action
- The Computer Department have full details on running the computer system. They retain the standard decks of cards for sorting the tapes etc.
The Controller provides the Computer Department with the assembled pack of cards to run through M10.

Stocks tape
- If the stocks information is to be obtained directly from the computer files, ask Operating Supervisor to save the 'STOCK COMMIT' tape relating to the end of the preceding week. The tape will generally be created on Monday.

Insert the Saturday of the preceding week as the STOCK DATE. Production information should relate to weeks after this date until the schedule start.

If no STOCK COMMIT tape is to be used, M10 will be run with the setting ON2.

Checking the Printouts
Two printouts are issued; one from M10, and one from M20. The second printout is formatted conveniently for checking; the first gives only card images. It is suggested that the checks are made on the second printout with the first used as a cross-reference. An appendix lists the error codes and their meanings.

Guidelines for Checking
1. Check the Description Cards
Look down the list of description cards to see if it is complete.
Check carefully any new descriptions. Many errors, such as an incorrect list number cannot be detected by the computer.

Note and correct any errors. These may cause
errors in later cards - so beware!
The totals at the end show the number of valid and invalid cards.

2. See if there are any unrecognised cards. If so, establish what the card(s) should be and correct them. (The sequence in IM10 may be helpful here).

3. Check carefully that the SYNC and WEEK cards are valid and correct. Note that blank spaces on the WEEK card are translated as 5.

For each machine type perform the following checks:

4. Check any new NCDA cards very carefully to see that they have been correctly coded. Scan earlier NCDA cards for any errors or warnings.

Note: For the exact card images see IM10 printout. The IM20 printout is easier to check.

5. Check CHRT and CHOV cards against the manufacturing group schedule.

6. Scan the remaining card types. Identify and clear any errors or warnings using the appendix to identify them.

7. Examine the stock projections by manufacturing group. These specify the production, requirements and stocks in each 4 week period. The production should approximately equal the production per machine week times the number of machine weeks.

The requirements should exceed production in season, and be lower out of season. The net stocks may become negative. If this is expected, do not worry; otherwise inform the Planning Manager. (Note: The final production
figures may be for fewer than 4 weeks, while the requirements are for a full four-weeks, so do not worry about stockouts in the final 4 weeks).

8. Check the control totals at the end of each machine type to see that all invalid cards have been found.

9. Examine the machine error/warning codes, establish the cause of each, and ensure either that this is acceptable or cure the error. Errors will all be identified with specific cards, as will some warning codes. These should already have been checked and cleared.

Other warning codes:

815. This indicates that the number of machines for which CHRT cards have been supplied differs from the number of machines for which a machine loading is given.
   If this warning occurs, re-check the CHRT and KCLD cards. They may well be correct, e.g. if a machine is currently empty.

822 & 824
These indicate that the production per machine per week is not in the expected range.
Warning code 824 is likely to occur if some machines are not running at present.
If either warning appears, check the total production figures.

830 to 850
These indicate that some set of records are incomplete, e.g. 840 indicates the STKS records are incomplete.
If the data is valid but the warning still appears, check against the description table. There may be description cards for inactive list numbers for which no stocks or size rolls are required.
These warnings automatically occur if there are any errors in the appropriate data since no output record is written.

10. After making these checks for each machine type, check the final run controls to see that all invalid cards have been found.

Note: No invalid cards does not necessarily mean the data is OK, it may be incomplete or wrongly coded.
The second scheduling run proceeds right through the system unless halted by errors, and finishes by printing out schedules for the INF.

A. If there were no errors in the first run and no corrections need to be made:
The scheduling can continue from the stage at which it was broken off.
The data cards do not need to be resubmitted. The Controller should remove the DESCRIPTION cards from the front of the data pack and insert them behind the CALENDAR card to run through IN50.

B. If there were errors in the first run:
Scheduling must recommence at the beginning (using the same STOCK COMMIT tape).
Error cards should be removed from the data pack and corrections inserted (not necessarily in the same place, at the end will do). The pack is then resubmitted to the Computer Department, together with a CALENDAR card. The Computer Department will remove the description cards from the front of the IN10 pack for use in the IN50 run.

When IN20 is finished, the run will continue, providing the console states no invalid cards, otherwise, they must be corrected and a further re-run made.

Running stops after IN40 if there are errors in either IN30 or IN40, in which case, the message HALTED EE appears on the console. Otherwise, the system proceeds to IN50 and prints the schedules.
Basic Checks: Completeness

1. Examine the schedule to see if a schedule has been produced for each machine, and to see whether it is complete. It may stop after the early weeks because of an error in E30 or E40. Check missing weeks against CHRT cards.

2. Examine the control totals to see if any records were rejected. There is a control total in E30 at the end of each machine type and in E40 at the end of the run.

3. Skip through the E40 printout to see if any schedules were abandoned due to some internal error. If so, a message will appear on the page previous to the 'FINAL STOCKS'. Any error here will cause an incomplete schedule and hence should have been detected already.

If all these checks are passed satisfactorily, the schedules are complete. If any errors are detected turn to the section on 'errors in the FORTRAN programs'.

Basic Checks: Suitability

The schedule is deemed to be suitable if it has no unavoidable stockouts and a satisfactory level of mould changes.

1. Check E30 printout under STOCK PROJECTION and see if there are stockouts for any list no. If there are, inform the Planning Manager if these are unexpected.

If there are any stockouts, stocks of other list numbers in the same manufacturing group should generally be low, but a stockout may occur if initial stocks of a list no. are low.

2. Check E40 printout on pages with FINAL STOCKS.

Note the total mould changes as a rate per week. Accept it if above zero and below the mould change limit. If there are no mould changes there may be a data error.

3. Check the final stocks figures. All should be positive. Occasional negative values (down to -2000) are acceptable.

A large negative value is suspicious and may indicate no moulds were available for that size or it was forced into an impossible machine.
If the schedule passes these checks it appears satisfactory and can be issued. The diagnostic printouts should be kept in case any queries about the schedule arise. (See use of the diagnostic output).
<table>
<thead>
<tr>
<th>Error Code</th>
<th>Condition</th>
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<tbody>
<tr>
<td>001</td>
<td>Unrecognised Card Code</td>
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<tr>
<td>005</td>
<td>Day invalid</td>
</tr>
<tr>
<td>006</td>
<td>Date non-numeric</td>
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<tr>
<td>010</td>
<td>Month invalid</td>
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<tr>
<td>015</td>
<td>Year below 74</td>
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<tr>
<td>020</td>
<td>Machine Type not 603, 606, 609 or 704</td>
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<tr>
<td>025</td>
<td>Manufacturing Group not between 1 and 5</td>
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<tr>
<td>027</td>
<td>Internal Product Number not 1 to 9</td>
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<tr>
<td>030</td>
<td>List Number not numeric</td>
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<tr>
<td>033</td>
<td>Every occurrence of list number must have same internal product number</td>
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<tr>
<td>035</td>
<td>Size range must be C, J, W or M</td>
</tr>
<tr>
<td>038</td>
<td>B or D marker must be B, D or ▽</td>
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<tr>
<td>040</td>
<td>Colour invalid. Spaces also accepted on CHOY.</td>
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<tr>
<td>047</td>
<td>More than 200 DESC cards</td>
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<tr>
<td>048</td>
<td>DESC Card out of sequence</td>
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<tr>
<td>050</td>
<td>Machine No. Not 1 to 5. Space acceptable</td>
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<td>055</td>
<td>Week between 1 and 60. Spaces acceptable</td>
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<tr>
<td>056</td>
<td>Week must be zero or spaces</td>
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<tr>
<td>060</td>
<td>Finish week greater than or equal to start week, except when blank.</td>
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<tr>
<td>065</td>
<td>Number of Moulds exceeds 5</td>
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<tr>
<td>070</td>
<td>Number of shifts outside Range 0 to 19</td>
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<td>087</td>
<td>Incorrect total</td>
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<tr>
<td>090</td>
<td>List number not in DESC table</td>
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<tr>
<td>095</td>
<td>Position (Pairs available) not numeric</td>
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Card Type Reference
- DESC CHRT CHOV FORC NKDA
- MOLD NLDS PROD RAWS
- REQS STKS SYN SRNL WEEK
- DESC etc.
- DESC CHRT CHOV FORC NKDA
- MOLD NLDS PROD RAWS
- REQS STKS SYN SRNL WEEK
- DESC CHRT CHOV FORC NKDA
- MOLD NLDS PRODS
- DESC CHRT CHOV FORC NKDA
- MOLD NLDS PRODS
- DESC
- DESC
- DESC
- DESC FORC KOLD NLDS
- FORC NLDS DESC
- DESC CHOV
- DESC
- DESC CHRT CHOV FORC NKDA KOLD
- CHOV FORC NKDA KOLD
- NLDS PROD RAWS SRNL
- STKS
- CHOV NKDA
- CHOV
- CHOV FORC NKDA PROD STKS SRNL
- NKDA PROD REQS STKS SRNL
- NKDA
- NKDA
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- NKDA
- NKDA

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<td>Part number not 1 or 2</td>
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<td>Average Production outside 500 to 3000</td>
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<td>120</td>
<td>Weekly prodn. outside 500 to 3000. Spaces acceptable.</td>
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<td>Largest size range = spaces, C, J, V, H</td>
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<td>Largest size = spaces, 1 to 13</td>
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<td>125</td>
<td>Desired Freestock = numeric</td>
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<td>130</td>
<td>Day/Week indicator = D, W</td>
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<td>135</td>
<td>Expediting cost, numeric not blank</td>
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<td>140</td>
<td>Set up cost, numeric not zero</td>
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<td>145</td>
<td>Colour change cost, numeric not blank</td>
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<td>Size scatter cost, numeric not blank</td>
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<td>Max. spread, numeric not blank</td>
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<td>Fraction saleable, 0 to 1000</td>
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<td>Size = 1 to 13</td>
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<td>B or D Moulds = ET, VB, BB, BD</td>
<td>MCLD</td>
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<td>DB, DY, TD, DD</td>
<td>MCLD</td>
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<td>Position (No. of Mlds) = spaces, Ø 1 or 2</td>
<td>MLDS</td>
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<td>Position (Pairs produced) numeric</td>
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<td>Part = 1 to 8</td>
<td>RAVS</td>
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<td>Week 1 less than Week 2</td>
<td>RAVS</td>
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<td>Week 2 less than Week 3rd</td>
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<td>Stock date must not be later than start date</td>
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<td>220</td>
<td>Numeric, blank entries at end of card only: Priority allocation may be</td>
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<td>WEEK</td>
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<td>230</td>
<td>Cumulative releases numeric</td>
<td>MATS PROD STKS SZRL</td>
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<td>250</td>
<td>Start date must be Monday</td>
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<td>260</td>
<td>No. of days not above 7 (Space = 5)</td>
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<tr>
<td>700</td>
<td>Warning: If equal to or greater than Ø less than 5</td>
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<td>705</td>
<td>Warning: If list no. and man.grp. disagree.</td>
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<td>730</td>
<td>Warning: If available stock &gt; 10,000</td>
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<tr>
<td>400</td>
<td>SYNC Card Invalid</td>
<td>All cards</td>
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<tr>
<td>402</td>
<td>WEEK Card Invalid</td>
<td>CHRT</td>
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<td>Incomplete set of parts for one record</td>
<td>MLDS MOLDS STKS REQS RAWS</td>
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<td>410</td>
<td>Start or end weeks outside schedule</td>
<td>MLDS FORC MOLD MOLDS MOLDS MOLDS</td>
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<td>420</td>
<td>Week nos. on RAWS card decreasing</td>
<td>RAWS</td>
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<tr>
<td>430</td>
<td>Creation date not within one month of</td>
<td>MOLDS MOLDS</td>
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<td>427</td>
<td>More than 5 moulds loaded in a machine</td>
<td>MOLDS</td>
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<tr>
<td>440</td>
<td>Start date over two months older than</td>
<td>CHRT</td>
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<tr>
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<td>SYNC schedule start date</td>
<td>CHOV</td>
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<td>445</td>
<td>Start date younger than schedule</td>
<td>REQS</td>
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<td>start date</td>
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<tr>
<td>450</td>
<td>Stock date does not equal SYNC stock date</td>
<td>STKS</td>
</tr>
<tr>
<td>475</td>
<td>Total size roll not between 990 and 1010</td>
<td>PROD</td>
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<td>SZRL</td>
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<td>Condition for Warning</td>
<td>Card Type</td>
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<tr>
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<tr>
<td>860</td>
<td>Creation date more than six months old</td>
<td>MGDA MLDS FORC SZRL</td>
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<td>865</td>
<td>Creation date over one month before schedule start date</td>
<td>MGDA</td>
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<tr>
<td></td>
<td>with non blank start or end weeks.</td>
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<tr>
<td>807</td>
<td>Fewer than 5 moulds loaded in a machine</td>
<td>MCLD</td>
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<tr>
<td>810</td>
<td>Costs on RANS card not decreasing</td>
<td>RAWS</td>
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<tr>
<td>815</td>
<td>Number of machines for CHRT AND MCLD differ</td>
<td>CHRT MCLD</td>
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<tr>
<td>822</td>
<td>Production per machine-week above 12,500 pairs</td>
<td>PROD</td>
</tr>
<tr>
<td>824</td>
<td>Production per machine-week below 4,000 pairs</td>
<td>PROD</td>
</tr>
<tr>
<td>830</td>
<td>Incomplete set of output records</td>
<td>REQG</td>
</tr>
<tr>
<td></td>
<td>(one per list no.)</td>
<td></td>
</tr>
</tbody>
</table>
| 835         | " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " 

3 58
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<th>MACHINE TYPE</th>
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<th>DESCRIPTION</th>
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<tr>
<td>609</td>
<td>1</td>
<td>Bright and Dull Wellingtons</td>
</tr>
<tr>
<td>609</td>
<td>2</td>
<td>Splashabouts</td>
</tr>
<tr>
<td>609</td>
<td>3</td>
<td>Fashion Wellingtons</td>
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<tr>
<td>609</td>
<td>4</td>
<td>Men's Industrial (PVC)</td>
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<td>609</td>
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<td>Women's Industrial (PVC)</td>
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<tr>
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<td>1</td>
<td>Toddlers</td>
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<td>603</td>
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<td>Golf Shoes</td>
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<td>6</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>12</td>
</tr>
<tr>
<td>COLOUR</td>
<td>COLOUR CODE</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>BLACK</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BROWN</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>RED</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>GREEN</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>BLUE</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>YELLOW</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>WHITE</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Each of the five programs in the scheduling system produces some output. The outputs from programs B'10 and B'20 are used to check the validity of the data. The outputs from B'30 and B'40 are mostly diagnostic information but provide a stock projection for each brand. The output from B'50 is the net of schedules for each machine.

**B'10 Output**

B'10 provides a listing of the data stating also the deck number in the pack and any errors found on the card. At the end a controls report states the numbers of valid and invalid cards, etc.

**B'20 Output**

B'20 sorts the data into sequence and prints out the information in a formatted manner so that one can readily identify the contents. The product description cards appear first, followed by the information common to all machine types. The remaining data is presented by machine type. At the end of each machine type, various completeness checks are made and warnings issued if necessary. A stock projection is issued for each manufacturing group stating the position at four-weekly intervals. A controls report again states the number of valid and invalid records.

**B'30 Output**

B'30 determines the scheduling requirements by manufacturing group within each machine type. For each manufacturing group (see table) a header section states when it is to be made, the initial stock, and total production. It then states how far the requirements are covered.

The 'requirements of each size' are presented in a table. A 'stock projection' shows the projected salable stocks by brand at four-weekly intervals.

A 'freestock analysis' shows the use of the average unbalanced stock. Finally the 'overall supplies' illustrate the situation at the schedule finish.

At the end of each machine type a controls report is printed.
SECTION 6 (contd)

USE OF THE PRINTER OUTPUT (contd)

**M**40 Output

**M**40 schedules by manufacturing group. For each group it prints a page of standard information for that schedule giving the stock above initial requirements, the average weekly demand for each size, the optimal batch sizes, etc.

For each week it then prints basic diagnostic information for the week, including the minimum stock cover for each size and the priorities of each mould.

At the end of each schedule it states the number of mould changes and the projected stocks for each size and brand in excess of the scheduling requirements.

**M**50 Output

**M**50 prints the schedules for each individual machine one manufacturing group at a time in 12-weekly blocks (or 12-days if appropriate).
STOCK PROJECTIONS

There are stock projections in two programs in the IMF Scheduling System.

In M20 total stocks at manufacturing group level are projected.
In M30 planned saleable stocks by brand are projected.
The stock projection in M30 is more detailed than that in M20 and is probably more useful.

The M20 Stock Projection

Example

<table>
<thead>
<tr>
<th>Week</th>
<th>PROD</th>
<th>REQS</th>
<th>STOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0</td>
<td>56000</td>
<td>80926</td>
<td>33691</td>
</tr>
<tr>
<td>C4</td>
<td>93800</td>
<td>81322</td>
<td>16213</td>
</tr>
<tr>
<td>O8</td>
<td>91000</td>
<td>141168</td>
<td>-33555 STOCKOUT</td>
</tr>
</tbody>
</table>

Interpretation

STOCK  Week C0  -  The expected stock at the schedule start date
        C4  -  "    "    "    after 4 weeks
        C8  -  "    "    "    after 8 weeks

PROD    Week C0  -  The expected production from stock date to schedule start date
        C4  -  do. do.  in the first 4 weeks of the schedule
        C8  -  do. do.  in weeks 5-8

REQS    Week C0  -  The expected requirements from stock date to schedule start date
        C4  -  do. do.  in the first 4 weeks of the schedule
        C8  -  do. do.  in weeks 5-8

Notes: 1 The stock at the end of a period equals the initial stock plus production minus requirements.

2 In the final 4 week period production covers only until the schedule finish but requirements cover the full 4 weeks so the final stock figure is misleading.
The PTC Stock Projection

Example

<table>
<thead>
<tr>
<th>LIST NO</th>
<th>STOCK</th>
<th>UNBALANCED STOCK</th>
<th>TOTAL REQS. OVER SCHEDULE</th>
<th>PROJECTED SALEABLE STOCKS 1MTH</th>
<th>2MTH</th>
<th>3MTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>44089</td>
<td>12395</td>
<td>60384</td>
<td>11130</td>
<td>8791</td>
<td>10424</td>
</tr>
<tr>
<td>5678</td>
<td>17979</td>
<td>15912</td>
<td>32197</td>
<td>4636</td>
<td>4331</td>
<td>3814</td>
</tr>
</tbody>
</table>

Interpretation

STOCK
This is the stock that would be available at the start of the schedule before meeting any of the requirements during the schedule.

UNBALANCED STOCK
The stock that would remain after selling as much as possible in proportion to the size roll. (When stocks of one size fall to zero it is assumed no further sales can be made).

PROJECTED SALEABLE STOCKS
These state the planned saleable stocks after meeting the cumulative requirements to the end of the first (2nd/3rd etc) four week period. (Note the term 'month' means a four week period here).

Total requirements over schedule
This is the total 'scheduling requirements' for that brand. The expected production of a brand (list no.) is the total requirements minus the initial stock.

Requirements for n months
These are the cumulative demand requirements up to and including 'month' n.

Note: 1
The distinction between demand requirements and scheduling requirements is important. Demand requirements are specified by the Sales Department and may exceed or fall well below the capacity.
The scheduling requirements are determined by the scheduling system. The total over all brands of the total requirements over the schedule equals the initial stock plus planned production.
The projected saleable stocks are determined to give an optimal balance between shortage costs (which decrease as these increase) and production costs (which increase as requirements for saleable stock are increased).
Note: 2

For short term schedules the stock projection has a slightly different format. The saleable stocks are only stated for one particular month, but the planned production and starting shift are also specified.

Overall Supplies

At the end of a schedule for a manufacturing group, there is a final stock projection entitled 'OVERALL SUPPLIES'. Here the stock is the final stock before meeting any requirements.
The projected saleable stock at the end of the final month is also before meeting any requirements; the total demand requirements over the schedule are as stated.
The projected unbalanced stock should equal the stock minus the projected saleable stock, but because of differences in calculating each term minor discrepancies will occur.
The MK30 stock projection was considered earlier. Other points of interest are stated below:

Header Information

The opening stock plus total requirements is sufficient to meet n.nn of requirements in month n.

1. eg. 0.622 of requirements in month 5
   This means the total supply is sufficient to meet all requirements to month 4 and 63.2% of month 5's requirements. Note that the stock is not all saleable so there may be shortages even though requirements can be met.

2. 2.375 of requirements in month 6
   Where n.nn is greater than 1,000 it indicates that the total supply exceeds all future demand (as supplied by Sales Department). In this case, the total supply is 2.375 times the total demand.

Requirements by Size

These are the net requirements by size and should be interpreted using the size table given later. (This is also used in MK40).
A negative value indicates the current stocks are sufficient to meet demand over the schedule.

Freestock Analysis

Example

<table>
<thead>
<tr>
<th></th>
<th>SIZE</th>
<th>COLOUR</th>
<th>RANGE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM</td>
<td>41650</td>
<td>8500</td>
<td>5000</td>
<td>55150</td>
</tr>
<tr>
<td>SURPLUS</td>
<td>14274</td>
<td>2775</td>
<td>2415</td>
<td>19464</td>
</tr>
</tbody>
</table>

Interpretation

A certain minimum freestock is needed to keep a batch production going in weekly intervals. There must be some stock of each size and brand not being made (see SIZE), and additional stock for colours not being made (see COLOUR); finally, if the full range of sizes cannot be made in one week because the extreme sizes are incompatible, there must be stocks of the sizes not being made (RANGE). One can not operate on minimum freestocks because production costs decrease as freestocks rise and because there is a limit on weekly mould changing, the surplus freestock enables larger batches to be run and has the same types of components.
Rejected Records

IM30 will determine scheduling requirements where it has both machine details from NCDA cards, and the manufacturing group is scheduled for that period.

If there is either no NCDA record or the manufacturing group is not scheduled in that interval, other records for that manufacturing group will be rejected. This should cause no concern. Rejection in other circumstances is disturbing and the cause should be found.
Initial Information

A header states the manufacturing group and scheduling period.
A small table then summarises the planned production of each brand.
This gives the total requirements, M30 is more useful in showing
how these vary from 'month' to 'month'.
The freestock situation is then analysed. Terms are self-
exploratory.

Note: 'The rest allows an average of n weeks between restarting
an average size', means that each size is run on average
once every n weeks, so the expected number of mould changes
= no. weeks x no. sizes/n.

'One mould change is valued at 6.72 weeks' stock'
means that an extra 6.72 weeks' stock (the production
per mould per week) would reduce the expected mould changing
costs by 1 change a week.

Average usage, batch sizes and peak cover (wk)

These 3 tables summarise the ideal scheduling information. They
state the weekly demand for each mould, the ideal batch sizes and
the maximum weeks' cover that each mould should have.
The information is presented in a table 10 x 4 the first row
corresponds to internal sizes 1-10, the second 11-20 etc. See
the size table to decode these.

Prior to the header information, the input records are printed
with the set of keys first, then the contents of the record.
These will only be needed if there are serious errors while running
the program. The file layout enable these to be interpreted.

Input records are also printed at the start of each week (if there
are any).
Weekly Information

Example

WEEK 3 COLOUR 7 2 MACHINES THIS COLOUR 3 1
SALES COVER (WK)
0.00 0.00 73.15 2.04 - 3.92 etc.

ADDITIONAL COST
0.00 0.00 280.33 103.40 59.54 etc.

LARGEST SIZES 22 0 14 SIZE RANGES 16 18 38 TRENDS 1

INITIAL PRIORITY
0.00 0.00 -281.93 -105.45 79.69 etc.

FINAL PRIORITY
0.00 0.00 -281.93 -105.45 -58.05 etc.

CUT-OFF PRIORITY -2.72

MOLDS ASSIGNED
0 0 0 0 1 etc.
2 0 0 0 0 etc.

HALF-WEEK MARKER
0 0 0 0 1 etc.
0 0 0 0 0 etc.

Interpretation

In week 3 making colour 7 (white) there are two machines in use. Machine 3 makes small sizes and machine 1 larger sizes. Various tables then follow with values for Child's 4 to Child's 8 moulds. Since child's 4 and 5 are outside the range for this manufacturing group all values are zero.

For child's 7 the initial stock will cover the requirements for 2.04 further weeks; there is a penalty cost of 103.40 for making that size (because larger sizes are desirable this week; see TRENDS 1 i.e. upwards). The initial priority is, therefore -105.45 and the mould is not scheduled.

For child's 8 the current stocks are insufficient and there will be a backlog of 3.92 weeks if there is no production. The penalty cost of 59.54 reduces the priority to 79.69 which is still sufficient to ensure that the mould is used.

One mould is assigned and the priority revised to -58.05.

The value of 1 on the HALF-WEEK MARKER indicates the mould is only to be run for half a week. (Zero is normal and -1 indicates the
Interpretation (contd)

Mould is making up the other half of a week but should remain in use.
The cut-off priority of -2.72 indicates that all moulds with priority not below -2.72 were either scheduled or could not be scheduled in with the earlier moulds (in the latter case the final priority of -1500 indicates this).
The desired largest size is the no.1 machine is size 22 and in the no.3 machine is size 14. There is no additional cost for size 14; the additional cost penalty for smaller or larger sizes increases the greater difference from size 14 (or size 22, whichever is appropriate).

Sizes below size 16 must go in the small size machine (machine 3).
Sizes 17 and 18 may go in either machine.
Sizes 19 to 23 must be in the large size machine (machine 1).

TREND 1 indicates that the machines are expected to hold larger sizes than last week.

" -1 " " " " " " " smaller "
" 0 " " " " " " the same range as last week.

Final Information

The final output states the manufacturing group, the total number of mould changes and the expected final stocks in excess of the scheduling requirements.
Negative values here indicate that the scheduling requirements have not been met and do not necessarily imply a stockout.
Large negative values suggest that something is wrong, for example if only one mould is available but the demand exceeds the production from one mould, the stocks will fall well behind.
Effects of the MCDM Parameters

Introduction

The earlier section on completing the MCDM cards recommended various settings for these parameters. These settings should normally suffice and give minimum cost schedules. They should be altered only as costs or production rates alter. However, if the form of the schedule is not liked for any reason and it is decided to alter the form, even though it may increase estimated costs, the parameters should be altered. This section explains the effects of the parameters.

One is only likely to alter the maximum size spread, the mould change limit, the weighting factor or fraction saleable. The table below shows some possible circumstances and the appropriate action.

<table>
<thead>
<tr>
<th>CIRCUMSTANCE</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread of sizes frequently too wide</td>
<td>Reduce maximum size spread</td>
</tr>
<tr>
<td>Wide spread of sizes would be acceptable</td>
<td>Increase maximum size spread, or set it to zero.</td>
</tr>
</tbody>
</table>

Safety stocks too low:

a) stocks generally low
b) stocks generally high
Too many mould changes generally
In single week
• Overproduction of one size range and underproduction of another

One mould keeps switching machines unnecessarily

Increase mould change limits.
Increase fraction saleable.
Reduce mould change limit adjust manually.
Increase weighting factor or calculate appropriate desired largest sizes and set factor to zero.
Reduce weighting factor.
**EFFECTS**

**Average Production Rate**

Variation of the average production rate will change the optimal batch sizes, but 10% variations should have no significant effect on the schedule. Normally, this should equal the average production rate per full week.

**Desired large sizes**

If it is desired to determine the size range for each machine manually rather than automatically, these values should be set. The largest sizes permitted in a machine will generally be one or two sizes larger than that desired; the smallest size permitted is one more than the largest size for the machine two before in largest size sequence. (See algorithms in program documentation for full details).

Note: If the desired largest sizes are set manually, the weighting factor should probably be set to zero, otherwise these values will be altered.

**Desired freestock**

This can be set to adjust the freestock required for production purposes, but this should not be necessary.

Normally: the production freestock equals the minimum quantity necessary if the stocks are low; as stocks increase above this minimum, a certain fraction (fraction saleable) becomes safety stock, the rest increases the production freestock.

If desired freestock is set: The minimum freestock is unaltered but as stocks increase, the production freestock will be fraction saleable x (desired freestock - minimum freestock) higher.
The absolute value of the costs is irrelevant to the scheduling. It is their ratios which matter. As the colour change cost increases relatively to the set-up cost, colour changes become less desirable so more stock is set aside to avoid colour changes and less to avoid mould changes. As the scatter cost increases it becomes less desirable to run a wide spread of sizes.

**Maximum Size Spread**

If the maximum size spread is zero, scheduling proceeds on the assumption that any pair of sizes can be made together, but, with more than one machine available, the size ranges will be restricted. Providing this restriction is sufficient, it is better to have a zero entry as the computing time is reduced. The maximum size spread is the largest spread the computer will permit (counting C9 to W3 as 9 sizes for example). Normally, the spread should be under two-thirds of the maximum. Since the minimum possible spread (not using duplicate moulds) is four sizes, the maximum spread should exceed 6. Values below 10 are inadvisable.

**Note:** Since the extreme sizes, small child’s and large mens are rarely needed, slightly larger spreads are permitted when making these sizes.

If it is desired to reduce the average spread of sizes, the maximum size spread should be reduced but the rate of mould changing will then increase noticeably. Conversely, if larger spreads would be acceptable, a higher maximum spread will reduce the mould changing.

**Mould Change Limit**

The mould change limit is the maximum number of mould changes the scheduling will permit. It will be exceeded only if the machines cannot otherwise be filled, e.g. at a machine change. If the mould change limit is raised, the minimum freestock necessary for production falls, so if stocks are low, the limits should be set as high as is acceptable.
**Weight factor**

As the weight factor is increased, the desired largest sizes are set with more emphasis on the largest current size and less on smaller and preceding values. A factor of zero ensures that the desired largest sizes remain as originally set and may be used in combination with a fixed setting of these on Card 1. Values between .500 and .500 give a reasonable emphasis to both the largest size in use and the other sizes also loaded. A value of 1.000 only considers the largest size and may have an undue effect when a large size enters the machine.

**Fraction Saleable**

Adjustment of this term allows the balance between providing safety cover and reducing safety stocks to be altered. To increase the safety cover increase the fraction saleable. (This will have no effect if the freestock is already at its minimum value).

**Note:** The fraction saleable should not be set at zero or one as then the safety cover or production costs will respectively remain in their worst settings.

**Trend**

A trend of zero means that each machine should always hold a similar range of sizes.

A trend of one means that each machine should hold larger sizes this week than last. A value of minus one means that each machine should hold smaller sizes this week.

The trend is automatically switched from plus one to minus one or vice versa when the most urgent size is in the opposite direction to the current trend but there is a slight bias in favour of keeping the current state.
SECTIONS 7

DETECTING ERRORS IN THE FORTRAN PROGRAMS

Program D30 may fail because of an execution error; D40 may also fail because of an execution error or it may cease scheduling for one manufacturing group due to an internal error.

Execution Errors

Execution errors are described in the FORTRAN manual. The most likely error is error 50 - Arithmetic Overflow - usually division by zero.

Trace information is output after the error and shows the last 25 subroutine entrances and exits. This enables one to pinpoint fairly accurately where the error has occurred. If no progress can be made in detecting the error, the program can be recompiled, as an overlaid program, at trace level 2. This gives comprehensive diagnostic information.

If D30 fails with an Execution error, the output tape is incomplete and D40 will halt Execution Error 107 on failing to read.

For other execution errors refer to the FORTRAN manual.

Note: D30 is likely to fail with incomplete or zero data of some record types.

Internal Errors

Internal errors are indicated by the message - "RUN ABANDONED FOR GROUP mm n IN WEEK nn DUE TO INTERNAL ERROR mm" followed on the next page by the final stocks.

<table>
<thead>
<tr>
<th>Error No.</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Program or data error</td>
</tr>
<tr>
<td>2</td>
<td>Too many moulds assigned</td>
</tr>
<tr>
<td>11</td>
<td>Error in filling machines</td>
</tr>
<tr>
<td>20</td>
<td>Error in deciding brand</td>
</tr>
<tr>
<td>100</td>
<td>Too few moulds assigned to fill available places</td>
</tr>
</tbody>
</table>

Of these errors only error 100 should now be possible. Other errors indicate a program malfunction or false data which should have been rejected earlier.

String Internal Error 100

This error is given when, after assigning all allowable moulds with utility above - 500, there are still mould places left.
This may occur because there are insufficient moulds, e.g. incorrect MLD cards or too many raw material availability restrictions with a high expediting cost (> 500).

It may also occur when a new machine is brought into use having earlier been vacant or making another colour. If the size range assigned to the new machine is already fully loaded into other machines, the machine cannot be filled. The solution is to re-schedule with a manual schedule for that week and machine i.e. decide what it should hold and enter appropriate MLD cards.

Note: This error is unlikely if the maximum spread is high (above 25 or 0) and if machines for essential sizes remain permanently in use.
APPENDIX 4  HANDBOOK ON MACHINE LOADING
FOR THE INJECTION MOULDED FOOTWEAR DEPARTMENT

Contents

Introduction
Part One - The Model
Part Two - Initial Data Processing
Part Three - Classifying the Projected States
Part Four - Machine Loading
Part Five - Summary
INTRODUCTION

This handbook describes an efficient method for planning the machine loading of the I.M.P. department by hand. The system requires a large effort to set it up, but once established is reasonably simple to run.

The system aims to minimise the expected production, storage and shortage costs for all injection moulded products. Since there are many constraints on permissible loadings, the system specifies the quantities of each manufacturing group to produce in each four-week period (called 'month' for convenience) and the planner is left free to choose the best loading for each week.

The machine loading is prepared in the following stages:

1. The data is collected and processed so that standard parameters can be used.

2. Each month is classified according to the expected supply position in that month. The classification ranges from 'Severely Understocked' to 'Overstocked'.

3. The optimal loading for the first 'month' is determined using an algorithm appropriate for that month.

4. The planner prepares the detailed loading for the month. If the proposed loading is impossible due to extra constraints, a revised loading is produced which satisfies these.

5. The planner proceeds to the next 'month' and repeats the process.
1.1 Introduction

The model is an aggregate model of the production process. It estimates costs in terms of certain variables for each manufacturing group. Since the true costs depend on the individual sizes of each brand, it is an approximate model.

This part first states the assumptions behind the model: it concludes that the appropriate weekly costs to be minimised are the storage, shortage and production costs.

A mathematical model of the costs is then produced; this is explained in subsequent sections. Finally some comments on the nature of an optimal solution are made.

1.2 Assumptions behind the model

It is assumed in the model that the resources in terms of machines, etc., are known and fixed; the labour force and hours to be worked are also specified for each week. There is no control over the demand, e.g. price-levels are set outside the planning system.

The controlled variables are therefore the quantities of each manufacturing group to produce during each week subject to a fixed total for the production hours (since the labour hours are fixed).

The model can consider all machine types simultaneously; but generally it is obvious which types should run at capacity, and each machine type is considered independently.

The expected cost of a machine loading schedule is estimated as
the sum of the weekly costs for each manufacturing group. Only costs which vary with the schedule need be considered; thus labour costs, for example, are ignored.

The relevant components of the weekly costs are the storage cost, the shortage costs and, during production, the production cost. There may in addition be costs for expediting raw materials.

1.3 Mathematical model of the weekly costs

\[
\text{Storage cost} = \text{V.I.St} \\
\text{Shortage cost} = P \int_{\text{Bal}/&}^{\infty} \frac{1}{\sqrt{2\pi}} \exp \left(-\frac{d^2}{2s^2}\right) dd \\
\text{Bal}/& \text{approximated by} \quad 0.16 \text{Bal}/& \times 0.4P & \text{if Bal} \geq 0 \\
\text{or} \quad 0.16 \times \text{Bal}/& \times 0.4P + P \times |\text{Bal}| \text{if Bal} < 0
\]

\[
\text{Production cost} = S(U \text{ on a set-up)} \\
\text{and K/PFr during production}
\]

\[
\text{Expediting costs} = E \cdot q^* \\
\text{where} \quad St = \text{Bal} + \text{PFr} + \text{InFr} + \text{UFr}
\]

1.4 Notation

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>St</td>
<td>Total stock</td>
</tr>
<tr>
<td>Bal</td>
<td>Expected balanced stock</td>
</tr>
<tr>
<td>PFr</td>
<td>Effective part of planned free stock</td>
</tr>
<tr>
<td>InFr</td>
<td>Ineffective freestock</td>
</tr>
<tr>
<td>UFr</td>
<td>Unplanned freestock</td>
</tr>
</tbody>
</table>
\[ q^* \quad \text{Quantity expedited for the} \]
\[ V \quad \text{Value of stock} \]
\[ I \quad \text{Interest rate} \]
\[ P \quad \text{Penalty cost per unit short per week} \]
\[ K \quad \text{Production constant} \]
\[ SU \quad \text{Set-up cost} \]
\[ E \quad \text{Expediting cost} \]
\[ \& \quad \text{Standard deviation of sales} \]
\[ d \quad \text{Difference between actual and expected demand} \]

1.5 **Storage costs**

The storage cost for a manufacturing group is estimated as the expected stock multiplied by the value of stock times the interest rate per week (= St.V.I.).

The expected stock, St, is the current stock plus planned production minus expected demand.

The interest rate, I, is set at the higher of the return obtainable elsewhere on capital, and the cost of borrowing less an allowance for the appreciation in stock value. If storage costs vary with the stock, I can be increased to allow for this.

The value of finished stock, V, is the average value weighted by demand for the products in the manufacturing group.

1.6 **Expediting costs**

Expediting costs, E.q*, equal the excess costs of obtaining raw materials in a hurry.
E is the expediting cost per unit and must be estimated for the particular item(s) being expedited.

$q^*$ is the quantity expedited.

1.7 **Shortage costs**

The shortage cost per week for a manufacturing group during a shortage equals the penalty cost per unit, $P$, multiplied by the shortfall. However, the shortfall is not known in advance, so it must be estimated.

The expected shortfall is a function of the expected balanced stock and the variability of demand. One measures the variability in demand by the 'standard error' of the forecast, also called the 'standard deviation', $\sigma$. This is a statistical measure with the property, for reasonable distributions, that there is a one in twenty chance that the difference between actual and expected demand is greater than two standard deviations.

1.7.1 **Estimation of the expected shortfall**

Actual demand does not exactly follow any standard distribution function. The mathematical model given earlier evaluates the expected shortfall assuming that the demand follows the 'Normal' distribution.

It is sometimes convenient to use a simple formula, the expected shortfall can then be approximated by the expression below:

$$\text{Shortfall} = \begin{cases} \cdot 16 \text{Bal}^{1/\alpha} \times \cdot 4\alpha & \text{if expected balanced stock is positive} \\ \text{Bal} + \cdot 16 \left| \text{Bal} \right|^{1/\alpha} \times \cdot 4\alpha & \text{if expected balanced stock is negative.} \end{cases}$$
this expression is always close in value to that given by the normal
distribution, with a maximum error of \( \frac{1}{20} \); and it is more easily
calculated. For greater precision the actual distribution of demand
should be carefully studied and then used in the calculation of
shortage costs.

1.8 Production costs

There are no production costs for a manufacturing group while it is
not being produced. During production the costs are greater in the
first week, i.e. on set-up, than in subsequent weeks.

For certain manufacturing groups produced in small batches, the
production costs are virtually independent of the batch quantity
since each product must generally be produced once during the run.
Such manufacturing groups are called class two groups; their
production costs are best represented by including the full
production cost in the set-up cost and giving no cost for subsequent
weeks.

Class one manufacturing groups are made in large batches. Individual
products may be made several times during a production run; indeed
one manufacturing group is in continuous production. The production
costs for these groups depend on the effective 'freestock' used in
reducing production costs. For example larger batch quantities of
individual sizes require greater production buffers - called
'freestocks'. The weekly production cost is inversely proportional
to the effective freestock (= \( K/PFr \) where \( K \) is the constant of
proportionality).

On setting up a class one manufacturing group, one makes a complete
would change and may also perform a screw-clean. Some of these costs are saved in subsequent weeks but the rest is the set-up cost, SU.

1.9 The nature of an optimal solution

An optimal machine loading, if followed by optimal loadings, minimises the expected present and future costs.

Current decisions affect future costs in two ways. Firstly, shortly after a set-up the manufacturing group will not need another set-up either because it is still in production or because the stocks are high. A set-up therefore reduces the immediate future costs.

One can represent this situation in several ways. The simplest of these is to calculate separately the optimal batch quantities and to delay production until stocks are appropriately far below their optimal level.

The second effect of current decisions on future costs arises if the optimal state in a future period cannot be reached because of over- or under-production in this period. The extra cost incurred in the following period is an 'opportunity cost' associated with the current decision.

Opportunity costs are likely to arise if the uncertainty in demand is high in one period, and a large correction to the expected demand is made in the following period. For most of the year the opportunity costs are negligible.
2.1 Introduction

The initial data processing establishes for each manufacturing group a graph showing the weekly costs associated with any stock level together with a second graph showing the marginal value of stock at any stock level. These graphs are used as the basis of the scheduling algorithms.

To create these graphs, the data required by the mathematical model must be collected. Where the source is not obvious some general advice is given here. Some simplifications can be made in current circumstances for two of the machine types.

2.2 Data collection

2.2.1 Division of the stock

The stock is divided into the expected balanced stock, the effective planned freestock, and the ineffective and unplanned freestocks.

2.2.1.1 The ineffective freestock

For each mould, production must start at the beginning of the week in which the planned freestock would fall to zero. On average this would occur half way through the week so there is an ineffective freestock which, on average, is at least half the weekly sales rate.

If more than one product is made from a mould, there will be an additional average freestock of half a week's production for each extra product. This arises because products are made in weekly
batches. The minimum ineffective freestock therefore equals half the weekly demand plus half the production per mould per week multiplied by the number of extra products. (Since the balanced stock is built up during production runs, the weekly demand can be replaced by the weekly production rate).

2.2.1.2 The unplanned freestock

The unplanned freestock is unknown, but it can be estimated by seeing how far the actual balanced stock falls below its planned value due to variations in production and sales from plan.

Since the warehouse does not run smoothly without some balanced stocks, demand can be unsatisfied even with a little balanced stock. This is allowed for by adding the minimum balanced stocks at the warehouse or in transit to the unplanned freestock.

The remaining stock is either effective planned freestock or expected balanced stock. The appropriate division of this stock is determined later in this section.

2.2.2 Shortage costs

2.2.2.1 The penalty cost

The penalty cost cannot be obtained directly from any source but must be estimated. Opinions of the sales staff differ widely on the cost of a shortage, but can be gauged from such questions as 'Is it worth storing an extra thousand pairs for a year to prevent a shortage for one week? (for one month?)'.

An answer 'yes' to the first question places the penalty cost at
over fifty times the storage cost. As a general rule, my investigations placed the penalty cost at between twenty and fifty times the storage cost.

2.2.2.2 The standard error of the sales forecast

The standard error of sales over the next two months should be estimated by finding the distribution of forecast errors for these sales. With existing forecasting methods, the standard error can be as high as the expected sales, but for a reasonable forecasting system a typical value is three times the weekly demand.

Where there are several brands in a manufacturing group, a shortage can occur in any brand, and safety stocks are required for each brand. The appropriate safety stock is proportional to the standard deviation of the sales of that brand. Therefore the figure used for the standard deviation should be the sum of the values for each brand in the manufacturing group. (This is allowed for in the above estimate).

2.2.3 Production costs

2.2.3.1 Class one groups

2.2.3.1.1 Set-up costs

The direct costs of a set-up are the mould and colour changing costs. However a machine change causes considerable inconvenience since the finishing gangs must alter the type of work they do, and many other workers are slightly affected. Raw materials are also ordered for each batch, and large batches enable greater discounts to be obtained.
There can therefore be considerable indirect costs for a machine change.

About half the mould changes made on set-up are saved in subsequent weeks, so the direct cost is around 2½ mould changes. Allowing for indirect costs, I suggest the set-up cost is set at the cost of five mould changes. It should possibly be much higher.

2.2.3.1.2 Minimum freestock

Since each product is made in batches lasting at least one week, the minimum freestock per mould is $\frac{1}{2}p$. Some of this is ineffective freestock, so the minimum effective freestock is around $\frac{1}{3}Numsize.p$.

The mould changing required at the theoretical minimum freestock exceeds the fitters' capability. A realistic minimum freestock, based on maximum mould changing, is $\frac{1}{2}Numsize.p$.

2.2.3.1.3 Production constant

The production constant, $K$, can be estimated by calculating the production costs for a specified effective freestock. For existing manufacturing groups, with an effective freestock of one week's production per mould, a mould change is needed for each mould on average once every nine weeks.

This makes $K$ equal to $MC.Numsize^2.p/9$ where $MC$ is the mould changing cost, $p$ the production per week and $Numsize$ the number of moulds.

Production costs are only incurred while a manufacturing group is in production, at other times the freestock is useless, so $K$ should
be multiplied by the proportion of time in production.

The freestock is reduced at the end of a run. It is reasonable to assume that the freestock above minimum while out of production can be reduced to around half its value during production. The increased balanced stock compensates for the inability to produce any urgent product quickly, so no extra value is placed on this extra balanced stock.

2.2.3.2. Class two groups

The production costs for class two groups are virtually independent of the batch quantity so $K$ is set to zero, and the set-up cost, $SU$, equals the full cost of the run.

Assuming that each colour and each size is made during the run, the minimum production costs are easily estimated. Let 'Dup' be the number of sizes for which the demand exceeds a fifth of the total demand so a duplicate mould is needed. Then 'Numsize + Dup' moulds are used for each colour; five moulds remain in use on change of colour, so the total number of mould changes is :-

$$N_{colour} \times (\text{Numsize} + \text{Dup}) - 5 \times (N_{colour} - 1)$$

The total set-up cost is obtained by adding the colour changing costs and the 'disruption' costs to this.

2.2.4 Practical simplifications

For each of the types of protective machine there is currently one class one manufacturing group, and one or more class two groups. A set-up for a class two group requires a subsequent set-up for the
class one group (since it is rare for class two groups to follow each other).

Subsequent calculations are simplified if the set-up cost for the class one group is ignored, and the costs of a set-up for each class two group are increased appropriately. This alters neither the total costs nor the optimal solution.

2.3 Estimating the weekly costs - summary

The actual weekly costs depend on the manufacturing group and on the production status which is one of: - 'starting production', 'in production' and 'not in production'. The costs can be calculated in this way and this may be appropriate in the early months if it is known that the unbalanced stocks will be exceptionally high.

However most of the time it is sufficient to use an approximate figure since periods in and out of production must be related to the ratio of demand to production rates. Weekly costs are therefore calculated on an average basis weighted appropriately for periods in and out of production.

On starting production, the cost is the normal weekly cost plus the set-up cost for that manufacturing group.

2.3.1 Class one manufacturing groups

During production, one assumes that the total stock is split optimally between balanced stock and freestock. (Ways of finding this optimal split are given later). The production and shortage costs can then be calculated for the appropriate values of the
balanced and freestock.

The total cost is obtained by adding the storage cost, proportional to total stock, and any expediting costs.

Out of production, the actual freestock should be below this optimal level and the balanced stock should be higher, but as just explained costs will be estimated exactly as during production.

2.3.2 Class two manufacturing groups

Class two manufacturing groups are assumed to be in production for a sufficiently small proportion of their time so that the effective freestock can always be assumed to be at its minimum value.

The production costs are assumed independent of the run length and have been included in the set-up cost, therefore only the shortage costs are important. For a more reliable estimate of balanced stocks during production assume half the production is balanced, with the full increase in the final week.

2.4 The use of standard cost curves

While cost curves can be produced individually for each manufacturing group, it is convenient to have a set of standard cost curves available if this is possible.

For the class one manufacturing groups, one set of curves will not suffice but details are given below on how to adjust the standard curves for each group.

For class two manufacturing groups one needs to know the optimal starting stock for production (trigger stock), and optimal batch
quantity. These can be calculated in terms of two standard parameters and read directly off two graphs.

2.4.1 Class one manufacturing groups

2.4.1.1 The 'standard' assumptions

The standard cost curves use standard units for cost and stock. The standard unit of stock is the standard error of the sales forecast, \&. For example if \& = 2,500 pairs then a stock of 7,250 pairs is 2.9 standard units.

The standard unit of cost is \( K/(\& \times 100) \), so that with an effective freestock of 1 unit, the production cost is 100.

The costs now depend on three parameters. These are the minimum effective freestock, MEF, the penalty cost per unit shortfall, P, and the storage cost per unit, C. (All these are measured in standard units).

The 'standard' values used in the cost curves are a minimum effective freestock of \( \frac{1}{4} \& \); a penalty cost per unit of 800; and a storage cost of 40. These particular values are realistic for the major class one groups and simplify the cost curves. Details on adjusting the costs for other values are given later.

2.4.1.2 The 'standard' costs

Define Bal as the expected balanced stock, and Fr as the effective freestock in standard units.

The marginal value of balanced stock is 800 x Probability demand exceeds Bal.
The marginal storage cost is constant and has been ignored in diagram 2. The correct marginal value of stock is found by subtracting the storage cost per unit from the value calculated from diagram 2. This adjustment should be made if storage costs differ between manufacturing groups.

2.4.1.3.2 The minimum effective freestock

The critical stock is defined as the balanced stock above which the freestock should exceed its minimum value. At this value the marginal value of balanced stock equals the marginal value of freestock at its minimum value, \( 100/MEF^2 \), therefore the critical stock satisfies the equation:

\[
\text{Probability demand exceeds the critical stock } = \frac{100}{P \cdot MEF^2}
\]

This can be solved once \( P \) and \( MEF \) are known. For the standard values the critical stock is zero.

To read diagram 1, the freestock will be the greater of the calculated value and the minimum effective freestock. In diagram 2, if the balanced stock is below its critical stock, the net effective stock should be corrected by subtracting \( MEF - 1 \) before reading the diagram. This also applies for diagram 3, but if extensive use is to be made of the total cost curve it is better to recalculate it.

2.4.1.3.3 The penalty cost

The correction for the penalty cost depends on whether the balanced stocks are above or below their critical level.
The marginal value of freestock is $100/Fr^2$.

The marginal value of freestock at the minimum effective freestock of $\frac{1}{8}$ is 400. The freestock should take its minimum value if the expected balanced stock is negative so that the probability of a stockout exceeds $\frac{1}{4}$. For positive balanced stocks, the probability of a stockout is below $\frac{1}{4}$ so the freestock should be above its minimum.

Using the simple approximation to the costs, the freestock should multiply by 2.5 for every increase of 1 unit in the balanced stock.

Diagram 1 shows the optimal split of the net effective stock into freestock and balanced stock. Diagram 2 shows the marginal value of stock (excluding storage costs - a constant) as a function of the net effective stock for the standard values of MEF and P.

Diagram 3 shows the total costs, and costs excluding storage costs, for the standard values. This shows that, for these values, the optimal stock is 3.4 units, and that there is very little variation in cost for stocks between 2.2 and 4.7 units.

2.4.1.3 Corrections for non-standard values

2.4.1.3.1 Storage costs

It is easiest to correct for non-standard storage costs. The storage cost is proportional to the stock so, to calculate the total cost, a linear addition must be made for storage costs. In addition a fixed constant should be added to cover the storage costs for ineffective stock, but since it is fixed it can be ignored.
Diagram 1

Optimal Split of Net Effective Stock
Into Freestock and Balanced Stock

Stock (standard units)

- Net effective stock
- Freestock

Balanced stock

Chart showing the split of net effective stock into freestock and balanced stock.
Diagram 2

Marginal Value of Stock as a Function of Net Effective Stock

Marginal value

800

600

400

200

Net effective stock (standard units)

-2 -1 0 1 2 3 4 5
Diagram 3

The optimal total cost as a function of net stock

- Total cost
- Excluding storage cost

Cost per week

3000

2000

1000

800

600

400

200

-1 0 1 2 3 4 5 6

Net effective stock (standard units)
Below the critical level

If below, (so that the current state is probably 'slightly understocked' or 'severely understocked'), the marginal value of stock is found by reading diagram 2 (after first correcting for non-standard values of the MEF); the true marginal value of stock is the answer from diagram 2 multiplied by P/800. I.e. the scale measures marginal cost in $800^{ths}$ of the penalty cost.

This correction gives an approximate value for the total cost (see diagram 3) but it is better to recalculate this if P differs greatly from 800.

Above critical level

Above the critical balanced stock, the marginal values of freestock and balanced stock should be equal. The larger the penalty cost P is the larger will be the balanced stock corresponding to any given freestock. The correction to the balanced stock from the value shown in diagram 1 could depend on the penalty cost and the freestock but fortunately the correction is almost independent of the freestock (in fact completely independent for the simplified expression for shortage costs).

The following table shows the adjustment that should be made to the balanced stock and to the net effective stock before reading diagrams 1, 2 or 3. This correction is also the critical balanced stock if MEF=4.
Penalty cost, \( P \) 100 200 300 400 500 600 700 800
Add 2.27 1.52 1.08 0.77 0.52 0.33 0.16 0
Penalty cost, \( P \) 900 1000 1200 1400 1600 2000 2400 3000
Subtract 0.12 0.23 0.43 0.59 0.74 1.00 1.18 1.42

General rule. Add \( 2.5 \log_{10}(P/800) \).

Examples: Assume the penalty cost \( P \) is 1200, and other parameters take their standard values.

a) From the above table the correction is 0.43 standard units therefore to find the marginal cost for a net effective stock of 3.10 units
1. Subtract 0.43 to give 2.67
2. Read marginal cost off diagram 2 - Answer 65

Note, from diagram 1, that the optimal balanced stock for a total effective stock of 2.67 units is 1.40 units, leaving 1.27 units for freestock. Therefore the 3.10 units should be split into 1.27 units of freestock and 1.83 (=1.40 + .43) units of balanced stock.

b) For a net effective stock of 0.60 units and a standard minimum effective freestock of 0.50 units, the balanced stock will be 0.10 units which is below the critical value (0.43 units) therefore the marginal value of stock is 1200/800 x 375 (read off diagram 2) i.e. 557.

2.4.2 The use of standard cost curves -
Class two manufacturing groups

2.4.2.1 Using the standard model

When creating the machine loading, one first calculates an implicit marginal value of stock. This is used to determine the optimal
starting stock and batch quantities for class two manufacturing
groups using diagrams 4 to 6.

The following standard parameters are used:

- The unit of stock equals the 'standard error' of the forecast, $\sigma$.
- $P$, which equals the ratio of the penalty cost to the implicit
  marginal value of stock
- $U$, which equals the set-up cost divided by the storage cost
  multiplied by the sales rate

(measured in units per week) i.e. $U=S/U\cdot sales\ rate/storage\ cost$.

2.4.2.2 The optimal stock and trigger stock

The optimal stock (at which the weekly cost is minimised) is found
by reference to diagram 4 for the appropriate value of $P$ (note the
change of scale).

The optimal batch quantity and correction for the trigger stock are
given by diagram 5 for the appropriate value of $U$.

Production should start when stock falls to the trigger stock which
is the optimal stock minus the correction found above.

2.4.2.3 Technical note

Given the problem of minimising average costs in batch production
with a set-up cost, diagram 5 is constructed using a graph of the
direct cost per week against stock (see diagram 6).

For a particular trigger stock, draw the horizontal line inter-
cepting the graph at that stock level. Calculate the area, $A$, above the graph but below this line, and the length of the line, $L$. 
THE OPTIMAL EFFECTIVE STOCK AS A FUNCTION OF RELATIVE PENALTY COST

Note change of scale

Optimal stock

Relative penalty cost

0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6

0
2
4
6
8
10
20
40
60
80
100
Diagram 5

THE OPTIMAL TRIGGER STOCK AND BATCH QUANTITY
AS FUNCTIONS OF THE SET-UP COST FACTOR

Quantity (standard units)

Note change of scale

Optimal batch quantity

Optimal trigger stock correction

Set-up cost factor
Example of the Graphical Derivation of the Optimal Batch Quantity and Trigger Stock

Cost per week

Batch quantity, L

A

Trigger stock  Optimal stock

Stock
before it intercepts the graph again.

This trigger stock is optimal if $U$, the ratio of set-up cost times sales rate to the storage cost, equals $A$. The corresponding optimal batch quantity is $L$.

By selecting a range of trigger stocks diagram 5 can be constructed. The appropriate trigger stock and batch quantity for the actual value of $U$ can then be read off the graph.

2.4.2.3.1 Mathematical note

This corresponds to constructing the stock levels at which the marginal cost associated with changing the minimum or maximum stocks equals the average cost - a property of the optimal values. The same conclusions can be found by differentiating the cost function.
3.1 Introduction

The planner has no control over the total demand, assuming unmet demand is backlogged not lost. The total production hours are specified by the management not the planner. He therefore has no control over the projected total stocks (measured in units of production time).

The machine loading must be appropriate to the projected supplies. For example, if the net stock is expected to be negative, shortfalls should be expected in all brands; while with very high stocks there should be no shortfalls.

A variety of machine loading algorithms are available to the planner, each appropriate in a different state. This part relates how to classify the projected state in each month using a projection of the future supplies.

3.2 Projection of future supplies (see accompanying example)

1. Convert stocks and demand for each brand into units of production time. E.g. 1 golf shoe equals two toddlers equals, say, one minute of production time.

2. Calculate the planned production allowing for breakdowns, etc., in each month. Forecast the demand by month for each brand, and add to obtain the total demand by month.

3. Project the final stocks by machine type for each month as the initial stocks plus planned production minus expected demand.
4. Subtract the ineffective stocks from the projected stocks; the residual is the expected effective stock. (Negative values indicate unsatisfied demand). The ineffective stocks include the ineffective and unplanned freestocks plus stock to keep the warehouse 'oiled'.

5. Estimate outside limits for the cumulative sales forecast for each brand such that the limits will be breached only one time in 20. Take half the difference; this provides an estimate of the standard error of the forecast (use the actual value if it is known). Add these errors over all brands.

The result is the 'standard forecast error'; it is the unit of stock referred to by the symbol & in previous sections.

6. Express the residual stock as a multiple of the standard forecast error. Classify the situation then by the rules given in the next section.

3.3 Classification of the projected supplies

The classification of the projected supplies in any month determines the algorithm used in scheduling the machine loading for that month. Each algorithm considers only the costs which significantly affect the scheduling. For example when projected stocks are negative only shortage costs are significant.

3.3.1 Definition of the states

Five states are used in the classification. These are: 'severely understocked', 'slightly understocked', 'satisfactory', 'pre-season'
## Production of Future Supplies (Example)

<table>
<thead>
<tr>
<th></th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
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<tr>
<td><strong>Initial Stock</strong></td>
<td>181</td>
<td>173</td>
<td>194</td>
<td>254</td>
<td>262</td>
<td>191</td>
<td>151</td>
<td>140</td>
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<tr>
<td><strong>Planned Production</strong></td>
<td>62</td>
<td>93</td>
<td>118</td>
<td>91</td>
<td>39</td>
<td>117</td>
<td>100</td>
<td>103</td>
</tr>
<tr>
<td><strong>Expected Sales</strong></td>
<td>60</td>
<td>82</td>
<td>58</td>
<td>83</td>
<td>110</td>
<td>157</td>
<td>111</td>
<td>64</td>
</tr>
<tr>
<td><strong>Final Stock</strong></td>
<td>183</td>
<td>194</td>
<td>254</td>
<td>262</td>
<td>191</td>
<td>151</td>
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<tr>
<td><strong>Min. Oper. Stock</strong></td>
<td>130</td>
<td>141</td>
<td>129</td>
<td>141</td>
<td>155</td>
<td>178</td>
<td>156</td>
<td>132</td>
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<tr>
<td><strong>Residual Stock</strong></td>
<td>53</td>
<td>53</td>
<td>125</td>
<td>121</td>
<td>36</td>
<td>-27</td>
<td>-16</td>
<td>47</td>
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<tr>
<td><strong>Standard Error of Forecasts</strong></td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>33</td>
<td>40</td>
<td>47</td>
<td>52</td>
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<tr>
<td><strong>Ratio</strong></td>
<td>3.5</td>
<td>2.1</td>
<td>4.1</td>
<td>3.6</td>
<td>0.9</td>
<td>-0.6</td>
<td>-0.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Classification**
- Satisfactory
- Satisfactory
- Pre-season
- Pre-season
- Slightly understocked
and 'overstocked'.

'Severely understocked' implies that there are major shortfalls on most or all brands. In such circumstances, the model may be inappropriate. The sales staff should be consulted before issuing the machine loading.

'Slightly understocked' implies that intermittent shortfalls are likely for most brands. Production freestocks should be at or near their minimum values.

'Satisfactory' implies that shortfalls are still possible, but these should be brief, so freestocks can increase as appropriate. This should be the normal state.

Shortly before the peak season, stocks are high but falling rapidly. While producing in this period, it is often not clear which products to make since whatever is chosen, another brand might subsequently be needed instead. The 'opportunity costs' associated with any decision must be included in this 'pre-season' scheduling. The 'pre-season' state applies whenever there are appreciable 'opportunity costs'. It can coincide with being slightly understocked, but this is rare.

Finally, 'overstocked' implies that current production may not be sold by the time horizon, which is beyond the end of the current season.

3.3.2 Classification of the state

If the residual stock is more than one standard forecast error below zero, the projection for that month is 'severely understocked'.

If the residual stock is within one standard forecast error of zero, the projection for that month is 'slightly understocked'.
If current stocks exceed the forecast demand to the scheduling horizon, one is 'overstocked'. This also applies when out of season stocks approximate the remaining demand this season.

If one is projected to be slightly or severely understocked during the peak season, then there are pre-season opportunity costs for months for which the final residual stocks are not needed in the following month, but are used in a month classified as 'slightly understocked'. Classify such months as 'pre-season'.

If none of the above states applies (so one is between 'slightly understocked' and 'pre-season'), the situation is 'satisfactory'.

Example

In the example given earlier, the state for the last four months is slightly understocked. The first and last of these months are borderline on satisfactory. The machine loading will be revised before the schedules for these months are finalised, by which time the forecasts should be more accurate, so the state may later alter.

The residual stocks for June (of 125) exceed the demand for July so will be used during a slightly understocked month (August or possibly September) so June is 'pre-season'. Likewise July residual stocks exceed August demand so July is 'pre-season'.

April and May are not 'pre-season' or 'understocked', hence these months are 'satisfactory'.

4 33
PART FOUR - MACHINE LOADING

4.1 Introduction

The machine loading is prepared one month at a time. Generally it is prepared separately for each machine type but simultaneously for all manufacturing groups within that machine type. Special circumstances might make another division appropriate.

The determination of the machine loading has the following basic stages:

A. Determine the marginal value of stock and the corresponding optimal stocks for each manufacturing group.

B. Determine how much and when to produce each class two manufacturing group.

C. Fix the production of class one manufacturing groups to give as near optimal a loading as is possible.

D. Adjust the machine loading to meet practical constraints.

The actual procedure to follow depends on the projected state during the month in question. Appropriate procedures are described for each projected state with the main details given under the 'satisfactory' state.

The section finishes with some comments on when the provisional machine loading may need to be adjusted, e.g. to avoid two major machine changes in a weekend.

4.2 Machine loading while severely understocked

Typically there are a group of brands with similar penalty costs; and
a few brands with widely different penalty costs - the priority, and
the non-urgent brands (including most class two brands).

The basic model assumes that shortage costs are proportional to the
shortfall. If severe stockouts are projected the marginal value of
stock will nearly equal the central penalty cost.

For brands with low penalty costs, this marginal value will exceed
their penalty cost; the first conclusion is therefore that such
brands should not be produced during periods of severe understocking.

The priority brands should receive extra production until there is a
reasonable probability that the brand will be in supply. The
appropriate production is determined by using the 'slightly under-
stocked' algorithm.

This leaves the remaining shortfall to be distributed over
manufacturing groups and brands with similar penalty costs.
Providing there is a shortfall for each of these brands, the costs
are independent of the actual shortfalls of each brand (since costs
are linear with the shortfall).

In practice, dissatisfaction will increase with the length of the
shortfall. Therefore to minimise dissatisfaction and give equal
treatment to all customers, the shortfalls should be proportional
to the demand. This would mean that the delay for receiving each
brand would be equal, e.g. six weeks delay on every brand.

**Summary**

Do not produce low priority brands.

Give equal delays for other brands, except high priority brands which
should receive better supply.
Note. Check the proposed loading with the sales department - they may have other priorities.

4.3 Machine loading while slightly understocked

4.3.1 General features

General characteristics of this state are that shortfalls are likely but should only be minor. Freestocks are kept to their minimum, so class one groups operate at minimum freestock and class two groups have minimum length production runs (generally two weeks for manufacturing groups with several colours). Subtract these minimum values from the residual stock to get the total expected balanced stock or shortfall.

4.3.2 The optimal stocks

The optimal stock level for each manufacturing group gives equal marginal shortage cost to each group. The appropriate shortage cost, which defines the marginal value of stock, is found by trial and error.

Estimate an initial value for the marginal value of stock. For each manufacturing group, convert this value into standard cost units. Use diagram 2 to determine the corresponding optimal standard stocks and convert back into actual stocks following the guide-lines given in part II. (For class two manufacturing groups either diagram 2 or 4 can be used).

Compare the total balanced stock with the sum of the optimal stocks. Adjust the marginal value appropriately. (Increase it if the total balanced stock is below the sum, and vice-versa)
Repeat the process for this new value and interpolate to give the optimal stocks for each manufacturing group.

4.3.3 Possible simplification

If all penalty costs are equal and the standard error of each forecast is proportional to the demand, the balanced stocks should be divided between the groups in proportion to their demand.

If all penalty costs are equal but the standard errors vary, the optimal balanced stocks are proportional to the standard errors.

4.3.4 Machine loading

The machine loading is determined exactly as described under 'Machine loading while satisfactory'.

In summary; first the production of class two groups is determined, then the class one groups are fitted around this in the best possible manner, finally the machine loading is adjusted to remove overloads for any category of worker.

4.4 Machining loading while satisfactory

4.4.1 General features

General characteristics of this state are that storage, shortage and production costs are all relevant. The set-up costs mean that no action should be taken within a range of stocks around the optimal value. Only immediate costs need be considered.

4.4.2 The optimal stocks

The optimal stocks for each manufacturing group have an equal marginal value of stock. This must be found recursively following...
the procedure below.

1. For each class one manufacturing group construct an average marginal cost curve if the standard parameters are not applicable. Alternatively the corrections suggested in part II can be applied to the standard curve in diagram 2.

2. Estimate an appropriate initial value for the marginal value of stock.

3. Determine, for each manufacturing group, the stock level corresponding to this marginal value. For class one groups use diagram 2 or the graphs produced at stage 1, for class two groups use diagram 4.

4. Add up the total stocks required for this marginal value, and compare with the available stock. Increase the marginal value to reduce the stocks required, and vice-versa.

5. Repeat stages 3 and 4 with the new marginal values until the allocation is approximately correct. This gives the optimal stock levels for each group and the true marginal value of stock.

4.4.3 Machine loading

The machine loading aims to get as near to the optimal stocks as is possible. If stocks of any manufacturing group substantially exceed their optimal value, other groups cannot reach their optimal levels. The optimal stocks should be recalculated ignoring this group which will not be produced in the month.

If the optimal stocks are achievable, the suggested procedure for machine loading is :-
1. Determine which class two groups should be made. A group should commence production when the stocks fall below the trigger level (determined using diagram 5), and the batch quantity should be the optimal quantity (also from diagram 5) rounded into a whole number of weeks' production.

2. For each class one group determine the final stocks if the group uses all the machines it is currently set-up upon for the whole month. If this is significantly below the optimum stock level, assign another machine to this group for part of the month; if this is not possible warn the planning manager of the projected shortfall.

3. Class two groups should be made on machines for which the current class one group has projected final stocks above the optimum. Where there is a choice between two class one groups, pick the alternative which has the lowest set-up cost and keep the marginal values of stock nearest to their optimal level.

   (Generally the best choice is obvious.)

   This gives a provisional machine loading for the month based on the optimal stocks and taking set-up costs into consideration.

4.4.3.1 Only one class one group

Note that where there is only one class one group for a machine type, the procedure can be greatly simplified since the marginal value of stock can (almost) be directly estimated. The optimal production of class two groups for this marginal value is found, and the class one group uses the remaining production capacity.
4.5 Machine loading 'pre-season''

The 'pre-season' situation resembles the 'satisfactory' situation with an additional factor. This arises from the restrictions placed on future loadings by the current loading.

Too low a stock of a manufacturing group means that, with full production, one cannot meet a peak demand. Too high a stock can result in surplus stock of one group while other groups are in short supply.

Ideally one wishes to remain in the safe zone (see diagram 7) where both minimum and maximum demand are catered for, but in the 'pre-season' period this may be impossible. To adjust for this the marginal value of stock is corrected for the opportunity costs involved.

4.5.1 Explanation of opportunity costs

Since opportunity costs are not widely understood, an explanation is required. They can best be evaluated after the event. The typical remark 'if only we had done that instead we could have saved £X' represents an opportunity cost for the actual decision of £X.

The marginal opportunity cost of understocking in a particular situation is the difference between the marginal value of stock for that manufacturing group after maximum production and the general marginal value of stock. The reason is that an extra unit of stock produced earlier would have saved this marginal opportunity cost by increasing the supplies of the understocked manufacturing group.
The marginal opportunity cost of overstocking a manufacturing group is the difference between the general marginal value of stock and the marginal value of this group with no further production; again this represents the potential saving, but in this case for reducing the supplies.

The expected opportunity cost is the sum of each opportunity cost multiplied by the probability that the event occurs, added up over all future months. (Note opportunity costs more than a few months ahead are generally zero.) Since understocking costs represent opportunity gains for increased production they should be subtracted from the overstocking costs.

An exact estimate of the opportunity costs is impossible without knowledge of both the distribution of current forecast errors and how the forecast may be altered before the final decision period.

With these figures a simulation would reveal the opportunity costs, but until a forecasting system is firmly established, crude estimates must be used.

4.5.2 Why are opportunity costs incurred?

Opportunity costs are incurred when a) decisions about a future month can be made at a later date, b) more information will be available to aid the decision-making then and c) current decisions restrict the choices that may be made subsequently.

4.5.3 Estimation of opportunity costs

4.5.3.1 Will opportunity costs be incurred?

1. Determine the last date at which the machine loading can usefully
be altered before the season.

2. For each manufacturing group produce minimum and maximum demand projections for that date. These will show the minimum (maximum) demand likely up to that date followed by the forecasts for the future that will be made at that date.

3. Estimate the stock during the season and the appropriate proportion for each manufacturing group. Add this to the demand projection above.

4. An overstocking cost may be incurred if the current stocks are greater than the minimum demand projection.

An understocking cost may be incurred if the projected stocks following maximum production from that date are below the maximum demand projection.

Diagram 7 shows how there are regions within which no opportunity costs are incurred, the 'safe' region; overstocking and understocking zones; and a zone in which both costs may be incurred.

4.5.3.2 Rule for estimating overstocking costs

1. Estimate the marginal value of stock during the season assuming slightly above normal demand.

2. The estimated marginal overstocking cost is measured using the minimum and average demand curves. At any time, the marginal cost is one quarter of the marginal value of stock times the excess of current stocks over minimum stocks as a proportion of the difference between minimum and average demand. (This figure represents the probability of overstocking times the average opportunity cost.)
To estimate the marginal overstocking cost multiply the average marginal cost by the part of the season for which it applies.

4.5.3.3 Rule for estimating understocking costs

In a like manner, the estimated marginal understocking cost is 'the average shortfall of maximum stocks below maximum demand as a proportion of the difference between average and maximum demand' times the 'appropriate part of the season' times 'one quarter of the difference between the penalty cost and the marginal value of stock'.

4.5.4 Determining the optimal stocks

The optimal stocks are determined in the same way as when the state is satisfactory but the current marginal value of stock is adjusted by the opportunity cost calculated above as the difference between overstocking and understocking costs.

4.5.5 The machine loading

The machine loading is determined in the same way as when the state is satisfactory.

4.6 Machine loading while overstocked

4.6.1 General features

If the stocks are so high that current production will not be sold during the current season, then storage costs and the risk of obsolescence become dominant factors in determining what to produce.

It is unlikely that the company would allow stocks to climb to such levels; almost certainly the workforce would be cut back before then.
Nevertheless some features mentioned here are relevant to high pre-season stocks.

4.6.2 Storage costs

Generally differences in storage costs between the products are irrelevant because the marginal value of stock is several times the storage cost, but with very high stocks the marginal value of stock may even be negative.

At such times one should concentrate on producing the manufacturing group with the lowest production costs per unit of production time. This is generally one of the class one manufacturing groups with large annual sales which is relatively cheap to produce.

4.6.3 Risk of obsolescence

When current production may not be sold for a year or more, there is a substantial risk that some products may become obsolete before then with the result that remaining stocks must be sold in a clearance sale or stored for a long time.

The more risky a product, the lower the period for which current stocks should satisfy expected demand. Since the cheap high-volume products are less risky, this again indicates that one should concentrate on class one groups.

4.6.4 New products

Obsolescence is particularly likely among new products since the market for them has yet to be established. This places a high opportunity cost on the production of new products.

General advice for these products is :-
To delay production as late in the season as is possible. The ability to raise the maximum production rate would be very useful here.

To monitor sales regularly and revise the forecasts frequently.

It might be helpful to time the release so that sales build up slowly, but this would preclude an initial sales drive.

4.6.5 Maching loading while overstocked

Production and shortage costs must still be considered while overstocked, so each manufacturing group should be made in large batches before stocks fall to a danger level. Nevertheless the emphasis must be placed on minimising long-term costs of storage and obsolescence.

General advice is therefore to concentrate production on the major cheap brands in class one manufacturing groups while producing other groups as appropriate with relatively large batch quantities.

4.7 Expediting costs

The above algorithms minimise production, storage and shortage costs. Any additional costs can be included as an adjustment to the marginal value of stock. In particular this applies to expediting costs.

If a manufacturing group cannot be produced in a month because of raw materials shortages, its stock will remain constant. The optimal stocks should be determined excluding this group.

If this group can be produced, but only at an extra expediting cost which falls to zero in the near future, the marginal value of stock
should be increased by the expediting cost per unit before the appropriate optimal stock is determined. (This reduces the optimal stock.)

4.8 Adjusting the machine loading

The provisional machine loading produced by following the algorithms above gives suggestions for when each manufacturing group should be produced. For class two groups this is the week in which stocks fall to their trigger level.

The provisional loading may contain undesirable combinations of manufacturing groups. For example two groups which require a lot of 'finishing' should not be manufactured together otherwise a backlog of footwear to be finished will build up. Also one should avoid two major machine changes at one weekend since the engineers may not have time to complete their work for such weekends.

There is little change to the total costs by adjusting production dates by a couple of weeks, therefore the provisional machine loading can be freely altered to produce an acceptable machine loading providing the total production of each manufacturing group is kept constant.
5.1 Introduction

The machine loading divides into two main stages each of which has several parts. The first stage is data preparation, the second machine loading.

The manufacturing groups are divided into two classes. Class one contains the major brands produced in large quantities; class two contains the specialised manufacturing groups of low-volume high-profit-margin brands which are produced in short batches. The treatment of these groups differs because of the large differences in the proportion of time when they are in production.

5.2 Data Preparation (see part II)

The first stage of data preparation is data collection, which involves the estimation of various costs, such as storage and shortage costs, and parameters such as the production constant, K, and the standard error of the forecast, \( \sigma \).

The next stage is to convert these costs and parameters into standard values so that the standard graphs can be used. This conversion differs for the class one and class two manufacturing groups since costs during production are more important in the former case, and set-up costs in the latter case.

A simplifying feature of these standard graphs is that an approximation is used for the shortage costs. This has the property that shortage costs fall to 16% of their previous value for every increase of \( \sigma \) in the balanced stocks, hence \( \sigma \) is used as the standard
unit of stock.

For class two groups, this conversion completes the data preparation. For class one groups, it may be desirable to construct a graph of the marginal value of stock against net effective stock particularly if more than one parameter has a non-standard value.

5.3 **Machine loading**

The machine loading is prepared in monthly blocks. Typically the production in the first month is fixed since the raw materials are already prepared; the second month is the important month since current decisions determine the machine loading for this month, the machine loading for subsequent months is only a guide and can subsequently be altered.

5.3.1 **Classification of the projected state** (see part III)

An algorithm is used to determine the machine loading in each month. Since one algorithm will not cover all circumstances, there are five algorithms designed to cover the full spectrum of circumstances.

To determine which algorithm to use in scheduling a given month, the supply status at the end of that month must be projected. This status is then classified according to rules given in part III; for each class there is a corresponding algorithm.

5.3.2 **Creating the machine loading**

The specific details on machine loading vary with the algorithm, but the general pattern has the following steps:

A. Determine the optimal stocks for each manufacturing group and
the corresponding marginal value of stock.

This involves estimating the marginal value of stock, then
determining the corresponding stock appropriate for each
manufacturing group using the pre-prepared graphs. The total
of the appropriate stocks is compared with available stock,
and the marginal value is adjusted suitably.

B. Determine the desired production of each class two manufacturing
group.

This requires the calculation of trigger stocks and optimal
batch quantities using pre-prepared graphs. These graphs will
also indicate the best week in which to start production.

C. Decide which class one groups should halt production to
accommodate the class two groups.

Project the stocks of each class one group with full production.
Fit in the class two groups on machines for which the projected
stocks are farthest above the optimal level. This determines
a provisional machine loading.

D. Adjust the machine loading to meet practical considerations.

Alter the machine loading as little as possible to reduce the
peak workloads for any category of worker to reasonable levels.
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APPENDIX 5 MONTHLY SALES (ADJUSTED) FOR SELECTED PRODUCTS
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Determination of the critical size for each brand

The critical size for any brand at a specified date is found by dividing the unallocated stock of each size, i.e. the current stock less immediate commitments, by the size roll of that size. The result is the potentially saleable stock associated with that size.

The saleable stock is the minimum over all sizes of the potentially saleable stocks and the corresponding size is the critical size. The freestock is the unallocated stock less the saleable stock.

Distribution of the critical size

Moulds were divided into three classes according to the fraction of potential production time for which a mould is in use (low up to 0.3, medium 0.3 to 0.9, high 0.9 and above).

The actual frequencies with which each size (and hence mould) is critical are found by determining the critical size at several dates for each brand. The theoretical probability should be proportional to the mould usage divided by its essentiality (see 10.4.4) which can be calculated for each mould giving the table in chapter 10.

Increases in balanced stocks due to a change in safety stock policy

Given two alternative safety stock policies, first calculate the safety stocks for each size of each brand and hence determine the change in safety stocks as a result of the policy change.
Divide the change in safety stocks by the size roll to get the potential change in saleable stocks if that size is the critical size. Use the distribution of critical sizes obtained earlier to determine the net effect on saleable stocks by adding up the individual changes.

Note that this assumes that the same size is critical under each safety stock policy - a realistic assumption for small variations. It overestimates the advantage of the alternative policy for large alterations in policy.

**Estimation of actual costs**

The actual storage and shortage costs are calculated using the stock position at one date by determining the rate of expenditure at that date and multiplying by 30 to get the expected monthly costs.

The storage costs are therefore obtained by multiplying the current stocks by the storage cost per month. The shortage costs are calculated as the unmet demand, defined as orders for last month not yet despatched, multiplied by the shortage cost per month. To avoid bias in these results all figures should be calculated at the same date in the month (since overdue orders are obviously higher early in the month), preferably near the end of the month.

The production costs are calculated from the actual mould schedules for the previous month, since the changes in this period have had the most immediate effect on the stocks. The important factors are the numbers of mould changes, and colour changes to lighter and darker colours. Each of this has a known cost which can be calculated at current prices using the table in section 8.5.
The total production cost is found by adding on the 'size-mix' cost for each machine each week using the formula in 8.8.2.

If any expediting was required in the month, its cost can be obtained from the planning manager. The total costs are the sum of the above costs.

Estimation of expected costs

The expected costs are calculated for each manufacturing group using the model provided in appendix C with the net aggregate stock equaling the total stock for all brands in that manufacturing group less the unsatisfied demand. The planned freestock and saleable stock are found from the appropriate graph. The various performance measures are calculated from the appropriate expected and actual costs.
APPENDIX 7  THE FIRST COMPUTER PROGRAM
DU 70 NBRAND=1, NBRAND = 70
IF (LISTF(JUNBRAND) .EQ. 70)
WRITE(30,0) LISTF(JUNBRAND), TSTOCK(BRAND), UNBALANCED(BRAND),
1 KUNPRBBN(BRAND), LASTFUND, KUNKLEASES(BRAND)
70 CONTINUE
C
C READ IN 'SCHED' RECORDS FOR NEW MACHINE TYPE IF NECESSARY
C AND THEN A 'INCDA' RECORD FOR SOME MANUFACTURING GROUP
C
100 CALL LNOUT(5,20,2)
IF (MLTYPE) 9000, 0, 0
110 LASTWEEKOFPLAN = ENDWEEK
112 RANALCUPF = .FALSE.,
113 NTYPE = STARTWEEK, NSHIFTTUT, NSHIFTSET = 0
115 WEEK = PLANINGWEEK
CALL CLEAR(JCLEAR, 445)
120 MACH = 0
MUNITH(WEEK+3)/4
DU 150 NC1 = 1.5
IF (MANYP, SCHEME(WEEK, MC) .GT. MANGP, 150, 150)
MACH = MACH + 1
NSHIFT = NSHIFTSCHEME(WEEK, MC)
KUNPRBBN(MC) = KUNPRBBN(MC) + (MANYP, SCHEME(WEEK, MC) .EQ. MACH)
1 = NLSCHSCHEME(MC) / PLANINGWEEK
NSHIFTTOTAL = NSHIFTTUT + NSHIFT
KUNOK = KUNOKSCHEME(WEEK, MC)
1 IF (KUNOK = 150) 150, 150, 0
NSHIFTSS(KUNOK) = NSHIFTSS(KUNOK) + NSHIFT
NSHIFTSET = NSHIFTSET + NSHIFT
150 CONTINUE
IF (MACH = 2) 210, 210, 0
WEEKSUFF = 0
IF (STARTWEEK) 0, 0, 230
STARTWEEK = WEEK
MUNCHTART = MUNCH
1 IF (STARTWEEK .EQ. 24) STARTWEEK = 24
1 IF (LASTWEEKOFPLAN, GT, IDUM) LASTWEEKOFPLAN = IDUM
GO TO 230
C
NO PRODUCTION THIS WEEK
C SEE IF THERE IS A FOUR-WEEK GAP IF SO STOP SCHEDULE HERE
210 IF (STARTWEEK) 250, 250, 0
WEEKSUFF = 0
1 IF (WEEKSUFF .EQ. 2) 250, 0, 0
RAISINGUP = .TRUE.,
GO TO 260
C
260 EVALUATE TOTAL PRODUCTION BY 'MUNCH'
270 IF (WEEK, MC, MUNCH, KUNPRBBN, 250, 250, 0, 0)
NMAC = 0
DU 240 NUNI = 1.5
MC = 1STMACA(NUM)
1 IF (MC) 240, 240, 0
1 IF (KUNPRBBN(MC) .LE. 0, 240, 0)
NMAC = NMAC + 1
240 MACHUSE = NMAC = NC
C
KUNOK = A MACHINE USED IN THIS SCHEDULE
250 TCUNPRBBN(MC) = KUNPRBBN(MC) + KUNPRBBN(NC)
240 CONTINUE
250 WEEK=WEK+1
   IF (WEEK=LASTWEEKPLAN) 120,120,0
   IF (STARTWEEK) 20,20,0

   NOW START PROCESSING

   CHECK TO SEE IF THERE IS A FIVE-WEEK GAP AFTER THE END
   IF SO THE FINAL STOCKS WILL HAVE TO BE BALANCED UP
   BALANCEUP=WEKOFF,61.0
   BALANCEUP=WEKOFF,61.0
   WEEK=LASTWEEKPLAN+1
   IF (WEEK=7) 320,320,0

   WE NEED NOT BALANCE UP IF THIS MAN.GRP IS MADE ON
   ANY MACHINE IN THE SUBSEQUENT 4 WEEKS.

270 IF (BALANCEUP=BALANCEUP) AND (MAN.RPK=MANPLAN(1),NE,MANGRP)

   LASTMONTH=(LASTWEEKPLAN+3)/4
   TOTPROD=(TOTPRIOU(JLASTMONTH)
   MACHICO=MACHICO+1
   PLANNINGTIME=STARTWEEK
   IF (DAILY) PLANNINGTIME=7*STARTWEEK

   READ IN STOCKS, SIZERO INDUS AND REQUIREMENTS
   C
   C
   C

   CALL INOUT(30,45,8)
   IF (.NOT.FIRSTLOOP) GO TO 310

   NBRANDS=0

   CALCULATE STOCK INFORMATION FOR EACH BRAND
   NBRANDSIZES=0
   DU 350 BRAND=1,NBRAND
   BALANCED,BALBAR=TSOUCOD(BRAND)
   DU 350 SIZE=1,40
   SIZEG=SIZEG(SIZE,BRAND)/THOUSAND
   IF (SIZEG) 330,330,0
   NBRANDSIZES=NBRANDSIZES+1
   KSTOCK=STOCKS(SIZE,BRAND)
   IRESIZE(SIZE)=IRESIZE(SIZE)-KSTOCK

   C
   C
   C

   CALCULATE THE BALANCED STOCKS OF EACH BRAND
   SALABLE=KSTOCK/SIZE
   IF (SALABLE-BALANCED) 0,340,340

   DUMMY=BALANCED
   BALANCED=SALABLE
   DUMMY=SALABLE

340 IF (SALABLE,BALBAR) SALBAR=1 SIZESL,LT,SIZE GT,30.) BALBAR=SALABLE

500 CONTINUE

   UNBALANCED(BRAND)=TSOUCOD(BRAND) - BALANCED
   UNBAR(BRAND)=TSOUCOD(BRAND) - BALBAR
   STORE THE UNBALANCED STOCKS FOR EACH BRAND
   C
   C

   TSOUCOD(BRAND) = TSOCOD(BRAND) + KUNRELEASES(BRAND)
   OUTPUT STOCKS RECORD FOR THIS BRAND
   CALL OUTPUT(1,BRAND),5

   CONTINUE

   CALL CLEAR(STOCK,400)

   C
   C
   C

   THIS RECORDS THAT THE STOCKS HAVE BEEN PROCESSED AND
THE STOCKS ARE OVERWRITTEN
ADD UP INITIAL STOCK
510 KUMKELFASES(brand) = 0
DU 520 brand = 1 brand
KUMRELEASED = KUMKELFASES + KUMKELFASES(brand)
540 INITSTOCKTOTAL = INITSTOCKTOTAL + TSTOCK(brand)
TSTOCK = TOTAL(brand) + INITSTOCKTOTAL
OPTIMAL CHECK CAN GO HERE
CHECK FOR PRODUCTS ONLY REQUIRED IN LATER MONTHS
NOW FIND THE MTH AND FRACTION SUCH THAT THE REQUIREMENTS
ARE NOT UP TO THIS MONTH AND "FRACTION" OF THAT MONTH.
CURREN(brand, MOUTH) IS THE TOTAL REQUIREMENTS
TO THE END OF EACH 4 WEEK PERIOD.
DU 560 MOUTH = 1 20
DU 560 BRAND = 1 BRAND
560 TCTREQU(brand, MOUTH) = TCTREQU(MOUTH) + KUMREQU(brand, MOUTH)
NEED TWO PERIODS FOR CALCULATIONS BELOW
CHECK TO SEE IF NETS TILL MONTH EXCEED TOTAL
IF THE REQUIREMENTS ARE SUFFICIENT, FRACTION IS THE PART
OF THE NETS FOR MOUTH WHICH COULD BE MET.
IF NETS INSUFFICIENT, FRACTION IS THE RATIO OF "TCTREQUOT"
TO THE INPUT NETS, FRACTION THEN EXCEEDS 1.
MOUTH = 1
570 MOUTH = MOUTH + 1
IF (TCTREQU(brand, MOUTH) - TCTREQUOT) > 0, 580, 580
IF (TCTREQU(brand, MOUTH) - TCTREQU(MOUTH)) > 0, 570
FRACTION = TCTREQUOT/TCTREQU(MOUTH)
DUMMY = 0
580 FRACTION = TCTREQUOT / TCTREQU(MOUTH)
1
DUMMY = ONF - FRACTION
590 DU DUO BRAND = 1 BRAND
PERSON = PERSON(brand)
IF (PERSON) AND (0, 0, 0)
UNPACK SIZE(UNITS) RECORDS
CALL OUTPUT(SIZE=UNIT(brand), 4)
SET UP TOTAL REQUIREMENTS FOR EACH BRAND
TOTALREQ(brand) = FRACXTION * KUMREQU(brand, MOUTH) +
1
DUMMY * KUMKELFASES(brand, MOUTH)
DETERMINE THE PROPORTION OF THE REQUIREMENTS
FOR EACH COLOUR AND FOR EACH BRAND
INITSTK(XKULOR) = INITSTK(XKULOR) + TSTOCK(brand) * KUMKELFASES(brand)
PROPORTION(brand) = (TOTALREQ(brand) - KUMKELFASES(brand)) /
1
PROPORTION(XKULOR) = PROPORTION(XKULOR) + PROPORTION(brand)
IF (PROPORTION(XKULOR), LT, 0, 0,11) PROPORTION(XKULOR) = 0, 0, 11
600 CONTINUE
NUMVARIETIES = NUMBRANDS
MCDA(26) = NUMBRAND
C
FIND OUT THE NUMBER OF COLOURS
MCDA(26) = NUMCOLOUR
DU NUM KOLOR = 1, 8
650 IF (PROPORTION(KULOR), NE, 0) NUMCOLOUR = NUMCOLOUR + 1
MCDA(25) = NUMCOLOUR
OUTPUT GENERAL INFORMATION ON MAN, GROUP
WHITE(50,0,0) METYPE,MANGRP,STARTWIF,LASTWEEKOFPLAN
1, INITSTOCK,TOTALPRODFRACTION,NMTH
CALCULATE THE REQUIREMENTS OF EACH SIZE
MAINLY FOR 'FORC' RECORDS, BUT ALSO FOR INFORMATION
THAT CONTAINS 'MAXDES1RSIZE' FOR THE SMALL SIZE MACHINE
IND I=1 TO 100
READ IN ANY FORCE RECORD
CALL (NOT(50,50,0))
IF (.NOT.FIRSTLOOP.AND.TWDCOUNT.GT.0) GO TO 810
FURTHER CALCULATION REQUIRED FOR TOP SIZES AND NUMSIZE
IF (SIZE=1,0)
DO 540 NBR=1,NBRAND
540 WORK OUT SET PLOTS OF EACH BRAND
ON FIRST LOOP THE INITIAL STOCKS OF EACH SIZE ARE KNOWN
ON SUBSEQUENT LOOPS THESE ARE ASSUMED BALANCED
NUMX=NUMX*BRAND
IF (.NOT.FIRSTLOOP) NUMX=STOCK/BRAND
900 THE #=THE #/THOUSAND
DO 180 SIZE=1,40
180 SIZE=X,1,0
DO 180 BRAND=1,NBRAND
600 INSIZE=W/THOUSAND(SIZE)*THE #/(BRAND)*SIZE*W/THOUSAND(1,0)
1 IF (SIZE=1,0)
2 NUPSIZE=NUMSIZE+1
MAXSIZE=SIZE
IF (INSIZE,EW,0) MINSIZE=SIZE
680 CONTINUE
WHITE(30,0,0) INRESIZE
DO NOT NEED TO SET MAXDES1RSIZE IF ALREADY SET
IF (DOM) 0,0,810
1 IF (DOM) 0,0,810
DO 1700 SIZE=MINSIZE,MAXSIZE
4 MEASURE CONTAINS THE 'FORC' RECORD IF ANY
1 IF (MEASURE(SIZE)) 730,730,0
ME=MEASURE(SIZE)
KMPRON(1,0)=KMPRON(1,0)-INRESIZE(SIZE)
730 CONTINUE
NUM=1
MACH=MACHNUM(NUM)
DO 500 SIZE=MINSIZE,MAXSIZE+1
1 IF (MACH) 750,750,0
500 IF (MEASURE(SIZE)) 1,0,750
1 IF (IFLAG) 1,0,750
500 IF (IFLAG) 1,0,750
SEI THE TOP SIZE FOR ANY MACHINE BY SEARCHING THROUGH TILL
THE CUM. PLATS EXCEED THE PLANT FOR THAT AND ALL LOWER MACHINES
MAXDES1RSIZE(MACH)=SIZE
NUM=NUM+1
MACH=MACHNUM(NUM)
500 IF (MACH) 750,750,0
500 KMPRON+KMPRON(MACH)+IFLAG=KMPRON(MACH)+IFLAG
750 CONTINUE
THE LAST MACH SHOULD FIND WITH MAXSIZE
IF (MACH,EW,0) MAXDES1RSIZE(MACH)=MAXSIZE
1 GO TO 810
WITH ONLY ONE MACHINE SET TOP SIZE AS 2/3 MAXSIZE
760 MAX FRESH = (FRESH(MACH=1)/(NMSIZE*MAXSIZE*MAXSIZE))/3
810 FIRST LOOP = FALSE
C CALCULATE THE MINIMUM AND AVAILABLE FREESTOCK
C
C IF (FRACTION) THEN IN ANY WEEK SOME FRACTION
C OF THE SIZES CANNOT BE MADE
FRACTION = ONE / (MACH*MCDA(25))/FLOAT(MAXSIZE-MINSIZE)
C
C IF (FRACTION) THEN
C IF (ONE - FRACTION) 820,830
820 FRACTION = 0,
C
C CALCULATE MINIMUM FREESTOCK
C IF THE MINIMUM DESIRED FREESTOCK IS ZERO, SET IT
830 MINSIZE = (MACH*MCDA(15)+MACH*PROD)*2
MINSIZE = MINSIZE
C
C THESE ARE THE MINIMUM STOCKS NECESSARY TO SUSTAIN
C STOCKS OF ALL SIZES AND COLOURS
C
C MINSIZE = MINSIZE
C IF (MCDA(17),LE,0) MINSIZE = MINSIZE
C
C DETERMINE SPLIT OF ANY EXTRA FREESTOCK
C MOST OF THIS GOES TO INCREASING THE BATCHSIZE
C BUT SOME INCREASES THE COLUMN AND RANGE EFFECTS
C THE RATIO IS MINSIZE/RATUG/RATUR
C
RATOL = MINSIZE/(MACH*MCDA(23))/MCDA(23)
RATIO = P/FRAC*P/FRACTION*MCDA(23)
C
C SIZES IN ML = HALF (FOR AVERAGE)
C FREES2 CONVETS THE FREESTOCK IN PAIRS TO THE PART
C USED TO INCREASE BATCH SIZES, AND DECREASE MOULD CHANGES
C
C FREESZ = ONF / (MINSIZE+MCDA(15)*MCDA(23)*MCDA(23))
C
C DETERMINE REQUIREMENTS
C
C SHORTTERM = DAILY, WEEK, LASTWEEKOFPLAN, ETC
C WRITE 'STOCK PROJECTION' HEADING
C
C IF (SHORTTERM) WRITE(30,004) (1DUP,1DUP,LAYOUT,LASTMONTH)
C
C CALL APPROPRIATE SUBROUTINE
C
C JENERAL(1) = STARTWEEK + 1
C JENERAL (2) = LASTWEEKOFPLAN = JENERAL(1)
C IF (SHORTTERM) GO TO 990
C
C CALL LONGTERM
C
C IF (LASTWEEKOFPLAN = LASTMONTH) 940,940,0
C WRITE(30,005) LASTMONTH
C
C RESCHEDULE FOR SHORTER PERIOD TO AVOID STOCKOUT
C
C GO TO 112
C
C 890 CALL SHORTTERM
C
C FILL UP OTHER PARTS OF 'AISC' RECORD
C 940 JENERAL(10) = AVERAGEFREEX/THOUSAND
C AVERAGE FREE WAS MEASURED IN WEEK'S PRODN/SIZE
C NOW MEASURE IT IN PAIRS
C SIZE EFFECT IN 1DUP, RANGE IN 1PAIR
C IDUM = AVERAGEFREEX/(MINSIZE*PROD)

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50
KOLORADV, JENERAL(9) = AVERAGEFREE * RATIO1 * PRODN
IFLAG = AVERAGEFREE * RAT101 * PRODN
AVERAGEFREE = AVERAGEFREE / FREESZ
JENERAL(11) = MINFREE - AVERAGEFREE
WRITE(S0,พรรณ) MINFREEZ, MINFREE1, MINFREE2, MINFREE3
WRITE(S0,พรรณ) IDUP, KOLORADV, IFLAG, AVERAGEFREE
WRITE OUT A 'MCDA' RECORD
BRAUN=0
CALL OUTPUT(MCDA,2)
WRITE OUT A 'MRC' RECORD
JENERAL(5) = MACH
CALL OUTPUT(JENERAL,1)
OUT "RECS" RECORDS
STORE FRACTION OF TOTAL YENTS MET BY SCHEDULE: END
FRACTION = (JENERAL(40) - JENERAL(5)) / FLOAT(JENERAL(40))
CALL CLEAN(JENERAL,40)
DU 470 BANNO1, INKAND
IF (LISTNU(ブランド)) 970, 970, 0
JENERAL(1) = LISTNU(ブランド)
JENERAL(2) = KOLORU(ブランド)
JENERAL(3) = KITALREG(ブランド) - 1
JENERAL(4) = KUREASES(ブランド) - 1
JENERAL(5) = KUREASES(ブランド) * 1000
KUREASES(ブランド) = 1
JENERAL(6) = MACH
CALL OUTPUT(JENERAL,5)
970 CONTINUE
700 PROCESS'NOUS' AND 'PAMS' RECORDS
CALL INOUT(55,54,4)
CALL INOUT(00,00,0)
START 'WEEKLY' PART OF SCHEDULE
THIS PROCEEDS ONE UNIT AT A TIME, WRITES OUT ANY OUTPUT RECORDS
CREATING NEW 'WKLY' RECORDS WHEN CHANGES OCCUR
IT ALSO UPDATTS THE TOTAL STOCKS
IF (PLANNINGWEEK,NE,1) MEASURE(17)=1
CALL CLEAN(JENERAL,40)
DU 1500 MACH=1,5
MC=HANGPSCHEDULE(PLANNINGWEEK, MACH)
IF (MC) 0, 0, 1220
WITH NO MANUFACTURING GROUP TO BE MADE THE CURRENT MOULDS
NEED NOT BE CLEANED.
RESET PLACES WITH AN IMPOSSIBLE COLOUR
JENERAL(MACH) = MEASURE(MACH)
JENERAL(50+MACH) = 10
1240 IF (NU=1,000,0,1300)
1250 IF (NU=1,000,0,1300)
1270 IF (NU=1,000,0,1300)
1300 CONTINUE
LAST WEEK, THIS DISCHARGE IS UNNECESSARY COLOUR CHANGES

WHILE NOT BLASPHEMING IN FAVOUR OF COLOURS NEEDING MANY MACHINES

THIS COVER IS A CONNECTED STOCK COVER

DU 1340 MC=1.15

1330 IF (MEASURE(MC),M.F,KOLOR) COVER(KOLOR)=COVER(KOLOR)-KOLORADV

1340 MACHASSIGN= MACHASSIGN + MACH

GU TO 1410

1360 DUMMY=ONMILLION

DU 1370 KOLOR=1.8

C FIND THE COLOUR WITH LOWEST COVER

IF (COVER(KOLOR),GE,DUMMY) GU TO 1370

KOLORMAX=KOLOR

DU DUMMY=COVER(KOLOR)

1370 CONTINUE

MACHINES(KOLOR,MAKE)=MACHINES(KOLOR,MAKE)+1

COVER(KOLOR,MAKE)= ONEMILLION

MACHASSIGN=MACHASSIGN+1

1410 IF (MACHASSIGN=MACHTHISWEEK) 1360,0,0

C HOW FIND THE MACHINES TO BE ASSIGNED

C FIRST REMOVE THOSE ALREADY FIXED

DO 1420 MC=11,15

KOLOR= GENERAL(MC)

IF (KOLOR) 1420,1420,0

MACHINES(KOLOR)=MACHINES(KOLOR)-1

1420 CONTINUE

C ASSIGN SAME COLOUR AS LAST WEEK (IF STILL NEEDED)

DO 1430 MC=11,15

IF (GENERAL(MC),MC,10) GU TO 1440

KOLOR= MEASURE(MC)

IF (KOLOR) 1440,1440,0

IF (MACHINES(KOLOR)) 1440,1440,0

GENERAL(MC)=KOLOR

MACHINES(KOLOR)=MACHINES(KOLOR)-1

1440 CONTINUE

C THIS HAS ASSIGNED ALL MACHINES WHERE THAT COLOUR WAS MADE

C LAST WEEK BECAUSE NO 5 704 IS BEST FOR CHANGING OUT OF

C BLACK, THIS MACHINE WILL BE LEFT FREE (WHERE THERE IS A CHOICE)

C ASSIGN REMAINING M.S - LOWEST COLOUR TO LOWEST MACHINE

MC=11

DU 1450 KOLOR=1.8

1450 IF (MACHINES(KOLOR)) 1460,1490,0

1460 IF (GENERAL(MC),FQ.10) GU TO 1470

MC=MC+1

IF (MC=15) 1470,1460,1490

1470 GENERAL(MC)=KOLOR

MACHINES(KOLOR)=MACHINES(KOLOR)-1

GU TO 1450

1490 CONTINUE

C ** SPECIAL CONDITION FOR STANDARD SPORTS **

C NUMBER 3 704 IS NORMALLY SINGLE INJECTION BUT CAN BE DOUBLE

C

1710 IF (MC=TYPE=14RALP,N.E.,014) GU TO 1720

1720 IF (GENERAL(LS),FQ.1) GENERAL(LS)=GENERAL(LS)+1

C CHECK TO SEE IF THERE ARE ALTERATIONS FROM LAST WEEK

C IF SO WRITE OUT A NEW RECORD

C
DO 1750 IDUH=1,15
IF (GENERAL(IDUH), EQ., MEASURE(IDUH)) GO TO 1/30
MEASURE(IDUH)= FERERAL(IDUH)
IFLAG=10
IF (I (I), 5, 0, AND, MEASURE(I), 5, 0, MEASURE(17)=1)
THIS INDICATES A MACHINE WHICH HAD MOLDS IN MUST BE EMPTYED
1750 CONTINUE
I DUM= MEASURE(S9)
10 IF (PLANNINGWEEK, LF, 40) MEASURE(9)=KUSTFIPRDATE(PLANNINGWEEK)
IF (L00, NE, MEASURE(9)) IFLAG=1
I DUM= MEASURE(40)
15 C CALCULATE THE RELATIVE FREESTOCK
MEASURE(60)= RELATIVEFREEMONTH
IF (SHORTTERM) MEASURE(40)= RELATIVEFREE(MONTH)
16 IF (I00, NE, MEASURE(40)) IFLAG=1
IF (IFLAG, NF, 40) CALL OUTPUT(MEASURE, 15)
MEASURE(17)=0
C PROGRESS STOCS OF EACH COLOUR AND BRAND
PROPCL(I)=ONE
1900 DU 1/60 MC=1,5
KULOR= MEASURE(10+MC)
20 IF (KULOR) 1/60,1/600,0
I DUM= MEASURE(S+MC)
IN SL TO THE PRODUCTION OF KOLOR
25 INITSTK(KULOR)+INITSTK(KULOR)*I DUM
DUMMY=I DUM/PROPCLCOLOR)
DU 1/40 BRAND, WBRAND
20 IF (KULOR, NE, 10, AND, KULOR, NF, KULOR(BRAND)) GO TO 1440
SALEABLE= DUMMY*PROPORTION(BRAND)
30 TSTOCK(BRAND)= TSTOCK(BRAND) + SALEABLE
UNBALANCFL(BRAND)=UNBALFL(BRAND)
40 UNBALFL(BRAND)= UBKFL(BRAND) - SALEABLE
V44 CONTINUE
1440 CONTINUE
45 C READ ACHIVE ANY RECORDS FOR THIS WEEK
CALL INPUT(50, 85, 9)
50 ADVANCE TO NEXT DAY OR WEEK
IF (., NOT, DAILY) GO TO 2020
60 DAY=DAY+1
64 IF (DAY=7) 2050, 0, 0
65 DAY=0
55 CONTINUE
2020 PLANNINGWEEK=PLANNINGWEEK+1
2030 PLANNINGTIME=PLANNINGTIME+1
50 IF (PLANNINGWEEK-LAST=EXEP(PLAN) 1210, 1210, )
C CHECK UP ON FINAL VALUES OF UNBALANCED STOCKS
DUMMY=MINSFREE + AVERAGEFREE RELATIVEFREE(LASTMONTH) THOUSAND
DU 2260 BRAND=1, UBKFL
EXCESS= DUMMY* PROPORTION(BRAND)
65 IF (SHORTTERM) EXCESS=MINFREE/NBRAND
60 IF (UNBALANCFL(BRAND), LT, EXCESS) UNBALANCFL(BRAND)=EXCESS
60 IF (UNBALFL(BRAND), LT, EXCESS) UBKFL(BRAND)=EXCESS
55 CONTINUE
2260 C SEE IF THIS MANUFACTURING GROUP IS STILL NEEDED
50 IF (LASTWEEKOFPLAN-ENDWEEK) 110, 20, 20
C WRITE END RECORD THEN PUT END OF FILE ON
50 CONTINUE
GO00 CALL OUTPUT(JENERAL,1/)
END FILE 20
STOP
END

END OF SEGMENT, LENGTH 316>, NAME IM30
SUBROUTINE SHRUTERKLOOTS
LOGICAL BALANCEUP,FIRSTLOOPY,DAILY,SHUNTFKM
INTEGER STUDY,SIZELINE,SIZEU
INTEGER PLANNINGUNIT,PLANNINGHEEK,PLANNINGTIME,WEEK,STARTWEEK
INTEGER WORKSU,ENDWEEK,BRAND,PROD
COMMON/ARRAYS/ARRAYS(10),SCHED(50,5),MLSCP(60,5),NSHIFTSCHED(60,5)
1, KOLORSCHED(50),SITBRO(10),KOLOR(10)
2, KUMRELASES(10),ISTOCK(10),NCDA(40),LSTMACH(5),KUMREL(10,25)
3, SIZENUM(40,10),KOSTEXPDET(40),MEASURE(40)
4, JENKAL(40),MACHINES(10),INITSTKLU,INPUTCOLOUR(5)
5, NSTARTS(5),NSHIFTS(10)
6, ENDSMTKU(10),FINALH(10),TOTALREL(10),TREME(10)
7, COVER(10),PROPRION(10),PROPCOLL(10)
8, TCMRK(20),RELATIVEF(15),SOMTHEOREMP(15)
9, IREGSIZE(40),NSHIFTS(10),KUMPRODUCT(5)
A, TCMPRODUCT(15),UNBALANCED(10),MANPART(10)
COMMON/VANS/MCTYPE,BRAND,PROD
1, PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME
2, INSTNOW,INOUTFAC,BALANCEUP,DAILY,FIRSTLOOPY
3, LASTWEEKPLAN,STARTWEEK,WEKF,WEKSOFF
4, MONTH,MONTHSTART,LASTMONTH,MONTHEND
5, PACH,APACH,PACHUSE,KOLOR,KOLORMAKE
6, NBRAND,NCOLOR,NSHIFT,SHIFTSF,NSHIFTTOT
7, PNFREK,INITSTCOTAL,WINPLEASER,ILDNUM,FLAGNUM
COMMON/WEALS/ UNT,THOUSAND,ONEHUND,THUM,THUM
1, FREE,FREESZ,AVERAGEREB,FRACTION
2, TCMKRENTS,TOTALKUN,WEKY
C
20
C IF(NCOLOUR-1),V U 60,40
NSHIFTS(KOLOR(NBRAND))=NSHIFTTOT
GU TO 300
C SET APPROPRIATE VARIABLES
40 MINIMUM=PLANNINGUNIT
1 IF(DAILY) MINIMUM=6
MANT=0
10 CONTINUE
100 CONTINUE
NSHIFTS(H) = NSHIFTS(KOLOR)
70 CONTINUE
NSHIFTSSET=ICOUNT
10 CONTINUE
100 IF(MONTH=0) 100,100,0
WRITE(30,1011) MCTYPE,MANGRP
C NOT ALL SHIFTS CAN BE ASSIGNED
1011 FORMAT(/42H WARNING* INSUFFICIENT REPTS = MAN, GROUP ,215/)
GU TO 200
C DETERMINE THE NUMBER OF DAYS EACH COLOUR WILL RUN
50 A CUMULATE REPTS UNTIL THE NUMBER OF DAYS OF EACH COLOUR
C REQUIRED TO MEET REPTS FINISHES DAYS AVAILABLE
E01 C 100 IF(NSHIFTS-NSHIFTTOT) 0,300,500
GU 120 BRAND=1,NBRAND
DUMMY = WHICH (BRAND, MONTH) = 1
STOCK (BRAND)

IF (DUMMY + UNBALANCED (BRAND)) > 120, 100, 0
UNBALANCED (BRAND) = DUMMY

C ACCUMULATE THE REQUIRED STDS OF EACH COLOUR TO MEET
SPEND IN START OF MONTH

120 CONTINUE

DUMMY = WORK OUT DAYS NEEDED FOR EACH COLOUR
DU 164 KILOGRAM = 1640
1640
IF (DUMMY (KOLUR) > 1640, 0)

DU = (STOCK (KOLUR) / DUMMY) * 10 + PLANNING UNIT
10 = (DUMMY, LT, MINIMUM) / DUMMY

130 IF (DUMMY, LT, MINIMUM) = (DUMMY, LT, MINIMUM)
HENSHIFT (KOLUR) = DUMMY

140 IF (DUMMY, LT, MINIMUM) = DUMMY

IF (DUMMY, LT, MINIMUM, PLANNING UNIT) = (DUMMY, LT, MINIMUM)

IF (DUMMY, LT, MINIMUM, PLANNING UNIT) = (DUMMY, LT, MINIMUM)

C IF BELOW = REPEAT LOOP

C HAVE NOW ALLOCATED THE MAMO DAYS IF ABOVE

C MUST ALLOCATE THE LAST BATCH IN ORDER OF URGENCY

200 DU 240 KILOGRAM = 2400

IF (KOLUR, LS, COVER MILLION) = 0, 2400

COVER (KOLUR) = COVER MILLION

IF (TAPE (KOLUR) = 0, 2400, 0)

C SEL IF ENOUGH TIME FOR A TWO-DAY RUN OR FULL-WEEK IF WEEKLY

IF (NSHIFT, LT, MINIMUM) = 250, 0, 0

NSHIFT (KOLUR) = MINIMUM

NSHIFT = NSHIFT - MINIMUM

C CALCULATE THE RATIO OF THE NEED TO THE PART NEEDED

220 COVER (KOLUR) = TAPE (KOLUR) / NSHIFT (KOLUR)

240 CONTINUE

250 SHORTFALL = COVER MILLION

C SEARCH FOR COLOUR WITH HIGHEST RATIO

DU 5000 KILOGRAM = 5000

IF (SHORTFALL, COVER (TOWN)) = 0, 5000, 270

SHORTFALL = COVER (TOWN)

KIROG = 10000

270 CONTINUE

C ADD EXTRA SHIFTS FOR KOLUR

NSHIFT (KOLUR) = NSHIFT (KOLUR) + PLANNING UNIT

COVER (KOLUR) = TAPE (KOLUR) / NSHIFT (KOLUR)

NSHIFT = NSHIFT + PLANNING UNIT

C ARE ALL SHIFTS ASSIGNED?

IF (NSHIFT = NSHIFT, LT, MINIMUM) = 250, 0, 0

SHORTFALL = COVER (TOWN)

C FIND THE STARTING RATE FOR EACH COLOUR

300 DU 300 KILOGRAM = 300

305 NSHIFT (KOLUR) = NSHIFT (KOLUR)

COLOR NOW EQUALS 0 - THIS IS NEEDED AT 330 IT IS DECREASED TO 0.

NUM, ASHIFT, STAY = 1
WEEK = START OF WEEK + 1
NSHIFT =

310 IF (NSHIFT, LT, SHIFT (KOLUR), LT, SHIFT (END), LT, WEEK) = 320, 320

C NSHIFT REPRESENTS THE SHIFTS TILL THE END OF WEEK
C NSHIFT SETS THE SHIFTS TO BE SET
WEEK = WEEK + 1
C *AB* POTEINUAL PROBLEMS IF SEVERAL MACHINES ON SHORT RUN
C WILL NOT OCCUR IN IMMEDIATE FUTURE
C CAN RESOLVE BY USING 'CONSIDERMENTS'
C IF (KULOR-LASTKULORFOLLOWS) 314,310,530
C CONTINUE UNTIL WEEK HAS CAUGHT UP WITH 'SHIFTSET'
C 320 KULOR=KULOR-1
C IF (KULOR) 540,530,520
C KULOR=KULORFOLLOWS
C IF A COLOUR IS SET MAKE THAT COLOUR
C OTHERWISE MAKE THE NEXT COLOUR NEEDED
C COLOURS ARE IN ORDER OF 'LUMINOSITY'
C 340 IF (NEWSHIFTS(KULORTOAKE)) 350,340,350
C STOP WHEN EITHER LAST COLOUR OR WEEK PASSED
C 350 DUMMY=ASHIFTSET-ASHIFTSET
C RELATIVEFRE= (DUMMM*THOUSAND)/SHIFTSET
C COVER(KULORTOAKE)=NEWSHIFTS(KULORTOAKE)/DUMMY
C SUN=SUM+COVER(KULORTOAKE)
C N=SHIFTSET=NUM=NUM+1
C 60 TO 310
C 310 N=SHIFTSET=NUM=NUM+1
C WORK OUT INITIAL AND TOTAL RIGHTS FOR EACH BRAND
C 320 DU=SUM=1,DUM
C 330 KULOR=THKULOR(KULOR)
C WORK OUT PRODUCTION OF EACH COLOUR
C THIS COLOUR WILL BE RUNNING FOR NSHIFTS' *PROPORTION* GIVES
C THE FAIR SHARE FOR EACH BRAND.
C SINCE PRODUCTION OF THIS COLOUR DOES NOT START TILL
C 'SHIFTSET', WE ADJUST THE RIGHTS SO THEY ARE NOT EFFECTIVE TILL
C THIS TIME. THIS MAKES THE 'INITIAL RIGHTS' MISLEADING.
C ** SEE LOGIC FOR FULL DETAILS **
C 340 SHORTFALL=5*TOTALPROD*COVER(KULOR)/PRODUN(KULOR)
C DUMMY=5*(SHIFTSET(KULOR)+PRID/PLANNINGUNIT)/PRODUN(KULOR)
C 560 BRAND=1,BRAND
C IF (KULOR=COLOUR(BRAND)) 560,560
C HAND+DUMMY*PROPORTION(BRAND)
C FINAL=FINAL(BRAND)*STOCK(BRAND)+PRID/PLANNINGUNIT)
C THE MINIMUM FREESTOCK NEEDED IS PROPORTIONAL TO THE NUMBER OF
C STEPS OF EACH BRAND.
C WITH SIMILAR BRANDS IT IS CORRECT TO DIVIDE BY NUMBER
C INITIAL=FINAL(BRAND)-SHORTFALL*PROPORTION(BRAND)
C BALSTOCKS FINAL=FINAL(BRAND)-FINAL(BRAND)+SHIFTSET
C 102 FORMAT // 115,2210,0,2215,3,2317,9,2219,0,2221,5+SHIFT,14,17,2)
C 560 CONTINUE
590 CONTINUE

C    NOW CREATING THE DETAILS FOR THE 'NSIC' RECORD

C    AVERAGEFREE=(TOTALPROD*0.6+NCDA(17)-MINFREE)/(NCDA(37)*PRODN)

C    THIS SHOULD GIVE A LAP EQUAL TO THE SCHEDULE LENGTH

C    IF (.NOT.DAILY) GO TO 650

C    GENERAL(17)=GENERAL(1)

C    GENERAL(2)=GENERAL(6)-2

C    ASSUMES NO WEEKEND OVERTIME IN LAST WEEK

C    GENERAL(3)=0

1570  GENERAL(4)=1

C    JENRAL(7)=JENRAL(6)/4

C    JENRAL(8)=THOUSAND*(1.5*SUM-(MINFREE/TOTALPROD))

C    GIVES THE RELATIVE VALUES OF TOTAL HOURS TO PRODN (=1000)

1590  IDUM=JENRAL(6)*1

C

C    INCREASE=(1000*NMSHIFT)/((MACH*PLANNINGUNIT)*GENERAL(2))

C    GENERAL(40)=INCREASE*GENERAL(2)

C}

DU   00  1=5, IDUM

690  JENRAL(42-1)=JENRAL(40)-INCREASE*1

RETURN

END

END OF SEGMENT, LENGTH 1028, NAME SHORTTERMKPUTS
SUBROUTINE LONGTERMFUNTS

INTEGER BALANCEP, FIRSTGROUP, DAILY, SHORTTERM
INTEGER STORAGESIZE, SIZETONE
INTEGER WEEKEND, WEEKENDS, WEEKENDTIME, STARTWEEK
INTEGER WEKEND, ENWEEK, DNEKEND, WEOEKEND
COMMON/ARAYS1/RANGE(2), MGRSCHED(20,5), MDRSCHED(20,5), MINFSCHED(20,5)

1 KOURN(60), KOURN(60), KOULOR(10)
2 RURELAFS(10), TSTOCK(10), MPCA(30), SCMACH(5), KUMPS(10,25)
3 SIZE(40,10), URESTK(10), URESTK(10)
4 GEORE(60), MAX(10), MAX(10), INTSIX(10), INTSIX(10)
5 NSTART(5), NEND(10)
6 ENWEEK(10), ENWEEK(10), TOTALP(10), TOTALP(10)
7 TOTALP(10), TOTALP(10), TOTALP(10), TOTALP(10)
8 CJUMPLF(10), INITSUM(10), URESTK(10), URESTK(10)
9 INITSUM(10), URESTK(10), URESTK(10), URESTK(10)
10 INITSUM(10), URESTK(10), URESTK(10), URESTK(10)

C
C IEPORKEF = PROJECTION (REAL) AND IEPORKEF (INTEGER) USE SAME STORAGE
C IEROSIZE IS USED ONLY IN SETUP
C
COMMON/VARS/ACTYPE, MANKP, BRAND, ENDWEEK, PROON
1 1 PLANNINGUNIT, PLANNINGWEK, PLANNINGTIME
2 INOUTMOU, IPUTKES, BALANCEP, DAILY, FIRSTGROUP
3 LASTWEEKOPLAN, STARTWEEK, WEEKEND, WEEKENDS
4 MTH, MTH, MTH, MTH, MTH, MTH, MTH
5 GSMACH, MSMACH, MACME, KOPN, KOPN
6 NSTART, NEND, NEND, NEND, NEND
7 INITSUM, INITSUM, INITSUM, INITSUM
C CUMULATIVE(20), CUMULATIVE(20), CUMULATIVE(20)
1 2 CUMULATIVE(20), CUMULATIVE(20), CUMULATIVE(20)
3 INITSUM, INITSUM, INITSUM, INITSUM
4 5 FREE, FREEZ, AVERAGEFREE, FRACION
5 1 FREE, FREEZ, AVERAGEFREE, FRACION
6 2 ICUMPLFTS, TOTALP(10), WEEKLY
7 3 AVERAGEFREE

C
C EVALUATE THE OPERATING FREESTOCK EACH MONTH
C
C FACTIONS OF A M LCHE(20)(9) THOUSAND
C 1.0
C
C FACTIONS SHOW WHAT PART OF SURPLUS STOCK CAN BE USED FOR
C PRODUCTION PURPOSES, FREEZ REPRESENTS THE ACTUAL ADVANTAGE
C GAINED, AND IS HIGHER WITH FEWER SIZES AND COLOURS OR LESS
C
C RESTRICTIVE SIZE RANGES FOR EACH MACHINE
C
C DUMMY = MPCA(30)(9) + MPCA(30)(9) + FREEZ*
C
C DUMMY IS THE FREESTOCK NEEDED FOR THE MAXIMUM CHANGING RATE
C PARTIALPLAN + LASTMONTH - LASTWEEKOPLAN + 0.25
C DO 100 MONTH = 1, LASTMONTH
C FREE = ICUMPLFTS + INITSUM + CUMULATIVE - TUMREH(MONTH) - MPCA(17)
C IF (FREE .LE. ICUMPLFTS) 100, 120
C IF (LASTMONTH-MONTH) 0, 120
C IF (BALANCEP) 100, 140
C IN THE LASTMONTH OF A TERMINATING RUN WE WISH TO BALANCEP
C SO THE ADVANTAGE OF CONTINUING WITH THE SAME SIZE IS REDUCED
C OTHERWISE ALLOW FOR INCOMPLETE MONTH
C FREE = (FREE + PARTIALPLAN*(TUMREH(MONTH) - TUMREH(MONTH-1))))*0.75
C 120 FREE FREE FREE
C 50 FREE FREE FREE
C 140 FREE FREE FREE
C SET *SMOOTHED* REQUIREMENTS TO MONTH
C 150 FREE FREE + MPCA(17) - MINFREE
C IF (FREE, LT, DUMMY) FREE = DUMMY

7 16
200 CONTINUE
AVERAGEFREE = AVERAGEFREE / (LASTMTH+1-MONTHSTRT)
JENERAL(7) = AVERAGEFREE
BU 250 IDUM=MNTHSTRT,LASTMTH
MNTHHDL=LASTMTH+MNTHSTRT = IDUM
MNTH= MNTHSTRT+1
RELATIVEFREE(MNTHHDL) = RELATIVEFREE(MNTHHDL) * THOUSAND/AVERAGEFREE
IF (MTHN=LASTMONTH) 0,10,45,
C
SET IF THE REIFS ARE INCREASING TOO FAST
C
IF INCREASE MORE THAN 50% GREATER THAN CHANGE IN PRODUCTION
C
THEN INCREASE EARLY FOI REIFS.
DUMMY = SHOUDREDREW(MONTH) = 1.5 *(TCUMPRUDN(MONTH))
1 = TCUMPRUDN(MNTHHDL)
C
250 CONTINUE
THE GRUSS REQUIREMENTS HAVE NOW BEEN FIXED
C
SET UP OUTPUTS
C
REINITIAL = SHOUDREDREW(MNTHSTART) - TCUMPRUDN(MNTHSTART)
JENERAL(8) = 1000
JENERAL(9) = 1
WEEK = GENERAL(2)
WEEKLY = 5 * TCUMPRUDN * SHOUDREDREW(LASTMTH) / REINITIAL / TOTALPORD
C
THIS IS THE AVERAGE WKLY REIFS
WEEKSUFF = (TCUMREIFS - SHOUDREDREW(LASTMTH)) / WEEKLY
IF (WEEKSUFF) WEEKSOF=1
C
WEEK = WEEKSOF = 0
WEEKSOF=20 - WEEK
C
THIS IS THE NUMBER OF WEEKS AFTER THE SCHEDULE END
C
JENERAL(3) = WEEKSOF
C
SET THE TARGETS FOR EACH WKLY FOR SAFERHEL STOCK
C
BY JENERAL(3) WEEKS AFTER THE END ALL HEATS SHOULD BE NET
C
IN EARLIER WEEKS THIS SHOWS THE NUMBER OF THOUSANDS COMPLETED
DUMMY = THOUSAND / WEEKLY
KWEK2 = LASTWEEKOFPLAN + WEEKSOF
KWEK1 = LASTWEEKOFPLAN
MNTH = LASTMTH
C
IFLAG=40
ITUP, ILLOW = (LCUMREIF = REINITIAL) + DUMMY
C
STARTING FROM THE FINAL WKLY PROCEED BACKWARDS TO THE FIRST
C
WEEK, DECLASING THE REIFS EVENTLY IN EACH MONTH
C
C
ITUP = WEEKSOF - THE NUMBER OF THOUSANDS COMPLETED
C
IF (WEEKSOF) 370, 370 +
C
370 ILOW = (SMOOTHREIF(MONTH) = REINITIAL) * DUMMY
C
IF (WEEKSOF) 370, 370, 370
C
PROCEED TO FILL UP JENEARL SO THAT THE CHANGE IS EVEN
C
IN EACH MONTH
C
350 JENERAL(IFLAG) = ITOP
C
IF (KWEK2 = KWEK1) 370, 370, 370
C
IF (KWEK1 = KWEK2 = 370, 370, 370)
C
ILOW = ITOP + INCREASE
C
IF (KWEK2 = KWEK1) 370, 370, 370
C
ITOP = ILOW
MNTH = MNTH + 1
C
IF (MNTH=MNTHSTART+1) 510, 310, 0
KWEK1 = L+MONTH
GO TO 350
350 KWEK1=STARTFLK+1
LLOW = 100000

C FOR THE FIRST FOUR WEEKS THE REQUIREMENTS ARE 50% UP
C THIS PREVENTS NEEDING MANY MORE CHANGES IN STARTWEEK.
C PROJECTED REQUIREMENTS ARE NOT DECREASED BECAUSE THIS WOULD
C INFLATE THE AVERAGE DEPAND.
C GO TO 360

C DETERMINE THE DETAILED REQUIREMENTS FOR EACH BRAND
C SET FIRST VALUES FOR INITIAL REQUIREMENTS
510 DO 520 BRAND=1, NBRAND
KOLOR=KOLOR(BRAND)
IF (KOLOR .LE. 520, 520.0)
FINALREQ(BRAND) = TOTALKED(BRAND)
INITIALREQ(BRAND) = PROPORTION(BRAND) * 1000
1 (KUNKRENCE + INITSTK(KOLOR)/PROCPOL(KOLOR))
520 CONTINUE

TSHORTFALL = 0
IFLAG = 1
1000 IF (MTHINSTRT+LASTMONTH)/2
530 DO 700 BRAND=1, NBRAND
SHORTFALL(STOCKOUT) = 0
200 C KFACULATE THE PROPORTION OF THE TOTAL REQTS OF TYPE BRAND
PROPORTION(BRAND) = FINALREQ(BRAND) / TCUMREQS
MONTOUT = MONTSTART
200 C CANNOT DO ANYTHING ABOUT INITIAL STOCKOUTS SO IGNORE
200 C (NORMAL REQUETS AS THESE ARE EQUALLY BALANCED)
200 C PROJECT INITIAL STOCKS FOR EACH MONTH
200 DO 530 MONT=1, MONTEND, 1
530 C *** EXCESS, STOCKOUT, SHORTFALL ARE ALL POSITIVE WHEN STOCKS ARE -VE EXCESS = -INITIALREQ(BRAND) + KUNKEN(BRAND,MONT)
1 IF (MONT, 6, LASTMONTH) EXCESS = EXCESS - PANTASTEPLAN
1 C EXCESS(BRAND,MONT) = KUNKEN(BRAND,MONT)
1 IF (EXCESS) 535, 530, 0
530 IF (STOCKOUT, LT, EXCESS) STOCKOUT = EXCESS
530 DUMMY = KUNKEN(BRAND,MONT) - INITIALREQ(BRAND)
300 C IF A STOCKOUT OCCURS SEE IF IT IS AVADABLE
300 IF (DUMMY, LE, SHORTFALL) GO TO 350
300 C SHORTFALLS ARE NORMALLY AVADABLE (EXCEPT IN MONT 1)
300 SHORTFALL + DUMMY
300 IF (DUMMY, LE, MONTSTART) MONTOUT = MONT
300 535 EXCESS = EXCESS - DUMMY
535 IF (DUMMY, LT, SHORTFALL) GO TO 530
535 C SHORTFALL + DUMMY
535 IF (MONTSTART, EQ, MONTSTART) MONTOUT = MONT
535 550 PROJECTION(-MONT) = -EXCESS
550 C UN FIRST LUMP ADJUST INITIAL STOCKS
555 IF (IFLAG, GT, 1) GO TO 550
555 SHORTFALL$SHORTFALL + SHORTFALL
555 C FIRST LUMP ONLY COVERS EARLY MONTHS
555 C ALLOW FOR TWO TIMES THE SHORFTALL
555 DUMMY = 1.0
555 IF (SHORTFALL, GT, DUMMY) SHORTFALL = DUMMY
555 C FIRST TEST DON'T ALLOW MORE THAN TWO WEEKS SALES
555 SECONDLY; BALANCED STOCK CANNOT INCREASE AT TWICE THE
C RATE OF PRODUCTION
DUMMY = TSTOCK( BRAND ) + 4 * DUMMY - UNRAI TED( BRAND )
1 = ( SUMRECED( BRAND ) / MONTH ) + PROJECTION( MOUTHSTART )
IF ( SHORTFALL .GT. DUMMY ) SHO TFALL = DUMMY
E INITIALRECEIVED( BRAND ) = E InitialRECEIVED( BRAND ) - SHORTFALL
TSHORTFALL = TSHORTFALL + SHORTFALL
GO TO 700
500 WRITE (30, 1012) LISTNO ( BRAND ), TSTOCK ( BRAND ), UNBALANCED ( BRAND ),
1 TOTALRECEIVED ( BRAND ), PROJECTION ( MOUTH ), MOUTH = MOUTHSTART,
2 LASTMONTH
1042 FORMAT ( // 115, 2F10.0, 2F15.0, / F9.0 )
1 IF ( S1OFTOUT ) 660, 660, 0
WRITE ( 30, 1065 )
1803 FORMAT ( 1H14*, 1H5X, 1H2, 1H4, 1H4, 1H3, 1H4, 1H6 )
1 IF ( MOUTHOUT .LT. MOUTHSTART ) AND ( MOUTHOUT .LT. LASTMONTH )
1 LASTMONTH = MOUTHOUT
C CHANGE THE TERMINAL MONTH IF THERE IS AN AVOIDABLE SHORTFALL
600 WRITE (30, 1014) SUMRECEIVED( BRAND ), MOUTH = MOUTHSTART, LASTMONTH,
1014 FORMAT ( 14X, 5F9.1, 7A, 716 )
700 CONTINUE
C ON FIRST LOOP ADJUST INITIAL REGTS
1 IF ( FLAG .GE. 2 ) GO TO 750
1 FLAG = 2
1 DUM = LASTMONTH
1 DUM = 720 BRAND = 1, BRAND
720 INITIALRECEIVED( BRAND ) = INITIALRECEIVED( BRAND ) - TSHORTFALL * PROPORTION ( BRAND )
GO TO 550
C ON SECOND LOOP INCREASE INITIAL REGTS SO TOTAL IS NOW
C "REQ INITIAL" NOT ZERO.
C RESET "PROPORTION"
750 DO 770 BRAND = 1, BRAND
1 E INITIALRECEIVED( BRAND ) = E INITIALRECEIVED( BRAND ) + REQINITIAL * PROPORTION( BRAND )
1 E PROPORTION ( BRAND ) = ( TOTALRECEIVED ( BRAND ) / TSTOCK ( BRAND ) )
770 CONTINUE
C RETURN
C END OF SEGMENT, LENGTH 1204, NAME LON GTERMRGTS

7 19
SUBROUTINE INPUT(LWTYPE,NWTYPE,PHTYPE,PROCESS)   8000
   INTEGER BALANCE,PRIORY,PHINT,WRINDEX
   INTEGER BUFSIZE,LINEINDEX,BUSINESS,PRUDM,PROCESS,NWTYPE
   INTEGER PLANNINGUNIT,PLANAYR,CREAT,PLANNINGTIME
   INTEGER HWTYPE
   DIMENSION INFORMATION(40),INPUTBUFFER(40)
   DIMENSION CLEAR(40)
   COMMON/VARIN/ BUFSIZE,BUSINESS,PRUDM,PROCESS
   COMMON/İNPUT/PLANNINGUNIT,PLANAYR,CREAT,PLANNINGTIME
   COMMON/THE/RBUCOUNT,ALREADYRUSTOM,DAILY,FIRSTLOOP
   COMMON/KEYS/KEY(1),INPUTBUFFER(10),CLEAR(1)
   EQUIVALENCE (SIZEBUFSIZE,INFORMATION(1,1))
   EQUIVALENCE (CLEAR(1),INPUTBUFFER(1))
   27 C ALL RECORDS ARE READ IN THROUGH THIS SUBROUTINE
   28 C THE KEYS ARE CHECKED, AND IF APPLICABLE NOW
   29 C THE INFORMATION IS STORED OR OUTPUT
   30 INPUTNOW=0
   31 C READ A RECORD IF NONE YET READ
   32 20 IF (KEY(1)) 60,150,0
   33 C CHECK WHETHER THE CURRENT RECORD IS VALID NOW
   34 IF (KEY(1)=NWTYPES(4)) 61,0,40
   35 IF (KEY(2)=NGRP) 50,2,50
   36 IF (KEY(3)=PLANNINGYEAR) 0,0,900
   37 IF (KEY(4)=NHWTYPES) 0,0,60
   38 IF (KEY(4)=LWTYPE) 70,0,0
   39 C ACCEPTABLE RECORDS SHOULD PASS ALL THESE TESTS
   40 THE RECORDS DEPEND ON THE PROCESS TYPE
   41 IF THE RECORD IS FOR LATER PROCESSING-RETURN (GO TO 900)
   42 IF (PROCESS(2)=72,355,50)
   43 SCAN RECORDS SHOULD START A NEW HWTYE
   44 IF (PROCESS(2) 72,350,90)
   45 A PFILE RECORD SHOULD START A NEW HGRP
   46 IF (PROCESS(2)=300,510,90)
   47 GENERALLY THESE RECORDS ARE FOR LATER PROCESSING
   48 BUT IN SOME CASES WHEN OUT OF SEQUENCE THEY MAY BE REJECTED
   49 IF (INPUTNOW,GT,0,OH,PROCESS,UT,2) GO TO 900
   50 C REJECT THE RECORD AS OUT OF SEQUENCE
   51 C THE RECORD TYPE IS NOT AS EXPECTED
   52 70 INPUTREJ=INPUTREJ+1
   53 WRITE(30,9410) KEY
   54 9401 FURMA/ /// 2RH ** REJECTED RECORD : KEYS =,514,64,278///
   55 GO TO 150
   56 C RECORD ACCEPTED
   57 120 INPUTACCE=INPUTACCE+1
   58 INPUTNOW=INPUTNOW+1
   59 C READ IN NEXT RECORD
   60 IF THIS RECORD IS STORED UNTIL IT HAS BEEN PROCESSED
   61 150 READ(10,9000) KEY,INPUTBUFFER
   62 9000 FURMA/ CRAG
   63 INPUTRECS=INPUTRECS+1
   64 GO TO 20
   65 C DEAL WITH 'SCNU' RECORDS
   66 67
210 IF (INPUTNO) 0, 0, 900
220 PROCSEQ=1
230 IF (MCTYPE) 250, 250, 0
240 WRITE OUT UPTIL FOR OLD MACHINE TYPE
250 WRITE(30,9000) MCTYPE, INPUTNO, INPUTACC, REJECTED
260 1
270 IF (INPUTNO) 3300, 557, 250
280 1
290 IF (INPUTACC) 2000, 557, 250
300 OUTREC=(1), INREC=(1), 15X, 12 RECORDS READ, 15.4X, REJECTED=0
310 CLEAR SPARE UPTIL AND OUTPUT COUNTS
320 CALL CLEAR(OUTPUTREC, 2U)
330 INPUTREC(3), INPUTACC, REJECTED=0
340 CALL CLEAR(SCHED(12000)
350 MCTYPE=KEY(1)
360 MANTYPES=0
370 IF (KEY(1)) 500, 0, 70, 20
380 RETURN IF NEGATIVE, REJECT RECORD IF ZERO, CHECK RECORD IF POS.
390 IF (KEY(1)) 900, 0, 20, 20
400 FILL UP SCHEDULE ARRAY
410 MACHA=KEY(2)
420 KWEEK=KEY(3)
430 DO 280 I=1, N
440 280 KSCHED(I,KWEEK, MACHA) = BUFFER(I)
450 GO TO 120
460 C PROCESS 'MCOA' RECORD
470 C REJECT IF NO SCHED RECORDS FOR THAT MCTYPE
480 300 IF (INPUTNO) 70, 10, 0
490 PROCSEQ=2
500 INPUTNO=0
510 C DEFINE NEW MANUFACTURING GROUP
520 310 MANTYPES=2
530 C CLEAR ALL ARRAYS FOR STICKS, SIZERULLM (MORE CLEARED IN IM30)
540 CALL CLEAR(1, CLEAR, 400)
550 FIRSTLOOP=0, TRUE
560 GO TO 20
570 C STORE 'MCOA' RECORD
580 350 PLANNINGUNIT(I, MCOA(1)+1)
590 C THIS INDICATES NO OF SHIFTS PER PLANNING UNIT (DAY OR WEEK)
600 DAILY=PLANNINGUNIT(I, 403)
610 DO 360 I=1, 5
620 MCOA(1)=BUFFER(I, 1, PLANNINGUNIT(I, 5)
630 360 I=1, 5
640 DO 370 J=1, 24
650 370 MCOA(I)=BUFFER(I, 1, PLANNINGUNIT(I, 5)
660 ENDWEEK=KEY(5)
670 IF (PLANNINGUNIT(I, 0)) PLANNINGUNIT(I, 5)
680 GO TO 120
690 C DETERMINE THE RECORD TYPE AND STORE INFORMATION OR WRITE OUT
700 IF (MANTYPES) 150, 0, 900
710 PROCSEQ=KEY(2)
720 RECITYPE=KEY(4)
730 C FOR SOME REC, TYPES 'HRAND' IS A MACHINE NO.
740 500 PROCSEQ=2
750 OUT
760 C PROCESS=2 = STORE AND OUTPUT
770 C PROCSEQ=2 = STORE INFORMATION
780 IF (PROCSEQ=0) 0, 0, 900

7 21
C

OUTPUT RECORD
I=0
CALL OUTPUT(1, BUFFER(I), 1)

IF (PROCESS-5) 120, 0, U

DETERMINE THE RECORD TYPE

520 NUM=0
IF (RECTYPE, FN, 50) GO TO 530
IF (RECTYPE, FN, 55) GO TO 560
IF (RECTYPE, FU, 40) NUM=NUM+10
IF (RECTYPE, FU, 65) GO TO 610
IF (RECTYPE, FU, 50) NUM=12
IF (RECTYPE, FU, 60) NUM=11

IF NONE OF THESE CONDITIONS ARE SATISFIED, REJECT RECORD

C

PROCESS A 'STOCK' RECORD

530 NUM=BRAND+10
KUPRELEASES(BRAND)=KEY(7)
TSTOCK(BRAND)=KEY(8)
STORE INFORMATION

540 BU $30 I=1,60
INFORMATION(I, NUM)=BUFFER(I)
550 CONTINUE
GO TO 120

C

PROCESS 'PRODUCT' CARD

C IF PLANNING WEEK=1, ADD TO STOCKS, OTHERWISE OUTPUT

560 IF (PLANNING WEEK=1) 570, 570, 0
CALL OUTPUT(INBUFF(1), I)
GO TO 120

570 BU $30 I=1,40
STOCK(I, BRAND)+=TSTOCK(I, BRAND)+ BUFFER(I)

580 CONTINUE
TSTOCK(BRAND)+=TSTOCK(BRAND)+ KEY(8)
GO TO 120

C

CUMBER CONTAINS THE CUMULATIVE REQUIREMENTS TO THE START OF MTH

610 LISTNU(BRAND)=KEY(7)
KOLU(I, BRAND)=KEY(8)

650 BU $30 I=1, 25
650 KUPRE(WH, BRAND, 1)=BUFFER(I+1)
GO TO 120

990 RETURN
END

END OF SEGMENT, LENGTH 647, NAME INOUT
SUBROUTINE OUTPUT(IARRAY, IRCTYPE)
INTEGER IRAYS, PLANNINGTIME
DIMENSION IARRAY(40)
COMMON/VARS/MCTYPE,MANGRP,BRAND,11,12,13,14,PLANNINGTIME
COMMON/RECORDS/RNAME(20),NLINPUTREC(10),NTOTAL,KEY(A)

C
C C C
C THIS SUBROUTINE WRITES THE OUTPUT RECORDS TO TAPE
C AND STORES THE TOTALS PRINTED AFTER EACH MACHINE TYPE
C
C
10 IF (IRCTYPE) 0,0,40
20 IF (IRAYS.NAME(IRCTYPE)) 50 TO 60
30 IRCTYPE=IRCTYPE-1
40 IF (IRATYPE) 0,0,10
50 IF DESCRIPTION IS NOT RECOGNISED MARK IT AS SUCH
60 IRCTYPE=IRCTYPE-1
70 NLINPUTREC(IRCTYPE)NLINPUTREC(IRCTYPE)+1
80 NTOTAL=NTOTAL+1
90 WRITE(20,1001) IRAYS,MCTYPE,MANGRP,PLANNINGTIME,
      IRCTYPE, BRAND, IARRAY
100 FORMAT(6X,'I',1X,A4)
110 WRITE(30,1002) IRAYS,MCTYPE,MANGRP,PLANNINGTIME,
      IRCTYPE, BRAND, IARRAY
120 CALL OVERFL(IDUM)
130 RETURN
140 END

END OF SEGMENT, LENGTH 126, NAME OUTPUT
BLOCK DATA
COMMON/RECORDS/NAMEm(20)
COMMON/REALLY/ONE,THOUSAND,ONE MILLION
DATA UNIT/1.,THOUSAND/105/,ONE MILLION/1E6/
DATA NAME/ WHOLE,RAWDATA,WHSTKS,WHZRL,WHWEUS,
1 WHFRE,WHRS,WHMELF,WHLD,
2 WHDLZ,WHCL,WHFCLD,WHAMTS,WHNL,
3 WHCONT,WHEND,WHNRE,WHMTOTL/
4400
4410
4420
4430
4440
4450
4460
4470
4480
4490
4500
4510
4520
4530
4540
4550
4560
4570
4580
4590
4600
4610
SUBROUTINE CLEAR(IRESET,NUM)
DIMENSION IRESET(NUM)
C
RESET ARRAY(S) TO ZERO
DO 10 I=1,NUM
10 IRESET(I)=0
RETURN
END

END OF SEGMENT, LENGTH 30, NAME CLEAR
APPENDIX 8 THE MOULD SCHEDULING PROGRAM
WRITE (30, 3600) DAAR, AVUSAGE, DC, DD, BACHSIZE, DE, DF, CVERP1NPRODN
WEEK=NEWKSTUSTART
WEEK=0
WEEKSLEFT=LASTWEEKKFREQ
LASTWEEKKFPLAN=LASTWEEKKFREQ - LASTWEEKKFPLAN
100 GOTO =EEK+1

READ IN ANY DATA FOR THIS WEEK

IF (WEEK, LE, WEEK) CALL INPUTZ
MODCHGNETOTAL = MODCHGETOTAL + MODCHANGES
MODCHANGES = 0
IF (WEEK=510) 0, 150, 130
IF (LASTWEEKKFPLAN = NEX[K AFTERPLAN] U, 0, 110
LASTWEEKKFPLAN = LASTWEEKKFPLAN + 1
GO TO 120

GO TO 120

START THE SCHEDULE FOR WEEKKFPLAN

150 IFLAG = 1
Weeksleft = CUMPART(1) - CUMPART(WEEKSLEFT)
IF (NOT, SHOWN, PLAN) MODCHGETotal, CUMPART(1)
1 = CUMPART(WEEKKFPLAN)
DO 220 SIZE = MINSIZE, MAXSIZE
ASSIGN(SIZE) = 0
DO 210 BRAND = 1, NBRAND
REDUCE STOCKS OF THE WEEK KS REQUIREMENTS

210 FREESTOCK(SIZE, BRAND) = FREESTOCK(SIZE, BRAND) - REQUENT(SIZE, 1 - WEEKSLEFT) * FRACTION(SIZE, BRAND) * THOUSANDTH) + HALF
DO 220 MACH = 1, 3
MACHINACH(SIZE, MACH) = 0
IF (MACH) 0, 220, 175
1 THIS CAN BE NEGATIVE IF THERE WAS A HALF-WEEK OF ANOTHER COLOUR
115 INMACH(SIZE, MACH) = 0
GO TO 220

THE DESIRED SIZE IN ANY MACHINES IS A WEIGHTED AVERAGE
IT MAY ALSO BE ADJUSTED FOR AN UPWARD OR DOWNWARD TREND
215 MAXRESISE(MACH) = MAXRESISE(MACH) + (UNE - WEIGHT) * SIZE + WEIGHT + 0.9
220 CONTINUE

CHECK COLOUR COMPATIBILITY

WITH SEVERAL MACHINES THE COLOUR MUST BE PRE-DETERMINED
WITH GAF COLOUR IT MAY BE FIXED OR DECIDED BY STOCK-LEVELS

IF (MACH(1) 440, 240, 0)
KULOR(1) = 10

310 KULOR(1) = KULOR(1) - 1
IF (KULOR(1) 100, 100, 0)
MCHS THIS COLOUR = 0
DO 520 MACH = 1, 5
520 IF (MACH COLOUR (MACH), PR KULOR(1) ) MCHS THIS COLOUR = MCHS THIS COLOUR + 1
IF (MACH THIS COLOUR) 310, 310, 390
340 MCHS THIS COLOUR = 1
KULOR(1) = KULOR(1)
IF (KULOR(1) 100, 100, 0)
IF (KULOR(1) 70, 300, 0)
C WITH NO COLOUR PROVIDED DETERMINE THE NUMBER OF WEEKS COVER

KULOR(1) = KULOR(1)
EACH BRAND HAS, GIVE THE CURRENT COLOUR AN ADVANTAGE
CALL PRODUCTCOVER(0, DUMPY, BRAND, KULOR)
KULOR(1) = KULOR(1) (BRAND)

360 MACH COLOUR (1ST MACH(1)) = KULOR(1)
390 KULOR(1) = KULOR(1)

C THIS IS THE COLOUR TO BE MADE THIS WEEK
DO 400 BRAND = 1, NBRAND
MAKEBRAND (BRAND) = 1
400 IF (KULOR (BRAND), NE, KULOR) MAKEBRAND (BRAND) = 0
410 C DECIDE WHICH MACHINES ARE TO BE USED, CALLED 'MACHINUSE'

C DELIDE HOW MANY MOLDS ARE AVAILABLE

C MACHPLACES, NHALFWEEKMSCS = 0
J = 1
GROUPPLACES Filled (1) = 0

C THESE ARE USED IN 'DESIRES NOT THE MAIN PROGRAM
DO 430 I = 1, NMACH
MACH = ISTMACH(I)
IF (MACH COLOUR (MACH), KULOR) 430, 0, 430
MCHSPACE(MACH) = MCHSPACE(MACH) + 2
MACHPLACES = MACHPLACES + MLUSPACE (MACH)
MACHINUSE (J) = MACH
J = J + 1
430 GROUPPLACES Filled (1) = 0
IF (MACHPLACES) 1000, 1600, 0
IF (MCHS THIS COLOUR (NMACH)) 0, 430, 999

C IF DIFFERENT MACHINES CONTAIN DIFFERENT COLOURS THEN THIS
C REALIGNS 'IMACHS' SO THAT THE CURRENT COLOUR IS FIRST.
C VALID FOR UP TO 3 MOLDS.
C THIS LOOKS AT THE COLOUR EACH MOLD WILL MAKE, AND MOVES
C THE MOLD TO THE BACK IF WRONG AND TO THE FRONT IF RIGHT
DO 450 SIZEih = INSIZE, MAXSIZE
NEXTMLD = ASSIGN(SIZE) + 1
DO 450 MLR = ASSIGN(SIZE) + 1, 3
MACH = INMACH (SIZE, MLR)
INMACH(SIZE, MLR) = 0
IF (MACH) 450, 450, 0
IF (MACH COLOUR (MACH) KULOR) 0, 440, 0
INMACH(SIZE, 6 - MLR) = MACH
GO TO 450
DU S10 SIZE=INSIZE,MAXSIZE
Covers(SIZE)=USERMILLION
IF (NUMMACHS(SIZE)) GT 10,510.0
HALF(SIZE)=0
CALL PRODUCTCOVE(SIZE,CoverS(SIZE),BRAND,MATERIAL)
EXTRALOST(SIZE)=ALTERCOST*MATERIAL
S10 CONTINUE
IF (SIGN,NE,0) CALL REARRANGE
DU S30 NUNF=1,NCHISCOLOUR
MAXOLD=MAX
MACH=MACHINUSE(NUNF)
MAX=MAXFILESIZE(MACH)
KTOPRANGE(NUNF)=MAXOLD + (.7*MAX-MAXOLD)/5
S30 CONTINUE
KTOPRANGE(MACHISCOLOUR+1)= MAXSIZE+1
KTOPRANGE(1)= MAXFILESIZE(MACHINUSE(1))/2
MACHINUSE(MACHISCOLOUR+1)= MACHINUSE(MACHISCOLOUR)
IF (SQUAREF) .GT 50.0,0.0
IF (MACHISCOLOUR-2) .LT 50.0,540.
KSPREAD=KSPREAD
KDIFFERENCE=MAX-MAXOLD
IF (KSPREAD = KDIFFERENCE*5) 0.0,540
IF (KSPREAD,LT,KDIFFERENCE) KSPREAD=KDIFFERENCE*/1
KTOPRANGE(1)-MAX = 2*(KSPREAD+1)/3
KTOPRANGE(2)=MAXOLD + KSPREAD/3
THIS COVERS A COMMON 700m CASE WITH TWO MACHINES
BUT A LOW SPREAD OF SIZES WANTED
NOW CALCULATE THE EFFECT OF RUNNING EACH SIZE WITH THE OTHERS
ADJUST THE PRIORITY FOR OTHER SIZES IN THE MACHINES
S40 NUM=1
1=2
MACH1,MACH2=MACHINUSE(1)
DU S50 MACH=MACHINUSE(NUM)
IF (NUMMACHS(SIZE)) GT 50.0,0.0
IF (SIZE,LT,KTOPRANGE(NUM)) GO TO S50
NUNF=NUNF+1
MACH=MACH2
MACH2=MACHINUSE(NUM)
S50 MACH=NACH(MACH,SIZE,MACH)
IF (SIZE) IS IN AN UNSUITABLE MACHINE, REMOVE IT
IF (MACH,NE,MACH1,AND,MACH,NE,MACH2) MACH=INACH(SIZE,MACH)
IF (MACH,NE,0) MACH=NACH1
COMPARE THE COST OF MAKING SIZE NOW, WITH THAT EXPECTED
NORMAL, WHEN IX=MAX IS THE LARGEST SIZE.
C  *** CHOOSE TO FIT 7474 CIRCUMSTANCES ***
C
C0  DIFF = (DUMM-SIZE)*DUMMY
C1  COST = RANGEFACTOR*DIFF*DUMMY
C2  IF (DIFF) 0,575,575
C3  COST = 4.9*COST
C4  DIFF = 2.4*DIFF
C
C  IF 'SIZE' IS ABOVE THE IDEAL SIZE IT IS PENALISED MORE HEAVILY
C
C5  SK  IF (DIFF, GE, SPREAD) COST = COST + (DIFF/SPREAD)**8
C
C  THERE IS NO ADJUSTMENT UP TO HALF THE MAXIMUM SPREAD
C
C6  IF (DUMMY=ONE) 0,550,0
C7  SUB = COST
C8  DUMMY = ONE
C9  [DUMMY,AxesINRESIZE,MACH]
C10  GO TO 570
C
C0  IF (COST,G.T,SUB) EXTRACOST(SIZE) = EXTRACOST(SIZE) + COST - SUB
C
C50  CONTINUE
A0  WRITE (30,4300) DG,DFS,LOVERS,DI,DJ,EXTRACOST
A1  WRITE (30,9500) MAXESINRESIZE,KTUPRANGE,SIGN
C
C  CALCULATE THE BASIC PRIORITY
C
C0  QU 700 SIZE = INSIZE, MAXSIZE
C1  PRIOR(SIZE) = -THOUSAND
C2  IF (COVERS(SIZE) ) UNMILLION 0,700,700
C3  PRIOR(SIZE) = PRIORITY(SIZE)
C
C70  CONTINUE
C8  WRITE(30,9300) DK,DG,PRIOR
C9  IFLAG = 2
C
C  NOW DECIDE WHICH SIZES TO MAKE
C
C0  PICK SIZE OF HIGHEST PRIORITY AND ATTEMPT TO SCHEDULE IT
C
C80  TUPPRIOR = -500
C9  IBESTSZ = 0
C10  INDX = 2
C11  IF [MACHPLACES,LF,MACHFACTORS] INDEX = 1
C12  DO 870 SIZE = INSIZE, MAXSIZE
C13  IF (TUPPRIOR-PRIOR(SIZE)) 0,700,700
C14  IF (IVARCHIESIZE,ASSIGN(SIZE)+1) 0,4,860
C15  CALL THE ROUCREDCHANGE LIMIT HAS NOT BEEN EXCEEDED
C16  OR THAT ONE IS NECESSARY
C17  IF (IFLAG, GE, 100, AND, NPLCHANG,GE, MACHLIMIT) GO TO 870
C18  TUPPRIOR = PRIOR(SIZE)
C19  IBESTSZ = SIZE
C
C870  CONTINUE
C
C0  IBESTSZ HAS THE HIGHEST PRIORITY, SU ASSIGN IT
C1  IF (IBESTSZ) 040,940,0
C2  SIZE = IBESTSZ
C3  NLD = ASSIGN(SIZE) + 1 + HALF(SIZE)
C
C3  DECIDE IF ONLY HALF A WEEK IS NEEDED
C4  IF (NACHSIZESIZE(SIZE) = PROPORTION(KOLOR),LE.
C5  1 APROUD(MACH,NIGHTARES(SIZE)+1) INDEX = 1
C6  IF (INDEX, GT, 1, AND, NIGHTARES(SIZE), GT, 0) GO TO 920
C7  0
Determine if there is a suitable place for 'INRESTIZE'.

CALL DESIRE(INBESTIZE,MLD,INDEX)

IF (INDEX) 0,420,677

IF INDEX IS POSITIVE SIZE WILL BE MADE

IF INDEX IS NEGATIVE A HALF WEEK WILL BE MADE

INDEX=1

GO TO 875

877 IMHALF(SIZE)=INDEX-2 - IMHALF(SIZE)

IF INDEX IS > A FULL WEEK IS PLANNED

IF INDEX IS > AN EXTRA HALF WEEK IS PLANNED

ADJUST IMHALF(SIZE) APPROPRIATELY

ASSIGN(SIZE)=MLD

NEXTHALM(L(SIZE))=NEXTHALM(L(SIZE)) + 1 + IMHALF(SIZE)

IF ONLY A HALF WEEK IS PLANNED THE EXTRA HOUND IS NOT NEEDED

DON'T COUNT AN EXTRA HOUR IF ONLY A HALF WEEK USE

PRIOR(SIZE)=PRIORITY(SIZE)

MACHPLACES=MACHPLACES + INDEX

IF (MACHPLACES) 499,1000,250

C THERE IS NO SUITABLE PLACE FOR 'INRESTIZE'

920 PRIOR(INBESTIZE) = -1500

IF (TOPPRIORITY,UT,THOUSAND) WRITE(50,960U) INBESTIZE,TOPPRIORITY

GO TO 850

940 IF (IFLAG-100) 0,999,999

IFLAG=100

GO TO 850

1000 NUM=1

WRITE(30,9360U) DL,DP,PRIORITY,NUM,DP,TOPPRIORITY

C STARTING WITH THE LARGEST SIZES, PLACE THEM IN THE MOST

C CONVIENT MACHINES WITH VACANT PLACES.

IFLAG=11

DU 1200 SIZE=MINSIZE,MAXSIZE

MACH=ASSIGN(SIZE)

IF (MACH) 499,1200,0

IF (IMHALF(SIZE)) 1120,0,1200

1020 DU 1100 MLU=1,4MLU

IF (INMACH(SIZE,MLU)) 1100,1040,1100

1030 NUM=NUM+1

1040 MACH=INMACH(NUM)

IF (MLDSPACE(MACH)) 499,1030,0

MLDSPACE(MACH)=MLDSPACE(MACH) + 2

1070 INMACH(SIZE,MLU)=MACH

1100 CONTINUE

GO TO 1200

C SECTION ON HALF WEEK RUNS

C FIND A SUITABLE SIZE TO FILL THE OTHER HALF WEEK

1120 IF (BATCHSIZE(SIZE)*PRODUCT(MACHKOLON,LT,HALFPRODN) IMHALF(SIZE))=1

1200 CONTINUE

C HOW CLEAR FURTHER HOUNDS OF THIS COLOUR

DU 1250 SIZE=MINSIZE,MAXSIZE

JNUM,NEXTMLU=ASSIGN(SIZE) + 1

DO 1250 MLU=JNUM,5

1210 MACH=INMACH(SIZE,MLU)
INMACH(size,MLD)=0
IF (MACH) 1250,1250,0
IF (MACH+1000)(MACH) 0,1250,1250
C THIS COLOUR HAS YET TO BE DONE. MOVE MOULD TO FRONT
INMACH(size,MLD+1)=MACH
NEXTMLD=NEXTMLD+1

1250 CONTINUE

WRITE(50,4600) DR,DS,ASSIGN,DT,DU,DU

C DETERMINE WHICH BRANDS ARE TO BE MADE. AND WRITE THESE OUT

IFLAG=20
DU 1500 MACH=1.5
IF (MACHCOLOR(MACH),NE.,KOLOR,OK,MLDPLACE(MACH),LE.,0) GO TO 1500
NUM=MACHPRODUCT(MACH)/2
DU 1400 SIZE=MINSIZE,MAXSIZE
C COUNT THE NUMBER OF MOLDS OF SIZE 'SIZE' IN THIS MACHINE
NMLD=0
DU 1350 MLD=1.3
1320 IF (INMACH<size,MLD,EU,MACH) NMLD=NMLD+1
IF (NMLD) 0,1450,0
C 'INDEX' IS A MEASURE OF WHOLE OR HALF WEEKS
INDEX=2
IF (IMACH(size),NE.,0) INDEX=1

C DECIDE THE BRAND TO MAKE
IF (MACHTYPE = 'FREESTUCK',LE.,0.08) IF (INMACH(size,1)=MACH) 0,1360,0
1350 CALL PRODUCTCOVER(size,COVER,BRAND,MATERIAL)
IF (BRAND) 9,49,49,1370
C *ND* ROUTINE FOR BRIGHT AND DULL WELLIES
C NOTE THIS ROUTINE CAN ONLY BE ENTERED ONCE PER SIZE
C THE DUPLICATE MOLDS ONLY TAKE DUNLOP PRODUCTS
1360 BRAND=1
C THE SECOND WELLINGTON TAKES ONLY 'DUNLOP' BRANDS
IF (SIZE,17,AND.,size,EU.2)(SIZE,2)) BRAND=3
GO TO 1400
C IF THE BATCH-QUANTITY REQUIRED IS BELOW 2/3 WEEK'S PRODUCTION
1370 IF (INDEX,EU.1,OR.,NEXTPWIDTH(1),6,LE.,1) GO TO 1400
IF (INDEX SIZE,FRACION(SIZE,BRAND)*(THOUSAND+PRODNUM) 0,0,1400
INDEX=1
NMLD=NMLD+2
1400 MPRODUCT(BRAND)=MPRODUCT(BRAND)+INDEX
C ADJUST 'FREESTUCKS' AND MATERIAL AVAILABILITY
FREESTOCK(size,BRAND)=FREESTOCK(size,BRAND)+INDEX*NUM
MATAVAIL(size,BRAND)=MATAVAIL(size,BRAND)-INDEX*NUM
NMLD=NMLD-1
IF (NMLD) 0,0,1350

C WRITE OUT PLANNED PRODUCTION FOR THAT MACHINE AND WEEK
C

DU 1420 BRAND=1,ABRAND
IF (MPRODUCT(BRAND)) 1420,1420,0
WRITE(20,4100) HCTYPE,MACH,MANGP,HPPERIOD,SIZE,
BRAND,WEK,MPRODUCT(BRAND)
9100 FORMAT(2X,4H602,2,AA)
1420 MPRODUCT(BRAND)=0
IF (IMULT(SIZE), EQ, 1) INMACH(SIZE, ASSIGN(SIZE)) = -1
1420 CONTINUE

C
NOW WRITE OUT MACHINE DETAILS
WRITE(20, 4260) MCTYPE, MACH, WEEK, MANGRP, KOLOR, MACHPRDN(MACH)
9260 FORMAT(24, 17, 601, 44, 8H )
1500 CONTINUE
C
PROCEED TO NEXT COLOUR OR WEEK
1600 IF (IMACH=1) 700, 140, 310
999 WRITE(33, 9440) MCTYPE, MANGRP, WEEK, 1FLAG
9440 FORMAT(/, 24X, 7THR RN ABD ONED FOR GROUP, 15, 12, RH IN WEEK, 13/
1 35A, 72RDUE TO INTERNAL ERROR, 14/1M)
700 IF WEEK=510
GO TO 100
940 END FILE 20
STOP
END

END OF SEGMENT, LENGTH 1461, NAME IM4O
SUBROUTINE INPUT
INTEGER SIZE, BRAND, PROD, WEEK, WEEKSLFT, SIGN
INTEGER REWEFT, FREESTOCK, SIZEROLL, ASIGN
INTEGER FURK, DESCRIPTION
LOGICAL SHOPTN, OUTPUTRQ
DIMENSION ICEAKE(357), CLEAP(57)
COMMON/ASSRNDY/. CHCOST, ALTEKOST, COLUKADV, VALFREESTOCK
1, RELATIVE FREE, IFREE, VALCHANGE
2, SHORTHAND, OUTPUTRQ
CUMON/NUMERIC/ONE, E10, HUNDRED, THOUSAND, THOUSANDTH, HALF, ONEMILLION
COMMON MINSZ(3), MAKSZ(37), VARAVG, PROD, MCTYPE, MANGRP, KOLOR
1, SHCOST, COLUKADV, HACHINUSE(N), KOLUMN(10), LISTS(10)
2, FREESTOCK(37, 10), SIZEROLL(37, 10), REEMENT(37, 20)
3, INIACH(37, 5), PATAVAIL(37, 10)
4, PACHRE(40), RUMBUFF(30), ASIGN(40)
COMMON/BLUE smelling, FREE, SHRED, RASHPROD, LAP, INCREASE, SIGN, MCHLIMIT
1, MAXFRESFSIZE(60), LISTACH(60), WXGHT, RANGEFFACTOK
2, INITIALKE(10), TOTALKE(10), PRODUPJUN(10), CUMPART(27)
3, WFFASTART1, WEEKAFTERPLAN, LASTWEEKUPPLAN, LASTWEEKOFREM
4, NOCOLOUR, NUMSIZE, NBRANDSIZE
COMMON/BLUE7/ KEY(6), IBUFFER(60), INPUTRECS, INPUTACC, REJECTED
EQUIVALENCE (ICLEAN(1), KOLUMN(1)),
EQUIVALENCE (ICLEAN(1), INITIALKE(1))

THIS ROUTINE STORES ALL INITIAL INPUT DATA
(SEE INPUT2)

KEY CONTAINS CHECK INFORMATION - VALIDATE EACH RECORD
WRITE(50, 1005)

1005 FORMAT(1H1)
   WEEKS*10
 10 IF (KEY(2)) 950, 00, 0
   IF (KEY(2)=MCTYPE) 100, 0, 100
   IF (KEY(3)=HANKP) 100, 0, 100
   IF (KEY(6)=UFEX-1) 0, 0, 100
   IF (KEYS(10)) 0, 0, 900
   ACCEPTABLE RECORDS SHOULD PASS ALL THESE TESTS
   BRAND=KEY(6)
   ISET=KEY(5)
   GO TO (200, 500, 400, 250, 500, 550, 600, 550, 700, 750), ISET
   RECORD TYPE INVALID OR OUT OF SEQUENCE
   50 INJECTED=INJECTED+1
   WRITE(30,1003) KEY
   GO TO 90

1003 FORMAT(/12HM ** REJECTION ** - KEYS .AA, 514/)
   GO TO 90

C RECORD ACCEPTED
70 INPUTRECS=INPUTRECS+1
   IF (OUTPUTRQ) WRITE(50, 1002) KEY, IBUFFER
   WEEK=KEY(4)
   90 READ(10, 1001) KEY, IBUFFER
1001 FORMAT(A44)
   INPUTRECS=INPUTRECS+1
   GO TO 20

C PREPARE FOR NEW MANGRP
100 IF (INPUTREC5=1) U,170,0
  DU 110 I=1,297
110 I: CLEAR(I)=0,
  DU 120 J=1,57
C SET ALL LARGE ARRAYS TO ZERO
  DU 130 K=1,37
130 MTYPE=KEY(2)
  MARK=KEY(3)
  OUTPUT=TRUE,
  DU 140 L=1,37
140 NUMHOMINS(1)=2
  GO TO 20

C PROCESS 'ASIC' RECORD
200 NWEKSTOSTART=BUFFER(1)
  LASTWEEKOFPLAN= BUFFER(2)
  NWEKAFTERPLAN= BUFFER(4)
  LASTWEEKOFREP= LASTWEEKOFPLAN + NWEKAFTERPLAN
  SNIORTK=BUFFER(5),LE.1
  NHACH=BUFFER(6)
  LAP =BUFFER(7)
  REQDPROM= BUFFER(8)*THOUSANDTH
  COLUMKADV= BUFFER(9)
  FREE =BUFFER(10)*THOUSANDTH
  IFRPL= BUFFER(11)
  NU 220 I=1,27
  220 CUMPAKT(I)= BUFFER(41-I)*THOUSANDTH
  IF (LASTWEEKOFREP,GT,20) LASTWEEKOFREP=20
  WEEK=NWEEKSTOSTART
  GO TO 70

C PROCESS 'MCDA' RECORD
300 PROUN= BUFFER(11)
  DU 320 I=1,5
  I=STACH(I)= BUFFER(I+6)
  MAXDES1KSIZE(I)= BUFFER(I+11)
310 CONTINUE
C READ IN COST INFORMATION - USED TO DECIDE THE PRIORITIES OF
  MOULD CHANGES, COLOUR CHANGES AND WIDER SPREADS.
C CNNGCUST= BUFFER(22)
C RANGEFACTUR= BUFFER(24)*THOUSANDTH
C SPREAD = BUFFER(25)*.7
C ONLY EXCEEDS CHANCE LIMIT IF, AFTER THE PERMITTED NO.
C OF CHANGES, IT IS IMPOSSIBLE TO FILL THE REMAINING PLACES
C WITH SIZES THAT WERE MADE LAST WEEK
C NCHLIMIT= BUFFER(26)
C MAXDES1KSIZE GIVES THE LARGEST SIZE DESIRED IN EACH MACHINE
C WITH AN EXPECTED SPREAD OF A THIRD 'SPREAD' ABOVE AND TWO-THIRD
C HELLO,
C WEIGHT' GIVES THE RELATIVE EMPHASIS OF THE CURRENT LARGEST SIZE
C AND THE FORWARD VALUE.
C 'WEIGHT'=0 GIVES A CONSTANT VALUE TO MAXDES1KSIZE AS INPUT
C 'SIGN' IS NORMALLY ZERO; IF + OR -1, THIS INDICATES THAT THE
C MAXDES1KSIZE WILL SHIFT AS THE SET OF SIZES IN THE MACHINE
C SNAKES UP AND DOWN THE SIZE RANGE.
C WEIGHT= BUFFER(27)*THOUSANDTH
SIGN = 1 BUFFER(24)
STORE INFORMATION ABOUT BRANDS AND SIZES
MCOL[N] = 1 BUFFER(35)
NB[BRAND] = 1 BUFFER(36)
NUM[SIZE] = 1 BUFFER(37)
NB[RANS[SIZE]] = 1 BUFFER(38)
MIN[SIZE] = 1 BUFFER(39)
MAX[SIZE] = 1 BUFFER(40)
GO TO 70

PROCESS 'STKS' RECORD

400 CALL STORE (FREESTUK)(1, BRAND)
GO TO 70

PROCESS 'SZRL' RECORD

450 CALL STORE (SIZE, NULL, 1, BRAND)
GO TO 70

PROCESS 'REDS' RECORD

500 LIST(N)(BRAND) = 1 BUFFER(1)
KULOWN[BRAND] = KOLOR[1 BUFFER(2)
EN[TRAL][5[BRAND]] = 1 BUFFER(3) THOUSANDTH
TOTA[RE][BRAND] = 1 BUFFER(4) THOUSANDTH
PRO[PORTION][KOLOR] = 1 BUFFER(5) THOUSAND
GO TO 70

C

UNUSED AT PRESENT - REJECT IF THESE OCCUR

550 GO TO 50

PROCESS 'PROD'

C

NO PROCESSING AT PRESENT
C
COULD BE USED TO FORCE CERTAIN PROGRAMMES
C
UNTIL THEN REJECT

600 GO TO 50

PROCESS 'FORCE' RECORD

700 CALL STORE (FORCE)
GO TO 70

C

PROCESS 'MLDS' RECORD

750 CALL STORE (NUMBER,MILLS)
GO TO 70

C
CURRENT RECORD IS FOR LATER PROCESSING
C
REJECT RECORD IF NUME ACCEPTED YET, OTHERWISE RETURN

900 IF (WEEK, 50) GO TO 50
RETURN
END RECORD READ AND PROCESSING FINISHED

950 MCTYPE = KEY(2)
WRITE(30,1004) INPUTRC, INPUTAC, REJECTED
1004 FUPHAT(1,40,12, RECORDS READ. 15/45X. RHACCEPTED. 15/
1 45X. RHREJECTED. 15/20X. RHEND 1)
RETURN
END
SUBROUTINE INPUT
INTEGER RESULT DESCRIPTION
INTEGER SIZE, BRAND, DROGH, WEEK
INTEGER KEYS, FESTOCK, FRACTION, ASSIGN
LOGICAL SHORTRUN, OUTPUTREQ
COMMON /ASSORTED/ CHK, GLOST, ALT, MTC, CTY, VAL, SFR, FESTOCK
1 , RELATIVE, FREE, VALCHANGE
2 , SHORTRUN, OUTPUTREQ
COMMON /NAMES/ clock, FNAME, THOUSAND, THOUSANDTH, HALF, ONE, MILLION
COMMON FNAME, CLOCKS, AASSORTED, BRAND, POUIN, MCTY, SFR, FESTOCK, KOLOR
1 , NPACHM, CSTHISCOLOR, MACHUSEN, AASSORTED, KOLOR(10), LSTNO(10)
2 , FESTOCK(37,10), FRACTION(37,10), REGENT(37,26)
3 , INHACK(37,5), PAYVAL(37,10)
4 , IPACHM(40), NUFILLIPS(40), ASSIGN(40)
COMMON /FPEEK/ KEY(2), TRUFEER(40), INPUTFES, INPUTACC, REJECTED
COMMON /HUCKS/ WEEK, WPEEK, WCOLOR, NACHCOLOR(5)
1 , PLAYOUT(4), MACPPOUN(4)

THIS ROUTINE CHECKS ALL WEEKLY INPUT DATA

KEY CONTAINS CHECK INFORMATION

ONLY PROCESS INFORMATION FOR CURRENT MCTY, MANGRP AND WEEK

20 IF (KEY1, LT, KEY4) GO TO 520
1 IF (MCTY, NE, KEY2), OR, MANGRP, NE, KEY3)) GO TO 900
1 IF (KEY(1)-0) 500, 50, 0
BRAND=KEY(0)
1 IF (KEY(0)+1) 50, 400, 0
1 IF (KEY(0)-1) 500, 600, 0
C RECORD TYPE INVALID OR OUT OF SEQUENCE
50 IF (REJECT=REJECTED)
C WRITE(30,7003) KEY, WPEEK
C
1003 COMMON (/FREED/ ** REJECTION ** - KEYS , A, D, 8, ) OR WEEK, 13/)
GO TO 150
C
REFLOOD ACCEPTED
100 INPUT=INPUTACC+1
1 IF (OUTPUTREQ), WRITE(50,100) KEY, TRUFEER
1002 FORMAT(1X, 14, 1, 12, 3, 2(201/20X))
C READ IN NEXT RECORD
150 READ(10,1001) KEY, TRUFEER
1001 FORMAT(4A4)
WEEK=KEY(4)
INPUTFES=INPUTFES+1
GO TO 200
300 IF (KEY(5), 50, 11, 50, 11, 30)
GO TO 900
C IF (KEY(5)-4) 50, 11, 50, 11, 30
C PROCESS 'FORCE' RECORD
310 CALL STORE(MACFORCE)
GO TO 100
C
C PROCESS 'HLD' RECORD
350 CALL STORE(HRUMDFIELD)
GO TO 100
C
C PROCESS 'MCLD' RECORD - MCTY BRAND IS A MACHINE NO.
400 MACH=BRAND
   DU 450 SIZE=MIN SIZE, MAX SIZE
   NUM=BUFFER(SIZE)
   IF (NUM) 450, 450, 0
   DO 430 MLD=1, NUM
      INMACH(SIZE, MLD)=INMACH(SIZE, MLD+1)=MACH
   430 INMACH(SIZE, MLD) =MACH
C    MOVE CURRENT MOULD OUT TO NEXT MACHINE.
   C    CONTINUE
   GOTO 100
C    PROCESS 'MATS' RECORD
C    MATERIAL AVAILABILITY IS ADDITIVE
C   500 DO 530 SIZE=MIN SIZE, MAX SIZE
C      MATAVAIL(SIZE, BRAND) = MATAVAIL(SIZE, BRAND) + BUFFER(SIZE)
   530 CONTINUE
   GOTO 100
C    PROCESS 'WKLY' RECORD
   600 MKCOLOR= BUFFER(16)
      ALTERNANT= BUFFER(19)
      RELATIVEFREE = BUFFER(40)* THOUSANDTH
      IF (ALTERNANT.LT. 80) ALTERNANT=ALTERNANT/VALFREESTOCK
       DU 630 MACH=1.5
      MLDPLACES(MACH)= BUFFER(MACH)
      MACHRONN(MACH)= BUFFER(MACH+5)
      MACHCULUUR(MACH)= BUFFER(MACH+10)
   630 CONTINUE
      IF (BUFFER(17)) 680,100,0
C    CLEAR MOLDL FROM ANY EMPT MY MACHINES
      DU 660 SIZE=MIN SIZE, MAX SIZE
      MLD=NUMOFMLDS(SIZE)
      IF (MACH) 660, 660, 0
      DU 650 NUM=1, NM D
      MLD=MLD+1- NUM
      MACH=INMACH(SIZE, MLD)
      IF (MACH) 650, 650, 0
      IF (MLDPLACES(MACH)=0, 650)
C    DO IF NO PLACES IN THE MACHINE, THEN RELEASE THE MOULD
      DU 640 INUM=MLD, NM D
   640 INMACH(SIZE, IDUM)=INMACH(SIZE, IDUM+1)
   650 CONTINUE
   660 CONTINUE
      GOTO 100
C    IF THERE IS AN INTERVAL BETWEEN SCHEDULES, IT IS ASSUMED
C    THAT THE MOULDS ARE REMOVED
   680 DU 690 SIZE=MIN SIZE, MAX SIZE
   690 INMACH(SIZE, MLD)=0
   GOTO 100
C    FOR ZUTURE MAN.GRP - NO MORE INPUTS FOR THIS GROUP
   900 KWEERK=520
   920 RETURN
END
FUNCTION PRIORITY(SIZE)
INTEGER SIZE, BRAND, PRVDN, LEAF, WEEKSLEFT, SIGN
INTEGER REVENT, FREESTOCK, FRECTION, ASSIGN
COMMON CAP(SIZE), MAX(SIZE), FFAMAIN, PRVDN, MCTYPE, MAXGRP, KOLOR
1 WEAKCT, CGTHS, CGTHU, MACHUSE(SIZE), KOLVR(SIZE), LISTSIZ(SIZE)
2 FREESTOCK(SIZE), FRECTION(SIZE), ASSIGN(SIZE)
3 INFAC(SIZE), KATAVAI(SIZE),
4 MACHUSE(SIZE), FFAMAIN(SIZE), ASSIGN(SIZE)
COMMON BUCKETS, FREE, SPR, RE-TO-THON, LAP, INCREASE, SIGN, MCHINIT
1 FAMESPS, FAMESPS(SIZE), FAMESPS(SIZE), FILTER, WEIGHT, RANGEF, FACTOR
2 FILTER, FILTER(SIZE), FILTER(SIZE), FILTER(SIZE), FILTER(SIZE)
COMMON FRACKS, FRACKS(SIZE), FRACKS(SIZE), FRACKS(SIZE), FRACKS(SIZE)
2 BUCKET(SIZE), BUCKET(SIZE), BUCKET(SIZE), BUCKET(SIZE)
3 BUCKET(SIZE), BUCKET(SIZE), BUCKET(SIZE), BUCKET(SIZE)
4 BUCKET(SIZE), BUCKET(SIZE), BUCKET(SIZE), BUCKET(SIZE)
COMMON ASSSYTEM, PHAS, ALTCOST, CULR, VAN, VALFREE, STICK
4 RELATIVE, FREE, VALCHANGE
COMMON NUMERICS/NICE, TNA, HUNDRED, THOUSAND, THOUSAND, HALF, MILLION

THIS FUNCTION EVALUATES THE BASIC PRIORITY OF MAKING THE MOST NEEDED BRAND FROM THE AVAILABLE SIZE. THIS WEEK

THE CALCULATION OF THE PRIORITY DEPENDS ON THE PLANNING HORIZON AND ON THE MACHINE STATUS.
IF SIZE IS NOT IN ANY MACHINE, THE PRIORITY DEPENDS ONLY ON THE WEEKS COVER PROVIDED BY THE CURRENT STOCK.
OTHERWISE, WITH A LONG HORIZON, THE PRIORITY IS INCREASED SO IT REMAINS POSITIVE IF STOCKS ARE BELOW THEIR DESIRED MAXIMUM, TWICE THE AVERAGE STOCK.
WITH A SHORT HORIZON, THE TOTAL QUANTITY STILL NEEDED IS ESTIMATED; THE PRIORITY IS FOUND BY COMPARING THE ALTERNATIVES OF MAKING THEM ALL NOW WITH THAT OF HAVING ANOTHER BATCH.

EXCESS(A) = A * COVER) / NUMORD(SIZE) * RELATIVE + VALCHANGE
MLD = ASSIGN(SIZE) * MAX(SIZE) * 1
1 (MLD = NUMORD/FRML(SIZE)) U, 0, 0
DUMMY = PRVD/AVISAG(SIZE)
EXTRA COVER = DUMMY * NEXTMLDS(SIZE)
COVER = COVERS(SIZE) + EXTRA COVER / PROPORTION(KOLOR)
IF (HALF(SIZE), LT, 0) COVERS = COVER + HALF * DUMY / PROPORTION(KOLOR)
MACHSTATUS = 0
IF (INRANCH(SIZE, MLD) G, 0) MACHSTATUS = 1
IF (NEXTMLDS(SIZE) > MINNUMHRLDS(SIZE)) 250, 0, 300
30 IF (COVER > 120, 120, 0)
PROVIDE HIGH PRIORITY IF NEGATIVE, COVER
IF (MACHSTATUS, G, 0, 0, 0, 0, 0, 0)
IF (NEXTMLDS(SIZE) > 0, 0, 0, 0)
40 IF (COVER, G, 0, 0, 0, 0, 0, 0, 0)
CALCULATE PRIORITY FOR NORMAL CASES
50 PRIOR = COVERS / NUMORD(SIZE) * RELATIVE + VCHSTUS = COVER
IF (PRIOR > 140, COVER - EXTRACOST(SIZE)) 150, 0, 0
PRIOR = 10 + PRIOR / EXTRACOST(SIZE)
RETURN
120 PRIOR = NUMORD + TEN * MACHSTATUS - COVER
150 IF (EXTRACOST(SIZE), G, 190) PRIOR = PRIOR / HUNDRED
PRIO R I T Y = PRIOR – EXTRACOST(SIZE)
RETURN

C
ASSIGN UP TO MINIMUM NUMBER OF MOLDS
RETURN

C
PRIOR=500.
GO TO 150

C
EVAL UATE THE PRIORITY WHEN THE MOULD IS SURPLUS
IF (AFTER = F O S T + ISCOLOUR*2) 0,30,30
PRIOR=500.
GO TO 150

C
IF AFTER 3 MORE WEEKS WITH PRODUCTION AT CURRENT RATE
C
THERE WILL STILL BE A SHORTAGE THEN TREAT AS URGENT
C
CLEAR ANY DEFICIT BY SCHEDULE END. (HORIZON THEN BELOW 3)
C
OTHERWISE FINISH FOR ANY MODIFICATIONS NEEDED

C
300 HORIZON= WEEKSLEFT-1
IF (HORIZON, GT,3) HORIZON=3
COVER=COVER * EXTRACOVER/HORIZON+HEATUPKOD
IF (COVER=HORIZON) 120,120,120
IF (COVER,GT,WEKLEFT) COVER=EXCESS(COVER)
PRIOR=(MouldNecessary-4)*VALCHANGE-COVER
GO TO 150
C
THIS IS A DUPLICATE MOULD BUT OF A SIZE WHERE DUPLICATES
ARE NEEDED. IF MOULD IS NEEDED TREAT AS URGENT
C
OTHERWISE ESTIMATE WHEN THE DUPLICATE WILL NEXT BE REQUIRED

C
350 DUM= COVER = (WEKLEFT-1)*EXTRACOVER
COVER=COVER*(ONE - EXTRACOVER)
IF (COVER,GT,DUM) COVER=DUM
GO TO 40

C
THE END IN MIND, THERE WILL EITHER BE ONE MORE BATCH OR NONE
NEAR THE END OF A SCHEDULE CALCULATE THE PRIORITY WITH

C
400 COVER=COVER * (WEKLEFT-1)*EXTRACOVER
VALUE=REFERENCE(SIZE,1)/PRODN
IF (VALUE=PRODN,NE,REFERENCE(SIZE,WEKLEFT)) GO TO 450
MouldNecessary=(WEKLEFT-1)*VALUE = 1*FIX(COVER/DUMMY)
IF (MouldNecessary>0,GT,450)
COVER=WEKLEFT+MouldNecessary*DUMMY
C
IF NO MORE MOLDS NEEDED SET EXCESS COVER

C
430 IF (COVER,GT,WEKLEFT) GO TO 40
MouldNecessary=(WEKLEFT-1)/DUMMY
GO TO 450

C
450 IF (MouldNecessary,GT,WEKLEFT) GO TO 450
C
IF ONLY ONE MORE BATCH IS TO BE MADE THE SAVING IS THE VALUE
C
OF A MOULD CHANGE DIVIDED BY THE REMAINING NUMBER OF MOLDS
DUM*VALCHANGE=MouldNecessary
C
IF THIS IS NOT THE LAST BATCH THERE MAY BE STILL BE AN
C
ADVANTAGE BY CONTINUING THE CURRENT RUN. THIS IS THE NUMBER OF
C
FURTHER MOLDS NEEDED TIMES THE SAVING MADE (=DUMMY WEEKS) BY
C
RELAYING THE START OF THE NEXT BATCH

C
PRIOR=(MouldNecessary+1)*DUMMY
IF (PRIOR,LT,DUM) PRIOR=DUM
PRIOR=PRIORITY-DUM
PRIOR=HUNDRED
GO TO 150

C
THERE ARE NO MORE MOLDS

C
800 PRIORITY=-2000.
RETURN
END

GO TO 450
SUBROUTINE DESIFR(SIZE,MILD,INDEX)
INTEGER SIZE, M, MLD, INDEX
INTEGER PARTNY, FREESTOCK, N, FRACTION, ASSIGN
INTEGER GROUPPLACESFILLED
COMMON MINSIZE, MAXSIZE, MBRAND, MLD, MCTYPES, MANGRP, XCOLOR
1, MACH, MACHCOLOR, MACHINUSE(N), KOLUTION(T), LISTNO(T)
2, FREESTOCK(SIZET, T), FRACT, 0, FREESTOCK(37, T), REQUENT(37, 26)
3, INITMACH(37, T), MATAVAILABLE(37, T)
4, 1MACHFREEC(300), WSMOD, KSPACES(N), 1TOPRANGE(7)
COMMON (KSPACES(6), MACHPLACES(N), HALFWEKES, WSMODPLACES)
IVEN(J) = 4*(J/2)+1, W = J - 1
IF J EVEN, -1 IF J ODD

THIS SUBROUTINE COUNTS THE REMAINING SPACES FOR EACH MACHINE
AND ALSO THE MOLD CHANGES
IT REJECTS ANY SIZE FOR WHICH A SUITABLE MACHINE CANNOT BE FOUND
THE SIZES ARE DIVIDED INTO GROUPS (1TOPRANGE) CHOOSED SO THAT
THEIR MEMBERS ARE SUITABLE FOR EITHER OF TWO MACHINES

MLDCH = 0
MACH = 1MACH(SIZE, MLD)
1. IF (MACH) 0, 0, 0
2. IF (MLDCH) 1
3. IF (MACH) 0, 0, 0
4. IF (IVEN(INDEX)) 30, 0, 0

IF NO SPECIFIC MACHINE IS TO BE USED, FIND APPROPRIATE SIZE GP

NUM = 0
20 NUM = NUM + 1
1. IF (SIZE, UT, 1TOPRANGE(NUM)) GO TO 20
2. IF (GROUPPLACESFILLED(NUM) = GROUPPLACESFILLED(NUM) + INDEX)
3. GO TO 50
50 NUM = 1, ((SIZE - MINSIZE) * MACHCOLOR / MAXSIZE - MINSIZE)
6. MACH = MACHINUSE(NUM)
7. MACHFREEC(MACH) = MACHFREEC(MACH) - 1
8. IF (MACHFREEC(MACH) < 0, 0, 0)
9. IF (IVEN(INDEX)) -1, 0, 0
10. HALFWEEKES - HALFWEEKES - 1
11. IF (MLDCH = 0, 0, 0)
12. GO TO 50
13. GO TO 250
14. CHECK TO SEE IF THERE ARE MORE MOLDS IN ANY GROUP THAN
15. AVAILABLE SPACES IN SUITABLE MACHINES
16. THIS INVOLVES SCANNING FIRST UPARDS, THEN DOWNWARDS
17. IF (MACHFREEC(MACH) > 0, 0, 0)
18. INCLUSIVE, IMPOSSIBLE = 0
19. GO TO 250

GO TO 450
INCLUSIVE=INCLUSIVE - GROUPPLACESFILLED(J)
9435
IF (INCLUSIVE.GT.0) INCLUSIVE=0
9440
INCLUSIVE=INCLUSIVE + MLDSPLACES(MACHINE(J))
9445
IF (INCLUSIVE.LT.IMPOSSIBLE) IMPOSSIBLE=INCLUSIVE
9450
60 CONTINUE
9455
INCLUSIVE=0
9460
DO 40 I=2,MLDTHISCOLOUR
9620
MLDTHISCOLOUR = I - 1
9625
INCLUSIVE=INCLUSIVE - GROUPPLACESFILLED(I+1)
9630
IF (INCLUSIVE.GT.0) INCLUSIVE=0
9635
INCLUSIVE=INCLUSIVE + MLDSPLACES(MACHINE(J))
9640
IF (INCLUSIVE.LT.IMPOSSIBLE) IMPOSSIBLE=INCLUSIVE
9645
40 CONTINUE
9650
9700
9705
9710
9715
9720
9725
9730
9735
9740
9745
9750
9755
9760
9765
9770
9775
9780
9785
9790
9795
9800
9805
9810
9815
9820
9825
9830
9835
END OF SEGMENT, LENGTH 315, NAME DESIRE
AVUSAGE(SIZE) = KTOTAL/CUMPRT(1)
MINIMUMLBS(SIZE) = (TOTAL-HISTOCK)/((CUMPRT(1)-ONE)*PRODN)
KVALUE=PRODN+NUMBERLBS(SIZE)

THIS IS THE MAXIMUM PRODUCTION RATE
HENCE IT ASSUMES ALL COLOURS ARE BEING MADE
WITH SEVERAL COLOURS AS IN MOST SHIRT RUNS YOU CAN
MAKE GREATER REQUIREMENTS THAN THESE AND STILL SATISFY THEM
HENCE WE INCREASE THE REQUIREMENTS IN THE NEXT WEEKS BY PRODN
IF (SHORTRUN) KVALUE=KVALUE+PRODN

IF THE REQUIREMENTS FOR THE LAST WEEK ARE LARGE THEN BRING THEM
FORWARD SO THAT IN NO WEEK ARE TOO MANY HOULD BE NEEDED

LASTREQ=TOTAL
THE REQUIREMENT FILE IS NOW SET UP
THE REQUIREMENTS FOR A PARTICULAR BRAND ARE FOUND BY MULTIPLYING
THE WEEKS REQUIREMENTS OF THAT SIZE BY THE FRACTION CORRESPONDING
TO THE BRAND

DU 170 WEEK=1,LASTWEEKOFREQ
NURLES=LASTREQ
LASTREQ=CUMPRT(WEEK+1)*AVUSAGE(SIZE)
INCREASE=NURLES-LASTREQ
IF (INCREASE=KVALUE) 160,160,0
IF (LASTWEEKOFREQ - WEEK - 1) 160,160,0
LASTREQ=NURLES-KVALUE
INCREASE=VALUE
160 REQUMT(SIZE, WEEK) = INCREASE
170 CONTINUE
200 CONTINUE
WRITE(30,210) HCTYPE,PANGRP,LASTWEEKOFPLAN,NWEEKSTOSTART.
1 LASTWEEKOFREQ=(LSTNCH(NBRAND),INITIALREU(NBRAND))
1 TOTALREU(NBRAND),PANGRP1,SRND)
210 FORMAT(M1,60A10)IN SCHEDULE FOR THE 16-15H MACHINES WITH
1 10M MANUFACTURING GROUP, 13/ 50X TO RUN FOR 13,
2 17X WEEKS AFTER WEEK, 13/ 20X, SRND, 10X,
2 initial TARGET SALEABLE STOCK,
3 10X PLANED SALEABLE PRODUCTION/ BOX, 4 NOVER, 13, 6 WEEKS/2
5 (20X, 15X, 10X, 10X, 15X, 30X, 20X, 11, 13, 6 PAIRS )
WRITE(30,200) INITIALREQ, LSTREQU, KFREE

290 FORMAT(M1,5X,5X,5X,5X) IN THE STOCK ABOVE INITIAL REQUIREMENTS 15, 18,
1 16 PAIRS/5X, 20X, 11, 13, 6 PAIRS/ 2
2 55X, 4 THE PLANNED UNALLOCATED STOCK IS 18, 6 PAIRS
KSTOCK=(SRANDSIZEX5SIZE) + SUBCARCHE + PRODN

VALCHANGE=+TVFREE
C VALCHANGE IS THE NUMBER OF WEEKS, STOCK IT IS WORTH HOLDING TO
SAVE A MOULD CHANGE.
VALFREE=STOCK*SUFX/VALCHANGE
CALL OVERFLOW(UFLOW)
1 TEST IF ANY DIVISION BY ZERO HAS OCCURRED
INCCREASE=MAX1-(MAXSIZE-MINSIZE)/LAP
RANGEFACT=MAX1/TVFREE
WRITE(30,290) KSTOCK, COLOURARR, LAP, VALCHANGE

292 FORMAT(M1,5X,5X,5X,5X) ALLowe FOR FULL WEEK RUNS/2
1 45X, 7H AND 15X, 10, 3X, 20X, 11, 13, 6 PAIRS NOT IN PRODUCTION
2 30X, 5 THE WEST ALLOWS AN AVERAGE OF 13,
3 45X WEEKS BETWEEN RESTARTING AN AVERAGE SIZE // 20X.
4 30X.33H* ONE MOULD CHANGE IS VALUED AT .56.2.
5 10H WEEK'S STOCK ** // )
6 DU 400 SIZE=MASTER,MAXSIZE
7 IF (AVUSAGE(SIZE)) COU,400,0
8 WEEKLY=AVUSAGL(SIZE) / PROD
9 IF (SHORTRUN) WEEKLY=WEKLY/RECTORP
10 FOR SHORT RUNS THE AVERAGE USAGES ARE GROSS OVERESTIMATES
11 THIS CORRECTS TO GIVE CORRECT BATCH SIZES
12 IDUM=WEEKLY
13 IDUM IS THE INTEGER PART OF THE WEEKLY USE OF MOLDS
14 WEEKLY=WEEKLY-IDUM
15 DUMMY=SORT(WEEKLY*(1.1-WEEKLY))
16 COVER=INPRUD: (SIZE)=4*PKUH+FRSF*DUMMY/AVUSAGE(SIZE)*IDUM
17 BATCHSIZE(SIZE)=(COVERINPRUD(SIZE)*AVUSAGE(SIZE))/ONE-WEEKLY
18 IF THE AVERAGE USAGE IS LITTLE GREATER THAN THE PRODUCTION
19 RATE, MOST WEEKS RUNS ARE PRODUCED BELOW THIS LEVEL.
20 IF (WEEKLY-IDUM,LT,0,03) BATCHSIZE(SIZE)=HALF*PROD
21 BATCHSIZE IS THE EXPECTED RUN LENGTH
22 *COVERINPRUD* IS SET SO THAT A SIZE REMAINS IN PRODUCTION
23 UNTIL IT HAS REACHED THIS NUMBER OF EXTRA WEEK'S COVER
24 AND CONTINUE
25 COLOURADV=COLOURADV - 1.25*(NCOLOUR-1)*PROD
26 IF (COLOURADV,LT,0) COLOURADV=0.
27 COLOURADV=.4*COLOURADV/(MACH*PROD)
28 IF (LAP,GT,6) LAP=6
29 CALL OVERFLOW(1UVERFLOW)
30 RETURN
31 END

END OF SEGMENT, LENGTH 563, NAME SETUP
SUBROUTINE PRODUCTCOVER(KSZE, COVER1, BRAND1, MAKE)
INTEGER SIZE, BRAND, BRAND1, WEEK, WEEKLEFT, SIGN
INTEGER REMAINT, FREESTOCK, FRACTION, ASSIGN
LOGICAL ALLOKANDS, NOURGENCY
COMMON MINSIZE, MAXSIZE, BRAND, PROD, NTYPE, Maker, KOLUR
1 MACHC, MACHSIZE, MACHINUSE(6), KOLUR(10), LISTNO(10)
2 FREESTOCK(37, 10), FRACTION(37, 10), REMAIN(37, 10)
3 MACHC(37, 5), MACHSIZE(37, 10)
4 REMAIN(40), NUMOFPLUS(40), ASSIGN(40)
COMMON ASSORTED, MACHCUSE, ALTCOST, KOLURADV, VALFREESTOCK
COMMON NUMERIC(100, 100), HUNDRED, THOUSAND, THOUSANDTH, HALF, ONEWILLION

THIS SUBROUTINE WILL GIVE THE BEST BRAND TO MAKE IF THE SIZE
IS SPECIFIED, BUT WILL ALSO GIVE THE BRAND MOST NEEDED
IF NO SIZE IS SPECIFIED. IN THIS CASE THE CURRENT
COLOUR IS FEED IN AS MAKE AND HAS AN ADVANTAGE

NUURGENCY=.TRUE.,
ALLBRANDS= ALTCOST, LE.0
BRAND1=0
COVAR=ONEMILLION
10 DO 12U BRAND1=1, NBRAND
 ADVANTAGE=0
 SIZE=KSZE
1 IF (KSZE) 20, 10, 0
2 IF (MKARAND(BRAND)) 120, 120, 50
3 IF (KOLUR(BRAND), EQ, MAKE) ADVANTAGE=COLOURADV
50 IF SIZE=SIZE+1
5 IF (FRACTION(KSZE, BRAND)) 100, 0, 100
 COVER=FREESTOCK(SIZE, BRAND)*THOUSAND/
3 (FRACTION(KSZE, BRAND)*AVUSAGE(SIZE))
3 COVER IS THE WEEKS COVER PROVIDED BY THE PRESENT STOCK
1 IF (COVER) 0, 0, 40
 NUURGENCY=.FALSE.
2 IF (KSZE, EQ, 0) COVER=100*COVER
4 IF BELOW CURRENT REUTS, INCREASE PRIORITY OF THIS COLOUR
 THIS REDUCES THE ADVANTAGE OF THE PREVIOUS COLOUR
80 COVER=COVER - ADVANTAGE
 IF (COVER=COVER) 0, 0, 100
 IF (NOT ALLBRANDS) IF (MATAVAIL(SIZE, BRAND)) 100, 0, 100
 BRAND1=BRAND
 COVER1=COVER
100 IF (KSZE, EQ, 0) IF (SIZE=MAXSIZE) 50, 0, 0
160 CONTINUE
1 IF (COVER) 0, 0, 220
5 IF MAKE IS ZERO THEN MATERIAL SHOULD BE AVAILABLE
 TO MAKE THE SELECTED BRAND
150 MAKE=0
 IF (ALLBRANDS, AND, ALTCOST, GT, 0) MAKE=1
 RETURN
220 IF (ALLBRANDS) GO TO 150
 IF (BRAND1, GT, 0, AND, (ALTCOST, GT, 50, .OH, NUURGENCY)) GO TO 150
 ALLBRANDS=.TRUE.
GO TO 10
END

END OF SEGMENT, LENGTH 260. NAME PRODUCTCOVER
SUBROUTINE STORE (ARRAY)
DIMENSION ARRAY(57)
COMMON/ALC2/ KEY(n), IRUFFER(40)

STORE INFORMATION FROM BUFFER INTO ARRAY

DO 50 I=1,37
  50 ARRAY(I) = IRUFFER(I)
RETURN
END

END OF SEGMENT, LENGTH 34, NAME STORE
SUBROUTINE REARRANGE

INTEGER SIZE, HUNDRED, WEEK, WEEKSLEFT, SIGN

DIMENSION COVERM(3), COVERH(3)

COMMON /BLOCK/ FREE, SPREAD, RESENSE, LAP, INCREASE, SIGN, MACHLIMIT

COMMON /MACH/ MACH, MAXSIZE, MACHINE(n), KULUV(10), LISTNO(10)

COMMON /FREE/ MACH, FREE(10), TOTALKEN(10), PROPORTION(10), CUMPART(27)

COMMON /BLOCK/ MACH, FREE(10), KULUV(10), INCREASE, SIGN, MACHLIMIT

C

THIS SUBROUTINE IS ONLY CALLED WHEN 'SIGN' IS NON-ZERO

INDICATING THAT THE BLOCK OF SIZES IN ANY MACHINE IS EXPECTED TO FLUCTUATE. THIS MAY MEAN A MACHINE WHICH ORIGINALLY HAD SMALL SIZES NOW CONTAINS LARGE ONES LIKE A SECOND MACHINE

TO REDUCE PROBLEMS A MINIMUM SEPARATION OF THE SIZE RANGES FOR EACH MACHINE IS ENFORCED.

MINSEP=15*SPREAD

IF (MINSEP.LT.5) MINSEP=5

MAX=0

DO 50 NUM=1, MAXSIZE, MCSMTHICOLOUR

MAX=MAX+MAXSIZE(MACH)

10 DO 20 NUM=1, MAXDSEXES, MACH

MACH=MACHOF(MACH)

IDUM=MAX-MAXOLD

IF (IDUM.GT.5) 0, 20

MACHOF(MACH)=MACHOF(MACH-1)

CHANGE THE ORDER OF THE TWO MACHINES

MACHOF(MACH-1)=MACH

GU TO 10

20 IF (IDUM.GE.MINSEP) GU TO 50

MAX=MAXDSEXES(MAXDSEXES(MACH)-MAXOLD + MINSEP

50 CONTINUE

C

SEARCH FOR THE SIZE WITH LOWEST STUCK COVER

IF AN END SIZE - MOVE THE AVERAGE SIZES FOR EACH MACHINE TOWARDS THAT END SIZE

IF A CENTRAL SIZE - DO NOT ALTER THE AVERAGE SIZES TO PREVENT UNDUE FLUCTUATIONS, AND TO ALLOW A MEANABLE PERIOD BETWEEN MAKING EXTREME SIZES, THERE IS SOME INERTIA AGAINST ALTERING THE TREND

C

DO 70 1=1,3

190 COVERK(1)=HAFMNILLION

DU 200 SIZE=KSIZE, MAXSIZE

COVER=COVERS(SIZE)

IF (COVER.LT.COVERS(2)) COVER=COVERS(2)

IF (SIZE.GT.HALF+MAXDSEXES(MACHINE(1))) 0, 130

IF (COVER.LT.COVERS(1)) COVER=COVERS(1)

130 IF (SIZE-GAFMNILLION) COVER=COVERS(1)

IF (COVER.LT.COVERS(3)) COVER=COVERS(3)

COVER=(2+SIGN)=COVER=COVERS(2+SIGN) = MAXSIZE*HALF+INCREASE

I=1

C

8 24
IF (CUEH11.GT.CUEH12) GO TO 500
IF (CUEH1(1).GT.CUEH1(2)) GO TO 500

THE CHANGE IN AVERAGE SIZES IS 'INCREASE', THIS DEPENDS ON LAD.
THE AVERAGE TIME BETWEEN REMAKING ANY SIZE1. (SEE SETUP)

300 SIGN=1-2
ON 350 MUD=1,MCST1+SCOL1
MACH = FACHINUSE(NUM)
MAXDIFFSIZE(MACH) = MAXDIFFSIZE(MACH) + 1
SIGN*INCREASE1 (MCST1+SCOL1+1)

350 CONTINUE
500 RETURN
END

END OF SEGMENT, LENGTH 33V, NAME REARRANGE
APPENDIX 9   THE SCHEDULE PRINTOUT

The accompanying diagram shows one page of the computer print-out of a mould schedule, greatly reduced in size.

Each page states the machine type and number and the name of the manufacturing group being produced on the machine. Across the page are details for up to 12 weeks (later weeks continue on the next page). Down the page is a list of the moulds to be used and the brands to be manufactured in each week.

Terminology

X    One mould to be used in this week
XX   Two moulds to be used in this week
H    One mould to be used for half this week
.    No moulds to be used this week
*    Another manufacturing group is being produced this week (see separate page)
++   Gap in the weeks due to holidays
<table>
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<th>08/09</th>
<th>09/09</th>
<th>10/09</th>
<th>11/09</th>
<th>12/09</th>
<th>13/10</th>
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<td>J 11</td>
<td>6294 B.S.C.</td>
<td>X</td>
<td>X</td>
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<tr>
<td>J 12</td>
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<tr>
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<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>J 2</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>W 5</td>
<td>6259 Dktp Bk1</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Machine Type No.** 609-2 **Manufacturing Group: Bright and Dull Wellingtons**